HYDROCHEMISTRY AND PLANKTON DYNAMICS OF EUTROPHIC TROPICAL LAGOON

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Abstract: The hydrochemistry and plankton dynamics of the Ologe lagoon was investigated between February, 2002 and January, 2004. Whereas the lagoon remained freshwater (S‰ < 0.5%o) and acidic to alkaline conditions (pH 5.8-8.1), all through the sampling period, the dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) values (0-28mg/l) indicated stress. Although nutrient levels at the lagoon were high (NO_3-N >1.02mg/L; PO_4-P < 1.5mg/L), heavy metal values were low (Fe < 0.99 mg/L, Cu < 0.06 mg/L, Zinc < 0.03). The occurrence of *Melosira granulata, Nitzschia palea, Cyclotella meneghiniana, Gomphonema parvulum, Pinnularia major , P. ambigua* (diatoms), *Euglena viridis, Lepocinclis sp, Phacus accuminatus* (euglenoids), *Microcystis aeruginosa, M. flos-aquae* (cyanobacteria), *Brachionus angularis, B. calicyflous, B. urceolaris* (rotifers) in high numbers may highlight pollution stress in the lagoon. The proliferation of the cyanophyta and other plankton species encountered were controlled by the nutrient level. The physico-chemical characteristics, Margalef, Shannon and Wiener and *Equitability indices* indicated pollutions stress and dominance by a few species. [Nature and Science 2010;8(9):140-149]. (ISSN: 1545-0740).

Keywords: hydrochemistry; plankton dynamics; Ologe; physico-chemical characteristics

1. INTRODUCTION

According to Kjerfve (1994), a coastal lagoon is an inland body of water, usually oriented parallel to the coast, separated from the ocean by a barrier, connected to the ocean by one or more restricted inlets, and having depths which seldom exceed a couple of meters. Lagoons vary in size and shape in relation to geomorphology and are known to experience forcing from river input, tides, precipitation, wind stress, evaporation and surface heat balance and they respond differently to these forcing functions (Kirk and Lauder, 2000; Suzuki *et a*l., 2002; Nwankwo, 2004 b).

According to Lawson and John (1982), lagoons can be classified as open, closed and semi-closed depending on whether they retain a permanent connection to the sea, an annual or less frequent connection, or an artificially restricted and hence intermittently closed connection to the sea. Lagoons are important in water transportation, energy generation, exploitation and exploration of some mineral resources including sand, provide natural food resources rich in protein, fish and fisheries farming sites as well as sites for the disposal of both domestic and industrial wastes (FAO, 1969; Kirk and Lauder, 2000; Onyema *at al*., 2003, 2007; Chukwu and Nwankwo, 2004).

Algae are thallophytes (plants lacking roots, stems and leaves), which have chlorophyll as their primary photosynthetic pigment and which lack a sterile covering of cells around the reproductive cells (Smith, 1950; Bold, 1957; Lee, 1999; Nwankwo, 2004a). Algae are primary producers in many habitats and have been described as the "grass of many waters" (Bold, 1957; Lee, 1999; Nwankwo, 2004a). Phytoplankton is free floating and mostly microscopic plants that contain chlorophyll and grow by photosynthesis and lack roots, stems (non-vascular) and leaves (Lee, 1999; Nwankwo, 2004a).

They absorb nutrients (carbon dioxide, nitrates, ammonium, phosphate and other nutrient forms and micronutrients) from the water or sediments, add oxygen to the water as by-products and are usually the major source of organic matter at the base of the food web in aquatic environment (Smith, 1950; Lawson and John, 1987; Lee, 1999). Chlorophyll a concentrations are an indicator of phytoplankton abundance and biomass in the aquatic environment (Smith, 1950; Lee, 1999; Suzuki *et al*., 2002).

Over the years, ecological studies have shown that there is a good relationship between water quality or environmental characteristics and plankton community structure (Palmer, 1969; Odiete, 1999; Onyema and Nwankwo, 2006). Similarly, (Dakshini and Soni, 1982; Nwankwo and Akinsoji, 1988; Nwankwo and Onitiri, 1992; Nwankwo *et al*., 1994 and Chindah *et al*., 1993, Nwankwo, 2004) indicated that plankton and have been diagnostic in assessing water quality and hydrological status.

