Journal of Biological Sciences and Bioconservation *Volume 2, September 2010*

SPECIES COMPOSITION AND DISTRIBUTION OF ZOOPLANKTON SPECIES IN SELECTED PARTS OF THE LAGOS LAGOON, NIGERIA

Ajani G.E.
Nigerian Institute for Oceanography and Marine Research
3, Wilmot Point, Bar beach, Victoria Island, Lagos.

ABSTRACT

Species composition, spatial distribution, abundance and diversity of zooplankton in some selected parts of the Lagos lagoon were investigated for seven months (March – September 2010), twelve stations on the lagoon were selected for this study. A total of twenty zooplankton species with seventeen genera forms were recorded for the study. Three phyla were identified; the phylum Crustacea, followed by Chaetognatha (arrow worms) and Rotifera (rotifers). Copepoda was the most abundant with three suborder forms which are calanoida, cyclopoida and harpaticoda. However, selected stations such as Queen's drive, Park view, Moba, Ofin, Ibese, Ikorodu port and Majidun showed significant variation ($p < 0.05$) in occurrence of copepods between sampling stations, while stations such as Ikate, Itedo, Oreta, Ofin and Nichem textile) showed no significant ($p > 0.05$) variation in occurrence of copepods between stations. Changes in zooplankton species in terms of occurrence and abundance at certain sampling stations of higher proximity to municipal and industrial effluent is indicative of anthropogenic perturbations.

Key Words: Zooplankton, anthropogenic, lagoon, municipal, industrial, spatial distribution

INTRODUCTION

The South-western Nigeria has an assembly of lagoons which receive a number of large rivers and creeks. The seasonal distribution of rainfall, causes the Lagos lagoon to experience seasonal flooding which introduces a lot of detritus, nutrients and dilute the water considerably [1] however it is open and tidal. It has a surface area of 208km^2, with an average depth of 1.5m is a shallow micro-tidal environment [2, 3].

Zooplanktons occupy an important trophic niche in the aquatic ecosystem, as they constitute the most links in energy transfer between phytoplankton and higher aquatic fauna [4]. These organisms have been use as biological indicators to monitor environmental perturbations [5]. Investigations of anthropogenic wastes and environmental modifications in the Lagos lagoon have revealed increased levels of pollution stress [6, 7, 8, 9].

An important ecological ramification of increasing population pressure, poor sewerage system, industrialization and poor waste management in Nigerian's coastal area is that pollutants freely find their way unabated into our coastal waters through drains, canals, rivers, creeks and lagoons that act as conduits [10]. Apart from enriching the water with high amounts of biodegradable matter, these discharges introduces nutrients, toxic and other land based substances that may consequently signal epidemiological problems and an increase in human induced stressors which impairs aquatic biodiversity [11]. Information dealing with the biodiversity of zooplankton species as it relate to anthropogenic activities along the Lagos lagoon, is quite limited. This data will also be useful for pollution management and environmental biomonitoring due to changes in the physicochemical characteristics of the lagoon and the establishment of more industries within the city metropolis.

METHODOLOGY

The Study Area

The Lagos lagoon (Fig 1) is located in Lagos state, Nigeria and is one of the nine lagoons in South-western Nigeria [12, 13]. It is an open, shallow and tidal lagoon, with a surface area of 208km^2 [2]. The study areas were delineated into twelve sampling stations, located progressively over a salinity gradient, ranging from freshwater with less than $0.5^0/_{00}$ at the northern part of the lagoon through brackish water with about $12^0/_{00}$ (mid Lagoon) to marine environment at the southern part up to $21^0/_{00}$ (ikoyi). Monthly samples were collected from twelve stations over a period of seven months (March – September 2010).

