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Distribution and Variation of Macrobenthic Invertebrates in Ikorodu Axis of Lagos Lagoon

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ABSTRACT

The macrobenthic composition, abundance and diversity of the Ikorodu axis of Lagos lagoon were investigated for six (6) months (April, 2010 and September 2010) in relation to environmental variation. The physico-chemical parameters of water were determined. The temperature ranged between 24oC and 33oC was observed throughout the study period. The pH, BOD, COD and the Total Acidity are generally low. A total of two hundred and ninety nine species (299species) comprising two (2) phyla, three (3) classes; seven (7) families were observed at the study area during the study period. They all belong to Phylum Mollusca and Phylum Arthropoda, three (3) classes; Gastropoda, Bivalvia and Insecta. Percentage abundance by major taxonomic keys include N. glabrata species which recorded 8.4% of the benthic composition. A. trigona recorded the highest percentage (37.8%) of occurrences during the sampling period while E. fischeri recorded the lowest percentage (1.3%). Gastropoda namely Tympanotonus fuscatus, Pachymelania aurita and Neritina glabrata and three species of Bivalvia; Iphigenia truncate, Eulima fischeri and Aloidis trigona were encountered throughout the study period. Species diversity is therefore very low around the study area.

The highest Shannon-Weiner index was recorded in August (Station D) while the lowest was recorded in September (Station A). The highest Evenness was recorded in May (Station D) and in August (Station E).

Keywords: *Macrobenthic, Diversity, Physico-chemical, Environmental, Composition;*

INTRODUCTION

Benthic macrofauna species are important as food for economically important fish and shellfish species in most aquatic environment where they are the major secondary producers

(Ajao and Fagade, 2002). They have been employed as indicators of organic pollution and other human-induced stress factors in aquatic ecosystem (Ajao and Fagade, 1990). Benthic organisms constitute an important part of the aquatic food chain, especially for fish.

Many of them feed on algae and bacteria, which are on the lower end of the food chain (Nystrom *et al.*, 1996). Some shred and eat leaves and other organic matter that enters the water, and because of their abundance and critical position in the aquatic food chain, benthos plays a major role in the natural flow of energy and nutrients (Stockley *et al.*, 1998). As benthic invertebrates die, they decay, releasing nutrients that are reused by aquatic plants and animals in the food chain. In view of this, they can be used to evaluate the wellbeing of the aquatic ecosystem. Over the past five decades an unexpectedly large diversity of marine benthos has been disclosed by the use of different biological and physio-chemical techniques in the Nigeria marine environment. The most recent benthological studies are on the impact of sediment characteristics and variations in salinity on the community structure and diversity of benthic macrofauna (Ajao and Fagade, 1990; Ajao and Fagade, 1991; Brown, 1998; Brown, 2000, Edokpayi *et. al.*, 2004; Edokpayi and Ayorinde, 2005, Edokpayi *et. al.*, 2008, Uwadiae, 2009). These studies focused and observed the abundance, composition and distribution of benthic faunaonments. The problem of water pollution arising from industrial discharge of untreated effluent cannot be over-emphasized in Lagos State, owing to the fact that it harbours about 60-70% of industries in the country. Lagos State water bodies (both lagoons and canals) serve as waste disposal basins for the entire community in Lagos, one of the most highly populated coastal cities in West

Africa. Sources of the lagoon of pollution include effluents from brewery, food industry, organic, chemical industry, textile, solid waste from slaughter houses, sawmills as well as domestic and sewage wastes. The neglect of environmental considerations in industrial development and planning is the causative factor of unsustainable industrialization in the country.

MATERIALS AND METHODS

Description of Study Area

Lagos State is situated within the low-lying coastal zone of Nigeria. This coastal terrain is dominated by a maze of estuaries; lagoon creeks and rivers. Lagos state covers a total area of about 3,577 square kilometers, occupying 0.4% of the total land area of Nigeria (Shekoni 1997) Out of the total land area covered by Lagos state; one-quarter is liquid surface: lagoons, creeks and coastal river estuaries. Lagos state is situated between Latitudes 6^{o}22'N to 6^{o}42'N and Longitudes 2^{o}42'E to 4^{o}20'E (Adefuye *et al*, 1987). It is bounded in the north by Ogun State and in the east by Ondo State. It shares an international boundary of about 45km with the Republic of Benin while the vast deep blue Atlantic Ocean constitutes approximately 180km along the southern limit.

Sampling Stations

The study area consists of 5 fishing villages in Ikorodu axis of Lagos lagoon. These lies between Latitudes 06^{o}32'N to 06^{o}33'N and Longitudes 3^{o}27'E to 3^{o}36'E using GPS.