Early plankton based research work carried out in south-western Nigeria include those of Fox (1957), Hendey (1958) and Olaniyan (1957, 1969) for the Lagos habour. Others include those of Akpata *et al.*, 1993; Nwankwo and Onitiri (1992) and Nwankwo (1998a) for the Epe lagoon and Nwankwo 1984, 1986, 1988, 1990a, 1990b, 1991a, 1993, 1996a, 1997, 1998a,b, 2000. More recently, are Nwankwo *et al.*, 2003a,b; Nwankwo *et al.*, 2004 for the Light house beach and Nwankwo and Onyema (2004) for off the Lagos coast, Onyema *et al*, 2003, 2007; for the Lagos lagoon, Onyema(2008) for Iyagbe Lagoon and Adesalu(2008) Lekki lagoon.

According to Odiete, 1999; Chukwu, 2002; Nwankwo, 2004; increasing urbanization and industrialization in the coastal zone of Nigeria, have increased anthropogenic stressors which eventually impacts negatively on the aquatic environment. There is need therefore, for a good understanding of the nature, dynamics and history of our coastal lagoons as they possess innumerable scientific, ecological and economic implications both now and for the future (Lawson and John, 1982, 1987)

There are no previous in-depth biological investigations of the Ologe lagoon system, its hydrological regimes, characteristics and plankton dynamics. Unfortunately, this sensitivity environment serves as a sink for surrounding facilities, especially Agbara industrial effluents and is gradually being transformed from a physically controlled to a biologically controlled environment. Hence there is a need to investigate the plankton diversity and biomass distribution of the lagoon and relate the observed changes to environmental factors.

2 Materials and Methods

2.1 Description of study site

The coastal water of south-western Nigeria lies within the rainforest belt that experiences a bimodal rainfall pattern that is concentrated into one season (May – October) and a dry season that spans between November and April. The tidal regime is semi-diurnal with tidal heights that decrease inland. The Ologe lagoon (Fig. 1) transverses Lagos state and Ogun states, in Nigeria and is one of the nine lagoons in South-western Nigeria (Webb, 1958a; Nwankwo, 2004b). It is located between Latitude 6^0 27’N, Longitude 3^0 01’E and Latitude 6^0 30’N, Longitude 3^0 06’ E at the distal end of Badagry creek (Webb, 1958a).

It is presumably the smallest lagoons in south-western Nigeria with a surface area of 9.4Km2**.** The major sources of water are River Owo, Ore, and Oponu in Ogun State (Akanni, 1992; Odewunmi, 1995). The entire area of the lagoon is riparined by swamp rainforest dominated by raphia palms except confluence points with Badagry creek where few mangroves are prominent. The effluents and organic wastes from Agbara industrial and residential estates are discharged all year round into the lagoon**.**

The main body of the lagoon lies within Badagry Local Government Area and it opens up to the Atlantic ocean via the Lagos Harbour and Dahomey in the Republic of Benin. The major source of water are River Owo with a source in a town called Toto Owo where River Ore and Illo form a confluent with River Oponu in Ogun State created within the lagoon. Water samples for physico-chemical analysis were collected 0.50m below the water surface in four litre plastic containers, properly labeled and stored in ice chests in the field. In the laboratory, the water samples were transferred into refrigerator (t = 4 ^oC) and analyzed within 24 h of collection. Water samples for biochemical oxygen demand (BOD_5) were collected in 200 ml light and dark bottles.

Plankton samples were collected using a 55 µm mesh size standard plankton net tied unto a motorized boat and towed horizontally at low speed (< 4 knots) for 10 min. The concentrated samples were stored in 200 ml well labeled containers with screw caps and preserved in 4% unbuffered formalin.

2.2 Physical and chemical parameters

The surface water temperature was measured with an ordinary mercury thermometer to the nearest ^oC and transparency estimated with a 20 cm diameter white and black painted Secchi disc. Total suspended solids (TSS) were determined by evaporating 100ml aliquot of the sample, while total dissolved solids (TDS) were determined by evaporating 100 ml of the filtrate in preweighed evaporating dish at 100 ^oC. Conductivity of the surface water was measured with a conductivity meter (model H18733) and salinity determined with a refractometer (model S100). Dissolved oxygen (DO) was measured with a Griffin oxygen meter (model 40) and the five-day BOD_5 determined according to the method described in A.P.H.A (1985). The pH was determined using a Griffin digital pH meter (model 80), while nitrate-nitrogen and phosphate-phosphorus were determined by the phenol-disulphuric acid and molybdenum blue methods respectively. The concentration of copper, iron and lead were determined using an atomic absorption spectrophotometer (A.A.S Unicam 99 model).