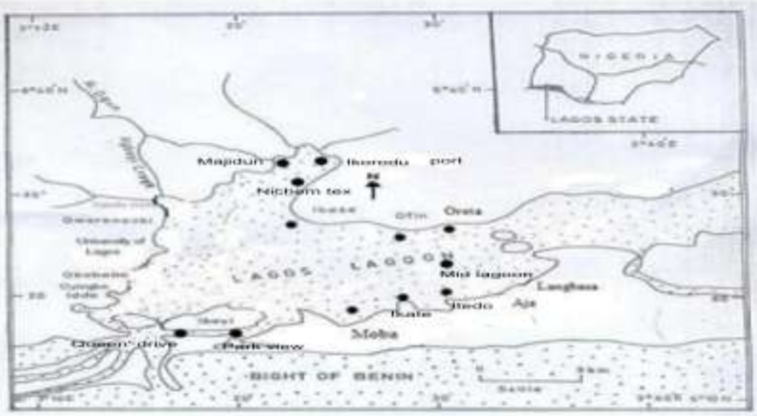

Fig. 1: Map of Lagos lagoon showing the sampling stations ●

Plankton samples were collected using a towing plankton net attached to a slow moving boat and fixed with 4% formalin to preserve the organisms. Enumeration and microscopic identification were performed using a wild II binocular microscope at 50x100x 400 magnifications. A suitable plankton sample mount was then created. The drop count microscope analysis method was used to estimate the plankton fauna. Since each sample drop from the dropper accounts to 0.1ml, the results on abundance / occurrence were multiplied accordingly to give the values as numbers of organisms per ml which is the standard unit of measurement [14]. Organisms were observed for zooplankton species. Final data were presented as number of organisms per ml. Identification guides used were those provided by [15, 16, 17, 18, 19, 20].

Collection and Analysis of Water Samples

Surface water samples were collected with a 1dm^3 water sampler and stored in 1litre water bottles and analysed in the laboratory for pH, conductivity, salinity and turbidity using a multi-meter water checker (Horiba U-12). Separate water samples were collected in 250ml dissolved oxygen bottles at each station for dissolved oxygen estimation using Winkler's method. Air and surface water temperature were measured *in situ* using mercury-in-glass thermometers. Alkalinity of the water samples was determined by titrating dilute HCl against 50ml of the water sample using methyl orange as an indicator.

Community Structure Analysis

Species Richness Index (d)

The Species richness index (d) [21] was used to evaluate the community structure.

$$d = \frac{S - 1}{\ln N}$$

Where:

d = Species richness index
S = Number of species in a population
N = Total number of individuals in S species.

Menhinick's Index (D) [22].

The Menhinick's Index (D)

$$D = \frac{S}{\sqrt{N}}$$

S = Number of species in a population
N = Total number of individuals in S species.

Shannon and Wiener diversity index (Hs) [22]

The Shannon and Wiener diversity index (Hs)

$$Hs = \frac{N \log N - \sum P_i \log P_i}{N}$$

Where Hs = Shannon and Wiener diversity Index
i = Counts denoting the ith species ranging from 1 – n
Pi = Proportion that the ith species represents in terms of numbers of individuals with respect to the total number of individuals in the sampling space as whole.

Species Equitability or Evenness index (j) [22].

The Species Equitability or Evenness index (j)

$$j = \frac{Hs}{\log_2 S}$$

Where

j = Equitability index
Hs = Shannon and Weiner index
S = Number of species in a population

Simpsons dominance index (C) [22].

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

Where n = the total number of organisms of a particular species
N = the total number of organisms of all species

RESULTS

Mean monthly variation in surface water temperature and air temperature were relatively high in all the sampling period. The highest air temperature 30.5^{0}C and 30.7^{0}C were recorded at Nichem textile and at Ikorodu port respectively while the lowest 26^{0}C was recorded at Moba. The pH values along the stations were relatively high indicating alkaline state of the water sample. The conductivity values were relatively low in all the stations, the lowest recorded at the mid lagoon (0.12mScm^{-1}). High turbidity was recorded in all the stations. Water salinity values were very low in all the stations. The station that recorded the highest dissolved oxygen value (18.4mg^{-l}) was Moba while Ikorodu port recorded the lowest dissolved oxygen values 8.0 mg^{-l}, (Table 1).