Two of the stations are chosen based on their close proximity to the thermal station where the waste water is discharged directly into the lagoon through underwater pipes, while the remaining three study sites are also chosen based on the anthropogenic activities of the study area. These are shown and highlighted in detailed in Figure 1.

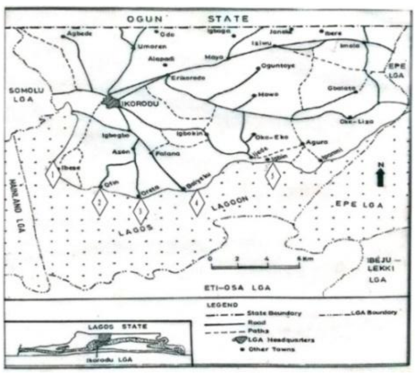

Figure1. *Map of Lagos lagoon showing the study areas*

Field Studies and Sampling Duration

Sampling was done monthly for six (6) months at five different stations between April, 2010 and September 2010. The water samples collected were from the five (5) stations to the laboratory iced chest for analysis of physico-chemical parameters. White and transparent 2-litres plastic containers were used on each sampling site. The kegs were thoroughly washed and dried to avoid any form of contamination. The kegs were filled to the brim and corked to prevent the influence of atmospheric oxygen.

Physico-Chemical Parameters of Water Samples

The physico-chemical parameters of the study sites such as air temperature, surface water temperature, transparency, depth, total solid, total dissolved solids, total suspended solids, rainfall, pH, salinity, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, conductivity, total acidity, and total hardness were taken throughout the duration of the investigation.

Sediment and Macrobenthic Fauna Sampling

0.lm^2 Van Veen grab was used for sediment sample. The grab was lowered from an anchored boat to the bottom of the lagoon. Some of the hauled sediment at each station was placed in plastic containers and was sieved through a 0.5mm mesh sieve.

The retained content of the sieve i.e. the animals were put into a plastic container and preserved in 5% formalin solution for sorting and identification.

Animal Sorting and Identification

The sieved preserved macro benthos from the field grab samples were sorted and identified using hand lens and dissecting microscope. Classification and identification to genera and species level were done after the following authors Olaniyan, (1968), Oyenekan, (1975) Edmunds (1978), Gosner (1971), Barnes *et al.* 1999) and Schneider (1990).

Statistical Analysis and Application

The following ecological indices were used to determine the distribution, abundance and comparison of animals (benthos) in the study area.

Shannon - Wiener diversity index (H).

$$H = \frac{N\log N - \sum f_i \log f_i}{N}$$

Where H = Diversity index,

N = Total No. of Individual species

f_i = no of individuals in each species

Margalef's (species richness) index

$$(d): d = \frac{S-l}{LogN}$$

Where S = No of species

N = Total No of individual species,

Equitability (Evenness) index (j):

$$J = \frac{H}{LogK}$$

Where: H = Shannon - Wiener index

K = No of Categories/Total No. of Individuals

RESULTS

Physico-Chemical Parameter of Water

The variation in the physico-chemical characteristics of water samples between April, 2010 and September, 2010 are presented graphically in fig. 2-22 and in Table 2 in the Appendix. The abundance of benthic organisms in the study areas are shown in table 19-21 and fig. 23-24.

Air Temperature (Oc)

Monthly variation in air temperature ranged from 24.0 in April to 33.0 in June and August respectively. The highest air temperature (33.0) was recorded in Station E in the months of June and August while the lowest was recorded in Station D in the month of June. Air temperatures were relatively higher in station E (fig.2-7).

Surface Water Temperature (Oc)

Throughout the sampling period the surface water temperature changes between 26.0^{o}C-33.0^{o}C (Fig. 2). The highest temperature was recorded at Station E, the station subjected to the greatest amount of cooling water discharge. The change recorded throughout the study period was relatively high. The lowest surface water temperature, 26.0^{o}C was recorded at Station C in April (fig. 2-7).

Ph (Hydrogen Ion Index)

The pH ranged between 4.4 and 8.8. The highest value was recorded in Station A. The average value is indicated in (fig. 22) and Table 5.

Total Solids

The total solids value ranged from 3.4 to 22. In April (22mg/l), the highest values recorded and the lowest value was recorded in Station B in the month of August (3.4mg/l) (fig. 8-13).

Conductivity

The conductivity values ranged between 260.0 to 8270.0µs/cm (fig. 21). There was a high fluctuation of conductivity throughout the study period. The highest value however was recorded at Station C in August.