2.3 Biological parameters

Plankton analysis was done using the microtransect drop count method described by drop count method described by Lackey (1938). For each aliquot sample, five drops were thoroughly investigated under an M II Wild binocular microscope with a calibrated eye piece. For each drop, at least five transects were investigated and the organisms identified recorded as number per ml. Three indices were used to obtain the estimate of species diversity. The species richness were estimated according to Margalef (1951), $d = (S - 1)/\text{In } N$. The Shannon and Wiener's (1949) diversity index ($H = -\sum Pi \text{ In } Pi \approx -(1/\text{In } 2) \sum Ni/N \text{ In } Ni/N$) and Pielon's (1966) evenness index ($J = E = H/H_{max} = H/\text{In } S = H \text{ In } 2/\text{In } S$) were calculated.

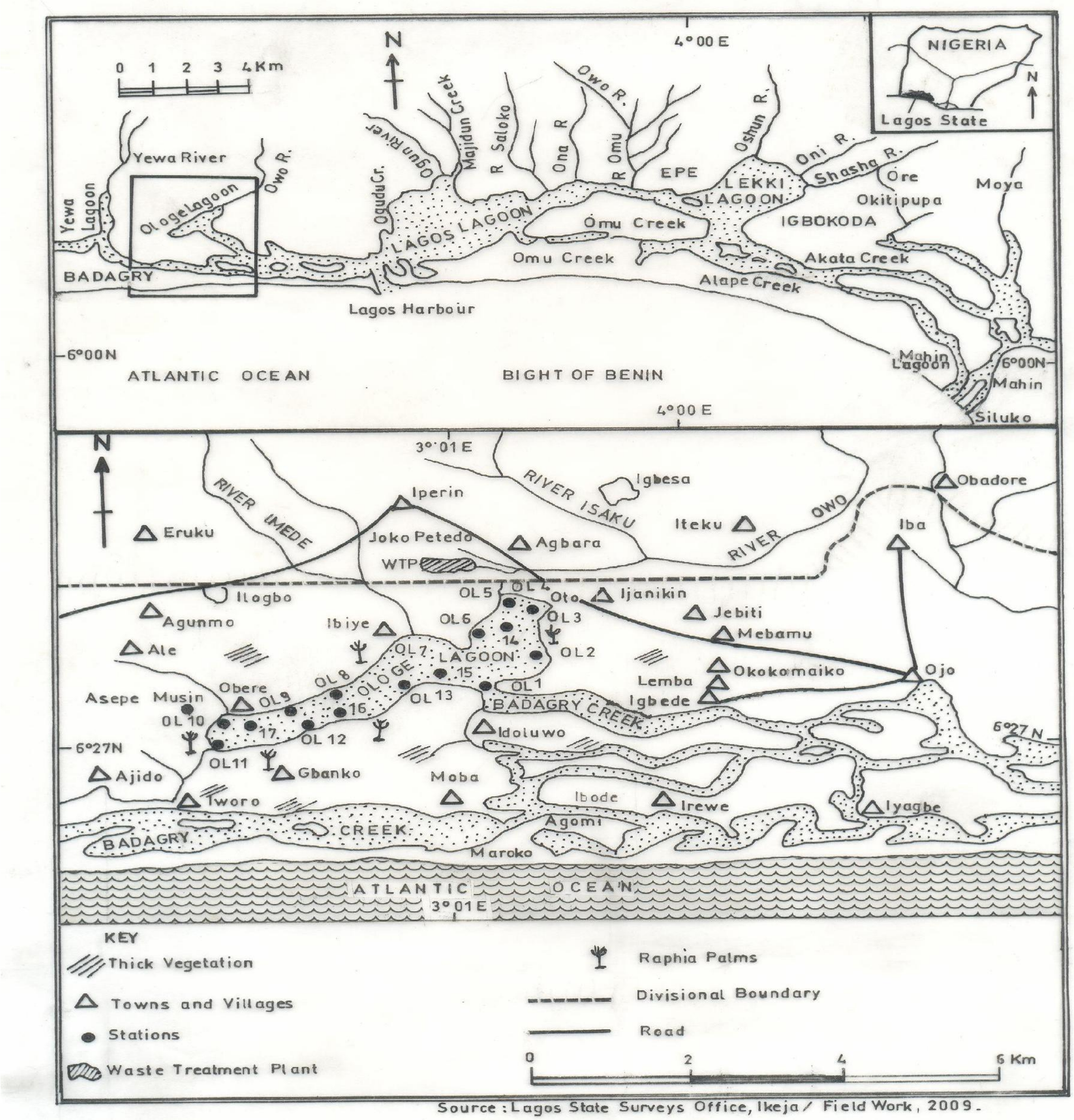

Fig. 1: Parts of Ologe lagoon Showing Sampling Stations

3.0 Results

The minimum and maximum values obtained for the estimates of environmental factors, their means and standard deviation are presents in Table 1. Also in Table 1 is whether each parameter recorded higher values in the wet or dry season for the two (2) years of study. Fig. 2 showed seasonal variations in some environmental factors among stations at the Ologe lagoon from Feb., 2002 to Jan., 2004.

Air temperature values ranged between 27°C to 33.5°C among all the sampled stations within the study period. The highest air temperature (33.5°C) was recorded at station OL1 (Idolowu) in March 2002, while the lowest was recorded at station OL14 (center of lagoon between Otto-Ijaniki and OL6) in August the same year. The lowest surface water temperature estimated was 25.2°C (August, 2002), the highest value obtained was 31.8°C (March, 2002. The highest transparency value (76cm) was recorded at station OL8 (between Ibiye and Obele) in March 2002, while the lowest values (24cm) was recorded at stations OL16 and OLI0 (Asepe Mushin) in the months of August and September 2003. Total dissolved solids ranged between 48 to 294mg/l, with the lowest value recorded in station OL5 (confluence between Owo River and Ologe lagoon) in September 2003. The highest total dissolved solids value (294mg/l) value was recorded at station OL1 (Idolowu) in March 2002. Total suspended solids valued ranged between 10 to 378mg/l,10 (OL3-Otto jetty in March 2003) and 378mg/l (OL10-Asepe Mushin in September 2003). Rainfall volumes showed both monthly changes and varied from one year to the next. In the first year the highest rainfall volume was recorded: highest rainfall volume (372.1mm) was recorded in June 2002 and the lowest rainfall volume (41mm) was in February 2002 . In the second year the highest rainfall as in highest rainfall volume (383mm) was recorded in July 2004 and the least (0.6mm) was in December 2003.