Community Structure

For the zooplankton species, 3 phyla were discovered during the study. They are Phylum – Crustacea, Phylum Chaetognatha and Phylum Rotifers. The Phylum Crustacea was the dominant phyla recorded for the study. Among the copepods which were the most important group in terms of diversity and abundance, 3 sub-orders namely Calanoida represented by 5 species (*Acartia clausii*, *Acartia discaudata, Acartia tonsa* and *Paracalanus parvus* and *Pseudocalanus elongatus*), Cyclopoida represented by 5 species **(***Corycaeus anglicus, Cyclopina longicornis, Cyclops strenus, Cyclops* sp. and *Oithona plumifera***)** and Harpaticoida represented by 1 species *- Enterpina acutifrons. With regard to the* Subclass: Branchiopoda (Cladocerans) they were represented by 4 species namely *Bosmina* sp., *Diaphanosoma excisum, Diaphnia* sp. and *Penilia avirostris.* For the Phylum – Chaetognatha (arrow worms), *Sagitta enflata* was the sole species recorded. For the Phylum Rotifera (rotifers) 4 species were recorded viz. *Brachionus plicatilis, Keratella* sp., *Lecane bulla* and *Tetrasiphon hydrocoral.* However a total of 20 zooplankton species from 17 genera were recorded for the selected stations along lagoon.

The spatial distribution of zooplankton at the twelve stations (Table 2 and fig 3) showed high copepod presence in all the stations except Nichem textile which indicate no presence of zooplankton (Table 3) this could be as a result of the untreated textile effluents that is being discharged into the lagoon. Analysis of variance showed significant variation ($p < 0.05$) in occurrence of copepods between sampling stations (Queen's drive, Park view, Moba, Ofin, Ibese Ikorodu port and Majidun). While in stations (Ikate, Itedo, Oreta, Ofin and Nichem textile) variation in copepods presence was however, not statically significantly ($p > 0.05$). The phylum chaetognatha especially, the order Apharagmorpha (*Sagitta enflata Vogt*) was only recorded at Queen's drive and Moba during the period of study (Fig 3). While the rotifers (phylum Chatognatan) were recorded at Mid lagoon, Ibese, Ikorodu port and Majidun (Table 3).

Table 4 shows indices of diversity, taxa richness and evenness of species and dominance of the zooplankton species along the selected stations. Ikorodu port and Moba have the highest diversity of zooplankton while Nichem textile has no zooplankton species. Evenness of zooplankton species among the stations is relatively low except Ikate which had the highest evenness of zooplankton species (Fig. 4). However, Itedo, Oreta and Ofin have the highest dominance of zooplankton (Table 4).

Table 1: Mean value of the physico-chemical parameters of the water samples in each station

	Queen's Drive	**Park view**	**Moba**	**Ikate**	**Itedo**	**Mid lagoon**	**Oreta**	**Ofin**	**Ibese**	**Nichmtex**	**Ikorodu port**	**Majidun**
Air Temp. (^{O}C)	28	27.2	26	28.3	30.1	30.1	30	30	30.5	30.5	30.7	31.2
H_2OTemp. (^{O}C)	29.4	29.5	28.7	28.5	28.9	29.0	29.0	29.3	29.5	28.7	28.2	28.0
Ph	9.1	8.9	9.0	9.1	8.9	8.8	9.2	8.9	9.0	9.0	8.8	9.1
Conductivity ($mScm^{-1}$)	0.84	1.0	0.64	0.67	0.61	0.12	0.19	0.3	0.24	0.54	0.18	0.61
Turbidity (NTU)	78	366	126	108	208	226	86	386	248	256	346	276
Salinity ($^{o}/_{oo}$)	0	0	0	0	0	0	0	0	0	0	0	0
D.O (mgl^{-1})	11.2	13.6	18.4	15.6	12.0	11.2	12.4	12.4	12.8	9.2	8.0	5.2
Alkalinity	8.0	8.0	6.0	8.0	10.0	8.0	8.0	8.0	8.0	8.0	12.0	8.0