Salinity

The salinity values ranged between 0.11‰ to 6.73‰ (fig. 8-13) Station C in the month of June recorded the lowest salinity value while the highest value was recorded in the month of April in station D.

Total Acidity

Values ranged between 3.0 and 9.0mg/l in station D in June and in station B in June respectively (fig. 14-19).

Dissolved Oxygen

The Dissolved oxygen value ranged between 4.3mg/l to 7.2mg/l (fig. 8-13). Station C in the month of August recorded the lowest D.O. value while the highest value was recorded in the month of September in station C.

Biochemical Oxygen Demand (B.O.D5)

The Biochemical Oxygen Demand was low throughout the study period with higher values recorded in April. Values ranged between 2.0mg/l and 10.0mg/l in station A in June and in station D in April respectively (fig. 8).

Chemical Oxygen Demand (C.O.D)

The Chemical Oxygen Demand ranged between 2.0mg/l and 18.0mg/l in station B and in station D in April respectively (fig. 8-13).

Total Hardness

Values of the total hardness ranged between 184 and 900mg/l in station D in May and in station B in April respectively (fig. 8-13)

Exchangeable Cations (Na+, Ca2+, K+)

Sodium values ranged between 29.0 and 922.05mg/l in station D in July and in station C in June respectively (fig. 14-19). Manganese values ranged between 0.1 and 5.4mg/l in station D in April and in station D in June. The Manganese values are generally low during the study period. Calcium was not detected in June and July in station E and with 90.0mg/l values in station B in April (fig. 14-19). Potassium values ranged between 33.78 and 72.41 in station E and in September in station C in April respectively. The values are generally low during the study period (fig. 14-19).