Hydrogen ion concentration (pH) values ranged between 5.8 (station OL4-Owo River point effluent discharge in the month of July 2002) to 8.16 (station OL11 in the month of March 2002). throughout the sampling period. Whereas the lowest conductivity estimated was 83µS/cm and recorded in OL5 (confluence between Owo River and ologe lagoon) in September 2003, the highest value obtained was621µS/cm recorded in station OL11 (Gbanko) in March 2002.

Salinity values ranged between 0.00 (station OL4 (point of effluent discharge), and 0.5 $\%_o$ (at station OL11 (Gbanko) in March, 2002). Alkalinity values were between 42 (station OL4 -Owo river- point of effluent discharge in September 2003) to 162mg/l (station OL1 (Idolowu) in April 2002) .

Dissolved Oxygen values ranged between 7 (station OL6 in March 2003) to 12.7mg/l (station OL14 - centre of Ologe lagoon between Otto-Ijaniki and OL6 in the month of June 2002). Biological Oxygen Demand values ranged between 3 (stations OL12 (Ajido) and OL13 (between Ajido and Idolowu) in September and October 2003 respectively) to 28mg/l (station OL3 (Otto jetty) in April 2002). Nitrate-nitrogen values were between (0.01 station OL4 (Owo river- point of effluent discharge) in January 2003) to 1.02mg/l (station OL3 (Otto jetty) in June 2003). Phosphate-phosphorus recorded between 0.03 (station OL17 in the month of March 2002) to 1.79mg/l (station OL10 in the month of June 2003). Silica values fell between 2.05 (station OL15 (between Ibiye and Idolowu) in March 2002) and 9.54mg/l (OL11 (Gbanko) in the month of May 2003). Calcium levels were between 34mg/l (station OL6 and OL8 (between Ibiye and Obele) in September and October, 2003 respectively) to 228mg/l (station OL1 (Idolowu) in April 2002). Magnesium estimates were between 10(at station OL8 (between Ibiye and Obele) in September 2003) and 76mg/l(station OL1 (Idolowu) in the month of April 2002). Copper values was between 23.1(station OL8 (between Ibiye and Obele) in July 2003) to 56.9µg/l(station OL11 (Gbanko) in the month of March 2002).Iron levels ranged between106(station OL17 in the month of September 2002) and 987µg/l(station OL4 (point of effluent discharge) in the month of March 2002) Zinc values ranged between 2.62 station OL7 (Ibiye) in August 2003) and 30.88µg/l(station OL4 (Owo river end receiving effluent) in the month of March 2002).