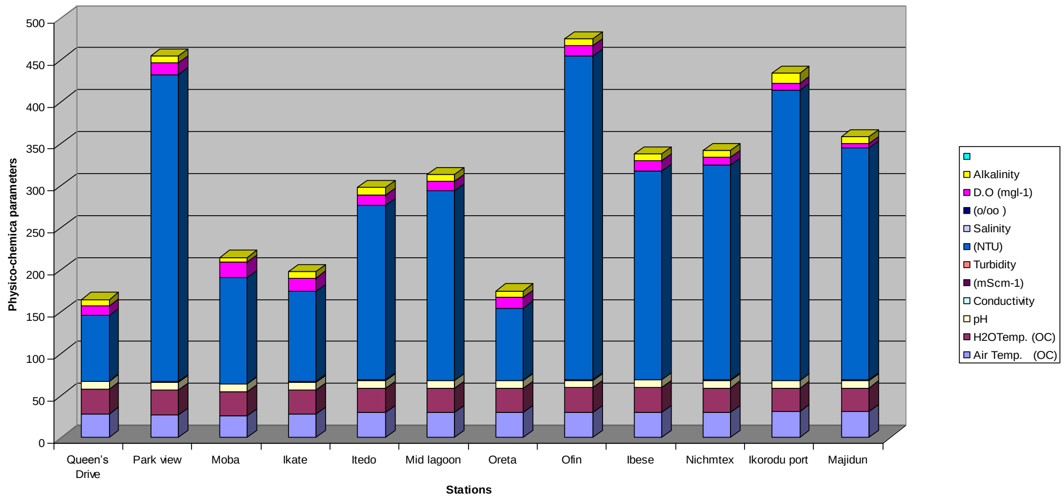

Fig. 2: Physico-chemical parameter for water sampled at each station along the lagoon

Table 2: Spatial variation of the zooplankton composition and abundance in selected parts of the Lagos lagoon.

Stations	**Queens Drive**	**Park view**	**Moba**	**Ikate**	**Itedo**	**Mid lagoon**	**Oreta**	**Ofin**	**Ibese**	**Nichemtex**	**Ikorodu port**	**Majidun**
ZOOPLANKTON TAXA												
Phylum- CRUSTACEA												
Class – COPEPODA												
SUB-ORDER I: CALANOIDA	25	10	15	5	-	5	-	-	10	-	-	-
Acartia clausii Giesbrecht	15	-	5	-	-	-	-	-	-	-	-	-
Acartia discaudata Giesbrecht	-	-	-	-	-	-	-	-	-	-	-	-
Acartia tonsa Giesbrecht	-	10	5	-	-	-	-	-	-	-	-	-
Paracalanus parvus (Claus)	5	5	10	-	-	15	-	10	5	-	10	-
Pseudocalanus elongatus (Boeck)	10	5	5	-	-	-	-	-	-	-	-	-
ORDER II – CYCLOPOIDA												

Corycaeus anglicus Lubbock	10	5	-	5	5	-	-	-	-	-	-	-
Cyclopina longicornis Boeck	5	-	-	-	-	-		-	-	-	-	-
Cyclops strenus Fisher	-	-	-	-	-	-	5	-	5	-	10	25
Cyclops sp.	-	-	-	-	-	-		-	-	-	5	5
Oithona plumifera Baird	15	5	5	-	-	-		-	-	-	-	-
SUB-ORDER III: HARPATICOIDA												
Enterpina acutifrons Dana	-	5	5	-	-	-	-	-	-	-	-	-
SUBCLASS: BRANCHIOPODA												
ORDER : CLADOCERA												
SUB-ORDER: EUCLADOCERA												
Bosmina sp.	-	-	-	-	-	-	-	-	5	-	5	5
Diaphanosoma excisum (Sar.)	-	-	-	-	-	-	-	-	-	-	5	15
Diaphnia sp.	-	-	-	-	-	-	-	-	-	-	5	10
Penilia avirostris Dana	25	15	5	-	-	-	-	-	-	-	-	-
PHYLUM – CHAETOGNATHA												
ORDER – APHARAGMORPHA												
Sagitta enflata Vogt	10	-	5	-	-	-	-	-	-	-	-	-
PHYLUM: ROTIFERS												
CLASS: MONOGONOTA												
ORDER: PLOIMA												
Brachionus plicatilis Muller	-	-	-	-	-	-	-	-	5	-	10	15
Keratella sp.	-	-	-	-	-	-	-	-		-		20

Lecane bulla Gosse	-	-	-	-	-	5	-	-	5	-	10	15
Tetrasiphon hydrocoral Ehrenberg	-	-	-	-	-		-	-	5	-	5	5
Total species diversity (S)	9	8	9	2	1	3	1	1	7	0	9	9
Total zooplankton abundance (N)	120	60	60	10	5	25	5	10	40	0	65	115