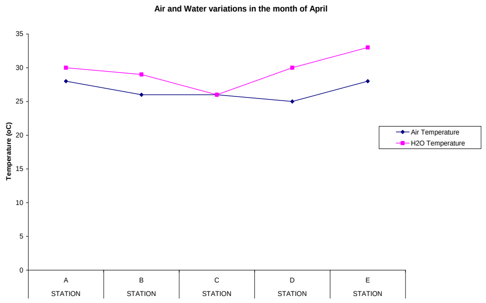

Figure2. *Temperature variations in the month of April*

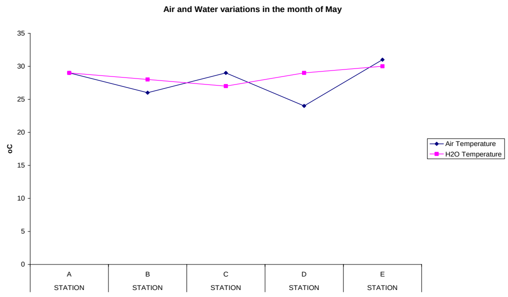

Figure3. *Temperature variations in the month of May*

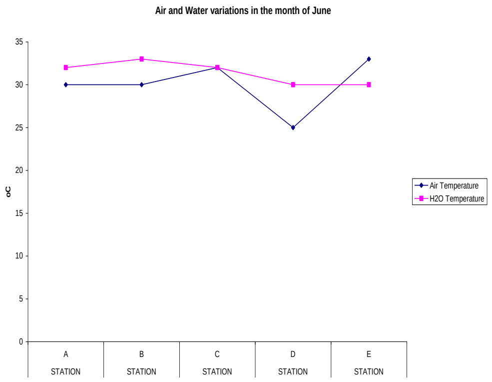

Figure 4. *Temperature variations in the month of June.*

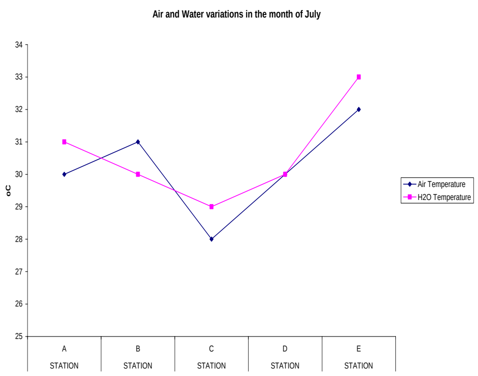

Figure 5. *Temperature variations in the month of July.*

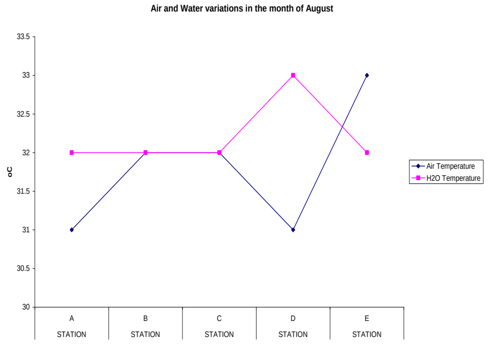

Figure 6. *Temperature variations in the month of August*

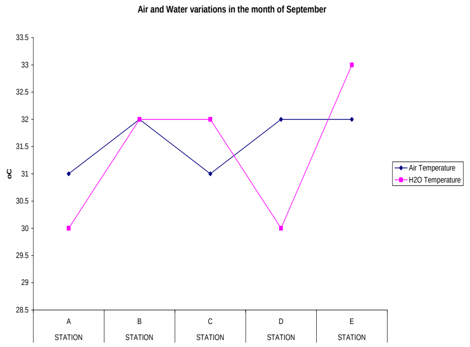

Figure 7. *Temperature variations in the month of September.*

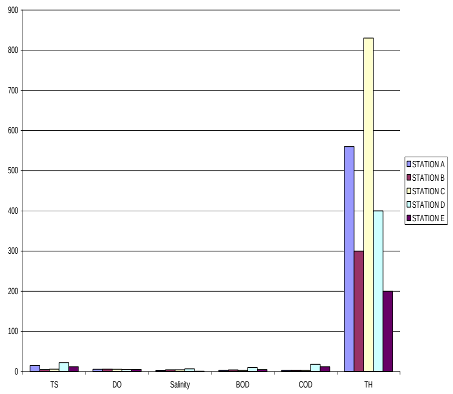

Figure 8. *TS, D.O, Salinity, BOD, COD and TH variations in the month of April*

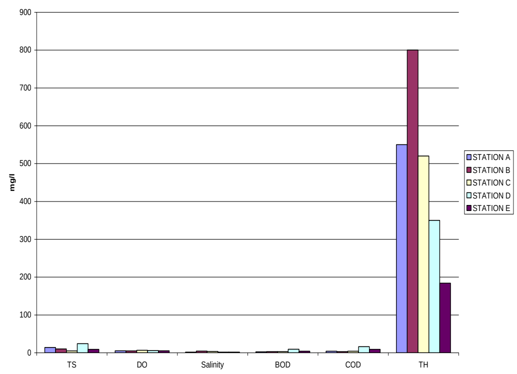

Figure 9. *TS, D.O, Salinity, BOD, COD and TH variations in the month of May*

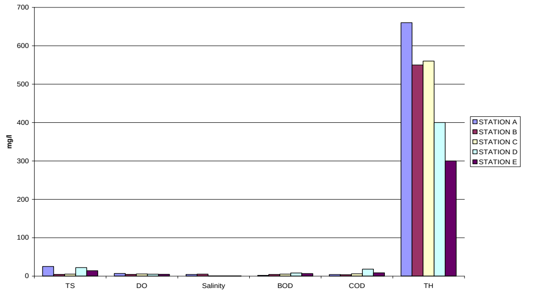

Figure 10. *TS, D.O, Salinity, BOD, COD and TH variations in the month of June*

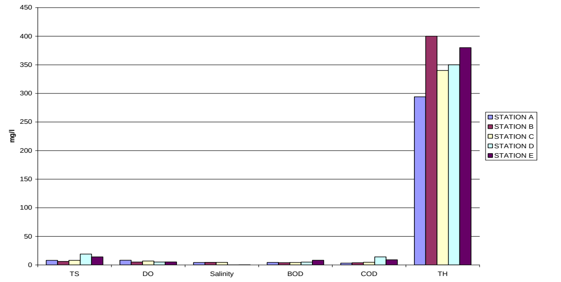

Figure 11. *TS, D.O, Salinity, BOD, COD and TH variations in the month of July*

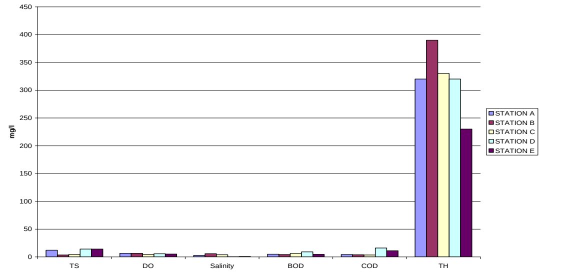

Figure 12. *TS, D.O, Salinity, BOD, COD and TH variations in the month of August*