Table 1: A summary of the minimum, maximum and mean estimated values for environmental factors from the Ologe lagoon (February, 2002 – January, 2004).

	Parameter/ Unit	Minimum value	Maximum value	Mean value ± S.D.	Higher values reported in t In the---
1	Air temperature (oC)	27	34	31.10 ± 0.22	Dry season
2	Water temperature (oC)	25.2	31.8	29.01 ± 0.47	Dry season
3	Transparency (cm)	24	76	51.54 ± 5.65	Dry season
4	Depth (m)	3.2	7	4.4	Wet season
5	Total Dissolved Solids (mgl-1)	48	294	139.23 ± 17.89	Dry season
6	Total Suspended Solids (mgl-1)	7	378	184.36 ± 14.90	Wet season
7	Rainfall (mm)	0.6	383	137.37	Wet season
8	Total hardness (mgl-1)	62	342	146.38 ± 26.52	Dry season
9	pH	5.8	8.1	6.92 ± 0.14	Dry season

10	Conductivity (µS/cm)	83	621	256.59 ± 36.65	Dry season
11	Salinity (‰)	0.0	0.5	0.10 ± 0.03	Dry season
12	Alkalinity (mgl-1)	42	162	100.20 ± 9.37	Dry season
13	Dissolved oxygen (mgl-1)	7	12.7	9.08 ± 0.42	Wet season
14	Biological oxygen demand (mgl-1)	0	28	13.11 ± 1.79	Dry season
15	Chemical oxygen demand (mgl-1)	6	39	21.34 ± 2.52	Dry season
16	Nitrate – nitrogen (mgl-1)	0.02	1.02	0.44 ± 0.08	Wet season
17	Phosphate – phosphorus (mgl-1)	0.03	1.79	0.80 ± 0.10	Wet season
18	Silica (mgl-1)	2.05	9.54	5.07 ± 0.45	Wet season
19	Sodium (mgl-1)	2.6	22.7	30.82 ± 6.13	Dry season
20	Potassium (mgl-1)	0.1	7.6	8.71 ± 1.78	Dry season
21	Calcium (mgl-1)	34	227	91.27 ± 17.89	Dry season
22	Magnesium (mgl-1)	0.01	7.6	2.64 ± 0.62	Dry season
23	Copper (mgl-1)	0.02	0.06	0.03 ± 0.001	Dry season
24	Iron (mgl-1)	0.12	0.99	0.35 ± 0.04	Dry season
25	Zinc (mgl-1)	0.002	0.03	0.01 ± 0.001	Dry season
26	Chromium (mgl-1)	0.001	0.04	0.02 ± 0.002	Dry season
27	Chlorophyll – a (µg/L)	0.1	64.5	16.99 ± 7.83	Dry season

The Plankton Flora of the Ologe Lagoon

Five major algal groups were represented in the micro-flora of sampled areas of the Ologe lagoon. These were the Bacillariophyceae, Cyanophyceae, Euglenophyceae, Chlorophyceae, and Dinophyceae. A total of 119 species from 49 genera were recorded. Diatoms were the most abundant group making up a total of forty-eight species belonging to eighteen genera. This was followed by green algae, with thirty-two species from fourteen genera, Cyanobacteria, with twenty-three species from eleven genera, euglenoids with seventeen species from five genera, while the dinoflagelates had one species. The inter and intra-annual variations in phytoplankton assemblages was dominated by diatom species. There were more prevalence of pennate diatoms and green algae during the wet season than the dry season, while the euglenoids were more prevalent during the dry season. The more dominant phytoplankton taxa included *Melosira granulata* and its varieties and forms, *Cyclotella meneghiniana, Nitzschia palea, Gomphonema parvulum, Pinnularia major , P. ambigua* (diatoms) (diatoms), *Chlorococcum humicolum, Scenedesmus obliquus, S. quadricauda, Coelastrum microsporum* (green algae), *Euglena viridis, , Lepocinclis sp, Phacus accuminatus* (euglenoid), *Microcystis aeruginosa, M. flos-aquae, M. wesenbergii* (blue-green algae).Table 2 shows a checklist of Ologe lagoon phytoplankton species and their classification. Species that are first reports for South-western Nigeria with regard to existing checklists (Nwankwo, 1988; Nwankwo *et al.*, 2003a, b; Nwankwo and Onyema, 2004; Wujek *et al.*, 2004) are preceeded by an asterick on the list .