Table 3: Spatial distribution of zooplankton community along the Lagos lagoon

Stations	**Queens Drive**	**Park view**	**Moba**	**Ikate**	**Itedo**	**Mid lagoon**	**Oreta**	**Ofin**	**Ibese**	**Nichemtex**	**Ikorodu**	**Majidun**
Phylum Crustacean	110	60	50	10	5	20	5	10	25	0	40	60
Phylum Chatognatan	10	0	5	0	0	0	0	0	0	0	0	0
Phylum Rotifers	0	0	0	0	0	5	0	0	15	0	25	55

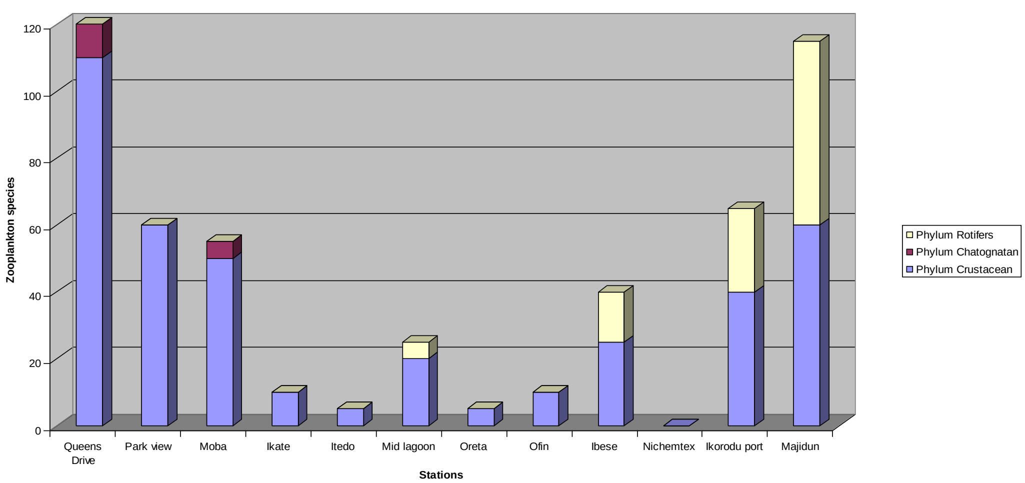

Fig.3: Zooplankton species distributed along selected stations on the lagoon

Table 4 : Indices values of General diversity, Abundance, Taxa richness and Dominance of the zooplankton species in selected parts of the Lagos lagoon.

	Queens Drive	Park view	Moba	Ikate	Itedo	Mid lagoon	Oreta	Ofin	Ibese	Nichemtex	Ikorodu port	Majidun
Shannon-Wiener Index (Hs)	0.89	0.86	0.91	0.30	0	0.41	0.00	0.00	0.83	0	0.93	0.89
Menhinick Index (D)	0.82	1.03	1.16	0.63	0.45	0.60	0.45	0.32	1.11	0	1.12	0.84
Margalef Index (d)	1.67	1.71	1.95	0.43	0	0.62	0	0	1.63	0	1.92	1.69
Equitability Index (j)	0.94	0.95	0.95	1.00	0	0.86	0	0	0.98	0	0.97	0.93
Simpson's Dominance Index (C)	0.14	0.15	0.14	0.50	1.00	0.44	1.00	1.00	0.16	0	0.12	0.14

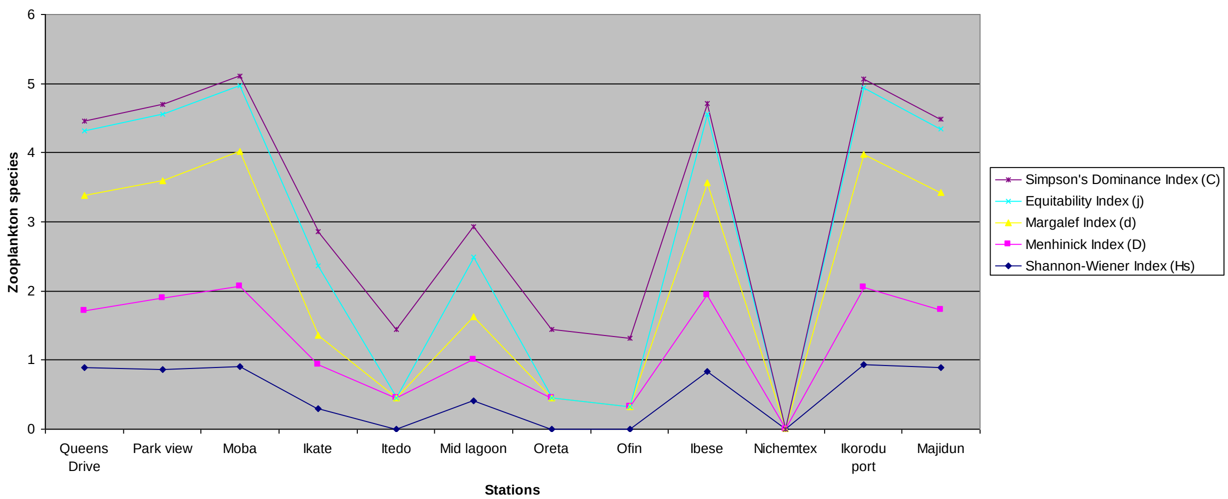

Fig.4: Biodiversity indices of the Zooplankton species distributed in selected stations on the lagoon

DISCUSSION

The highest air temperature (30.5°C) and water temperature (29.5°C) were recorded at Ibese sampling station. Surface water temperatures were high (28°C - 29.5°C) in all the sampling stations. Majidun had the lowest dissolved oxygen values (5.2mg/l) when compared with other stations. This value is just a little above the minimum W.H.O [23] standard of 5mg/l required for water quality assessment. The water samples were very turbid in all the stations. The period of sampling was around the rainy season and particulate matters brought into the lagoon by surface run-off and flood must have caused high turbidity. Zero salinity value was recorded for all the stations and this implies a freshwater condition. The dynamic interplay between freshwater inflow and tidal seawater incursion determine the Lagos lagoon environment from year to year [7]. The wet season creates an increased in river flow leading to a low brackish water conditions in various parts of the lagoon, however this study revealed a low salinity in all the stations. For the present study, (Table 1) there was no value for the salinity measurement at all the stations sampled. This is likely due to freshwater inflow and reduced tidal incursion [12]. In the Lagos lagoon, there is a direct relation between the seasonal bimodal rainfall pattern, the environmental and biota gradient [8]. Furthermore, Biddulphia, Coscinodiscus, Ceratium, Acartia, Paracalanus species, various crustacean, gastropod and bivalve larvae and fish eggs were recorded in the stomach of *Ethmalos afimbriata* from the Lagos lagoon [8] . Highest dissolved oxygen value (18.4mg^{-l}) was recorded in Moba while Ikorodu port recorded the lowest dissolved oxygen values 8.0 mg^{-l} , (Table 1) this is due to less influx of human and industrial effluent at Moba while lots of human activities and industrial activities takes place at Ikorodu port. The study described relatively low zooplankton diversity, although the rains during these periods did not end as usual. A distributive rainfall pattern in southwestern Nigeria showing four ecologically important periods in Nigerian coastal waters were reported [11]. These are the dry months (Jan –March/ April) when high salinity is experienced in the coastal waters and lagoons; April/May, when the salinity drops drastically causing a stress condition and a resultant loss of biodiversity arising from the death of marine biota that invade the coastal water. Moreso, the current state of environmental perturbations from untreated industrial and municipal effluents could lead to a decrease in biodiversity. For instance, Nichem textile is an industry that produce textiles, the study showed no presence of zooplankton species at this station. The obvious consequence of such activity is a gross reduction in abundance and diversity of these primary consumers, resulting in altered food web, distortion of the energy transfer process and general ecological imbalance. Changes in the biodiversity of these primary consumers could make pollution management and environmental biomonitoring a little bit difficult because of the role played by these delicate but very important organisms.

Furthermore zooplankton species are increasing in diversity in areas close to the harbour with less human activities. Changes in the biodiversity of these primary consumers could make pollution management and environmental biomonitoring a little bit difficult because of the role played by these delicate but very important organisms.

REFERENCES

1. Nwankwo, D. I. 1993. Cyanobacteria Bloom Species in Coastal Waters of South-Western Nigeria. Arch. Hydrobiol., 90 (Suppl): 553-542.