Six major phyla groups were represented in the micro-faunal of sampled areas of the Ologe lagoon(table 3). These are the Arthropoda, Rotifer, Mollusca, Nematoda, Chordata and Annelida. The dominant zooplankton forms included Arthropoda- Cyclops sp, Eucyclop sp, Eurytemora sp, Evadne sp and Copepod nauplius, while rotifers are – Branchionus sp and Keratella sp. Both Margalef's species richness (*d*), Shannon and Wiener's diversity index and equitability index of phytoplankton species were higher in the dry months than in the wet months .Among the zooplankton, similar observations were also observed among the diversity indices.

Table (2): A checklist of phytoplankton species of the Ologe lagoon

DIVISION: BACILLARIOPHYTA

CLASS: BACILLARIOPHYCEAE

ORDER 1:CENTRALES

Aulacoseira granulata (Ehr.) Sim.

A. granulata var.*angustissima* (O.F.Mullar) Sim.

**A. granulata* var.*angustissima f.spiralis* Hust.

**A. granulata* var.*angustissima f.curvata* (Hust.) Sim.

A. granulata var.*muzzaensis* (Meist.) Hust

**A. islandica* (O. Muller)

Stephanocyclus sp

Cyclotella meneghiniana (Kutzing)

C.striata (Kutz.) Grunow

C.stelligera Cleve ex Grunow

Coscinodiscus centralis Ehrenberg

C. eccentricus Ehrenberg

Melosira varians Agargh

Actinoptychus sp

N.vermicularis Hantzsch

Pinnularia major (Kutz.) Cleve

P. interrupta W.M.Smith

P.laevis (Ehr.) Compere

P.hemiptera (Kutz.) Rabenh.

P.ambigua Cleve

Pinnularia sp

Navicula oblonga Ehrenberg

N. radiosa Kutzing

N. gracilis Ehrenberg

N. mutica Kutzing

N. cuspidata Meist

Cocconeis placentula (Ehr.) Cleve

C. Disculum (Schum) Cleve

**Epithemia sp*

Cymbella affinis Kutzing

C. minuta Hisle ex.Rabenh

Eunotia gracilis Meister

E.lunaris (Ehr.) Grunow

E.monodon Ehrenberg

Surirella elegans Ehrenberg

S. ovata Kutzing

Fragilaria construens Ehrenberg

**Gomphonema parvulum* Kutzing

DIVISION: CHLOROPHYTA
CLASS: CHLOROPHYCEAE
ORDER I: CHLOROCOCCALES

Pediastrum simplex (Meyer) Lemm

P. simplex var.echinulatum (Wittr.) Lemm

P. duplex Meyer

P. duplex var.gracillimum (W. West) Thinmark

P. tetras (Ehr.) Ralfs

P. tetras var. tetraodon (Corda) Rabenhorst

*P. boyanum (*Turpin) Meneghini

Scenedesmus acuminatus (Lagerh.) Chordat

S. quadriacuada (Turp.) Breb

**S. dimorphus* (Turp.) Kutzing

S. apiculatus (W.et G.S.West) Chordat

S. arcuatus Lemm.

Ankistrodesmus acicularis (A.Braun) Korsh.

A. falcatus (Corda) Ralfs.

Tetraedron sp

ORDER II:VOVOLVOCALES

Volvox aureus Ehrenberg

Biddulphia laevis Ehrenberg

ORDER 11: PENNALES

Synedra ulna (Nitzschia) Ehr

S.acus Kutzing

Nitzschia palea (Kutz) W.M.Smith

N. closterium (Ehr.) W.M.Smith

N. acicularis (Kutz.) W.M.Smith

V. africana Ehrenberg

Eudorina elegans Ehrenberg

ORDER III: ZEGNEMATALES

Staurastrum leptocladium Nordst

Staurastrum paradoxum Meyen

Staurastrum sp

Desmidium swartzii Ag

Micrasterias sp

Spirogyra africana (Fritsch) Czurda

Zygnema sp

Closterium ehrenbergii Menegh

C. aciculare T.West

C. kuetzingii Breb.

C. intermidium Ralfs

Spondylosum sp

Cosmarium sp

DIVISION: EUGLENOPHYTA
CLASS: EUGLENOPHYCEAE
ORDER: EUGLENALES

Euglena acus Ehrenberg

E. caudat Hubner

E. convoluta Korishikor

E. viridis

E. polymorpha Dangeard

Euglena spirogyra Ehrenberg

Lepocinolis sp

Phacus accuminatus Stokes

P. longicauda Duj.

P. orbicularis Hubner

P. curvicauda Swir

P. tortus (Lemm) Skvort

Trachelomonas caudata stein

T. hispida Lemm

T. armata (Ehr.) Stein

T. acanthostoma (St) Deft

Eutreptia sp

DIVISION: CYANOPHYTA
CLASS: CYANOPHYCEAE
ORDER I: CHROOCOCCALES

Microcystis aeruginosa Kutzing

M. flos-aquae Kirchn.

M.wesenbergii Komark

Merismopedia glauca Ehr. Nag.
Gloeocapsa decortisans

ORDER II: HORMOGONALES
Spirulina major Kutzing
S. princeps W.et G.S.West
S. platenensis Geitler
Spirulina jenneri Geitler
Aphanocapsa sp
Aphanothece sp
Anabaenopsis sp
Anabaea spiroides Klebahn
A. flos-aquae Elenkin
Lyngbya contorta Lemm.
L. circumcreta
L. limnetica Lemm
**Oscillatoria formosa* Bory
O. limnetica Lemm.
O. nigro-viridis Thwaites
Nostoc sphaerica Vaucher
* *N. linckia* Bornet et Thuret
* *N. caeruleum* Lyngbye

DIVISION:DINOPHYTA
CLASS:DINOPHYCEAE
ORDER:PERIDANALES
Peridinium cintum

Table 3. A checklist of zooplankton at the **Ologe lagoon** during the period of **(February, 2002 – January, 2004).**

Phylum/Division	Group/Class	Family	Species
Nematoda	--------	----------	Nematode larvae
Arthropoda/Crustacea	Cladocera	---------	Moina sp
		Bosminidae	Bosmina longirostris
		Holopedidae	Latonopsis occidentalis
		Polyphemidae	Evadne spinifera
			Evadne tergestina
			Polyphemus sp
	Copepoda	----------	Copepod nauplius
		----------	Onchocamptus sp
		---------	Harpicticus sp
		Acartidae	Acartia sp
		Calanidae	Limnocalanus sp
			Sinocalanus dorrii
		Cyclopidae	Cyclopina longicornis
			Cyclops strenuus
			Cyclops varicans
			Cyclops vicinus
			Eucyclops agilis
			Eucyclops bicolor
			Eucyclops serrutalus
			Eucyclops varicans
			Macrocyclops distintus
			Mesocyclops sp
			Microcyclops sp
		Diaptomidae	Diaptomus forbesi
			Diaptomus wardi
			Diaptomus wilsonae
		Oithonidae	Limnoithona sinensis
		Temoridae	Eurytemora affinis
			Eurytemora lacustris
			Eurytemora lacustris
			Temora sp

Mollusca	Gastropoda	----------	Gastropod larvae
Rotifer	Monogononta	---------	Monostyla lunaris
		Branchionidae	Branchionus angularis
			Branchionus falcutus
			Branchionus sp
			Keratella quadrata
			Keratella sp
			Keratella valga
Chordata	Pisces	--------	Fish larvae
Annelida	Polychaeta	---------	Polychaete larvae

Table 4. Phytoplankton community structure indices during the period of February, 2002 – January, 2003).