2. F.A.O. (1969). Fisheries Survey in the Western and Mid-Western Regions of Nigeria. FAO/Sf: 74/NIR 6. 142pp.

3. Brown, C.A. and Oyenekan, J.A. (1998). Temporal variability in the structure of benthic macrofauna communities of the Lagos lagoon and harbour, Nigeria. Pol. Arch. Hydrobiol. 45(1): 45 – 54.

4. Iloba, K.I. (2002). Vertical distribution of Rotiferal in the Ikpoba Reservoir in Southern Nigeria. *Trop. Freshwat. Biol.* 11: 69-89.

5. King, R. P. and Jonathan G. E. (2003). Aquatic Environmental Perturbations and Monitoring. African Experience. Texas. 166pp.

6. Ajao, E.A. (1996). Review of the state of pollution of the Lagos lagoon. NIOMR Tech. Paper No. 106. 19pp.

7. Onyema, I.C., Otudeko, O.G. and Nwankwo, D.I. (2003). The distribution and composition of plankton around a sewage disposal site at Iddo, Nigeria. Journal of Scientific Research Development.7: 11-26.

8. Onyema, 1.C., Okpara, C.U., Ogbebor, C.I. Otudeko, O. and Nwankwo, D.I. (2007). Comparative studies of the water chemistry characteristics and temporal plankton variations at two polluted sites along the Lagos lagoon, Nigeria. Ecology, Environment and conservation. 13: 1 – 12.

9. Edokpayi, C.A. and Nkwoji, J.A. (2007). Annual changes in the physico-chemical and macrobenthic invertebrate characteristics of the Lagos lagoon sewage dump site at Iddo, Southern Nigeria. *Ecol. Env. & Cons*. **13**(1): 13-18.

10. Nwankwo D. I. (2004). A Practical Guide to the study of algae. JAS Publishers, Lagos. Nigeria.86pp.

11. Nwankwo, D. I. and Akinsoji (1988). Periphyton Algae of eutrophic Creek and their possible use as Indicator. *Nigerian Journal of Botany 1*: 96 – 105.

12. Hill M.B and Webb, J.E. (1958). The Ecology of Lagos lagoon. 1: The lagoons of the Guinea Coast. Philosophical Transaction Royal Society London. Ser B: 241-283.

13. Onyema, I.C. and Ojo, A.A. (2008). The zooplankton dynamics and chlorophyll a concentration of a tropical tidal creek in relation to water quality indices. Life Science Journal. 5 (4): 7 – 14.

14. Onyema, I.C. (2007). Mudflat microalgae of a tropical bay in Lagos, Nigeria. *Asian Journal of Microbiology, Biotechnology and Environmental Sciences*. **9 (4)**: 877 – 883.

15. Olaniyan, C.I.O. (1975). *An introduction to West African Ecology*. Heinemann Education Books Ltd., London. 170pp.

16. Newell, G. E. and R. C. Newell (1977). Marine plankton: Aguide. Hutchinson and Company Publishers Ltd. London. 229p.

17. Maosen, H. (1978). Illustration of freshwater plankton. Agricultural Press. Wuxi City, China. 108p.

18. Bettrons, D.A.S. and Castrejon, E.S. (1999). Structure of benthic diatom assemblages from a mangrove environment in a Mexican subtropical lagoon. *Biotropica.* **31**(1): 48 – 70.

19. Kasturirangan, L. R. (1983). A key for the identification of the more more common planktonic copepoda of Indian Coastal Waters. Council of Scientific and Industrial Research. New Delhi, India 87pp.

20. Waife, G. and Frid, CL.J (2001). Marine zooplankton of West Africa. Marine Biodiversity Capacity Building in the West African Sub-region. Darwin Initiative Reports 5, Ref. 162/7/45/. 120pp

21. Margalef R. (1951). Diversidad de especies en las comunidales naturales. Publ. Inst. Biol. Apl. (Barcelona). 9: 5-27.

22. Ogbeibu, A.E. (2005). *Biostatistics: A practical approach to reseach and data handling*. Mindex Publishing Company limited, Benin city, Nigeria.264pp.

23. World Health Organization in Geneva (1993). A guidelines in assessing water quality standards.