Indices	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sept-02	Oct-02	Nov-02	Dec-02	Jan-03
Species richness index (d)	1.49	1.23	1.54	1.54	1.50	1.48	1.43	1.35	1.28	1.33	1.40	1.46
Shannon-Wiener's Index (Hs)	0.67	0.45	0.53	0.50	0.44	0.42	0.49	0.42	0.34	0.39	0.45	0.55
Equitability (j)	0.58	0.40	0.53	0.50	0.44	0.42	0.40	0.34	0.34	0.39	0.42	0.55

Table 5. Zooplankton community structure indices during the period of **February, 2002 – January, 2003).**

Indices	**Feb-02**	**Mar-02**	**Apr-02**	**May-02**	**Jun-02**	**Jul-02**	**Aug-02**	**Sept-02**	**Oct-02**	**Nov-02**	**Dec-02**	**Jan-03**
Species richness index (d)	0.45	0.96	0.97	1.72	1.33	1.43	1.24	0.89	0.51	0.58	0.62	0.67
Shannon-Wiener's Index (Hs)	1.35	1.36	1.40	1.44	1.80	1.86	1.21	1.06	1.17	1.21	1.25	1.32
Equitability (j)	0.52	0.52	0.54	0.60	0.52	0.48	0.45	0.48	0.44	0.50	0.54	0.50

4. Discussion

The modification of the areas around the Ologe lagoon, mainly by way of discharge of effluents may have created eutrophic conditions experienced in the lagoon. According to Nwankwo (1996a), environmental modification creates new environments and in some cases nutrient traps that may induce blooms. The pH of the Ologe lagoon falls within the values recorded for some Nigerian water bodies. For instance, in Kainji lake, 6.3 – 8.4 was recorded by Adeniyi (1978); 5.78 ± 0.83 for Oguta lake Nwadiaro and Umenam (1985), 5.1 – 6.3 for Nworie stream(King and Nkata, 1991). A range of 6.0 – 7.5 was reported by Visser and Villenueve

(1975) for West African waters. pH values of the lagoon were essentially slightly alkaline for a good part of the study. Values lower than 7.0 were observed only seldomly in the wet season and at stations closer to Owo River. Chinda and Braide (2003) also recorded alkaline pH for studies in the lower Bonny River.

The low transparency may be connected to the high algal cell counts recorded in the lagoon as well as to biodegradation waste disposed into the lagoon. According to Nwankwo (1996b) seasonal variation in transparency in the coastal water of south-western Nigeria is linked to the rainfall pattern and associated floods from adjoining rivers. Low DO and high BOD_5 values recorded in the lagoon all through the sampling period may be due to sewage and other biodegradable waste effect on oxygen consumption during organic matter decomposition. Similar observation was reported by Saad and Antione (1983) in the Ashar canal Iraq. The relatively lower DO values and higher BOD_5 in the dry months may be due to elevation of water temperature in the dry season and increased the rate of bacterial decomposition of organic matter in a small man-made West African lake.

Hynes (1960) reported that BOD_5 values between 1 mg/L – 2 mg/L or less represent clean water 4 mg/L – 7 mg/L represent slightly polluted water and more than 8 mg/L represent severe pollution. Based on the above criteria, the Ologe lagoon is severely polluted. However according to Odiete *et al* (2003), chemical measurements reflects water quality at a given time while biological assessment reflects conditions that have exited in a given environment over a long period of time.

The total phytoplankton population in the lagoon was lower in the wet months possibly due to the dilution effect of storm water which diluted ion concentration in water and modified the water chemistry. The occurrence of such species as *Nitzschia palea, Gomphonema parvulum, Microcystis aeruginosa, M. flos-aquae, M. wesenbergii* (blue-green algae), *Scenedesmus obliquus, S. quadricanda* (green algae), and *Euglena sp*(Euglenoids) may be an indication of the level of pollution of the lagoon. It is possible that wastes from surrounding areas may be a major pollution problem particularly in turning the site into a nutrient trap and in prompting the excessive algal growth experienced.

Cholnory (1968) reported that *N. palea* and *C. meneghiniana* are nitrogen heterotrophs and that *N. palea* is a very good indicator of pollution. The observed high level of nutrients and the low heavy metal levels in the lagoon may in part have contributed to the predominance of ***M. aeruginosa*** and ***M. flos-aquae(***Gerloff ***et al.*** 1952). Furthermore, the prevalence of euglenoids notably ***E. viridis, E. oxyuris, Lepocinclis texta*** and ***P. pyrum*** may be a further indication of organic contamination. The frequency of rotifers alongside other organisms could be an additional pointer to the level of contamination.

From the data presented in this paper, there is no doubt that the Ologe lagoon is under pollution stress and needs restoration.

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