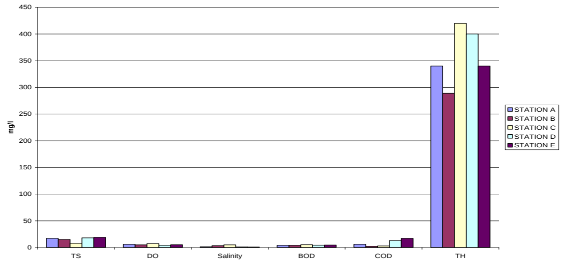

Figure 13. *TS, D.O, Salinity, BOD, COD and TH variations in the month of September*

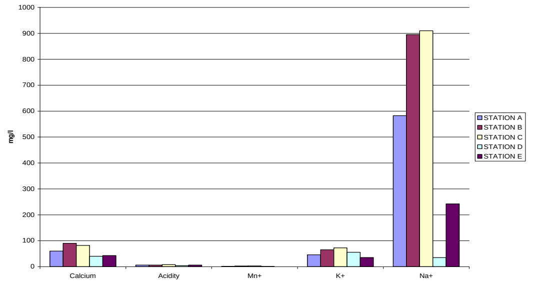

Figure 14. *Acidity and Cations variations in the month of April*

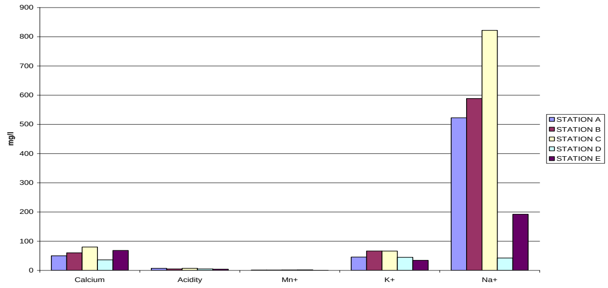

Figure 15. *Acidity and Cations variations in the month of May*

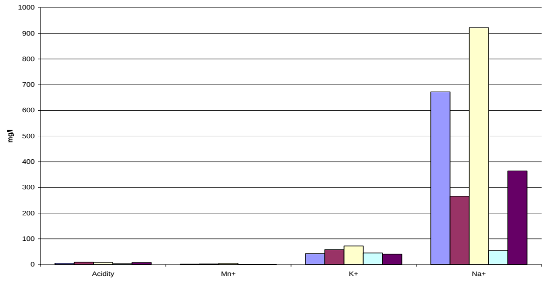

Figure 16. *Acidity and Cations variations in the month of June*

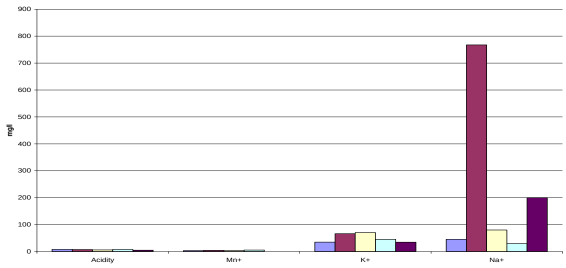

Figure 17. *Acidity and Cations variations in the month of July*

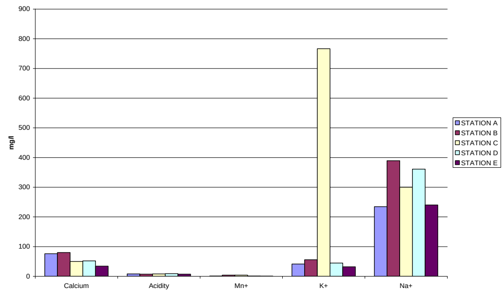

Figure 18. *Acidity and Cations variations in the month of August*

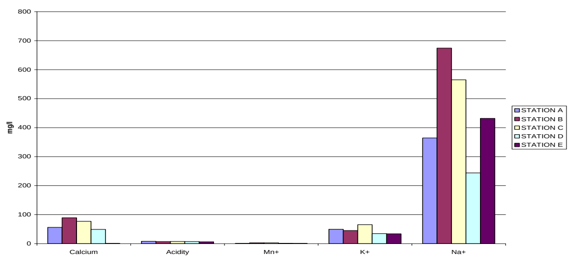

Figure 19. *Acidity and Cations variations in the month of September*

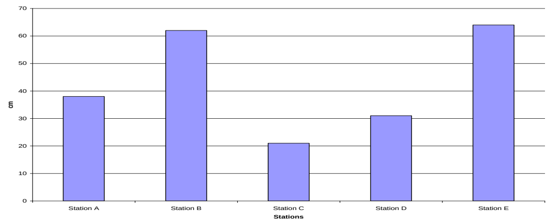

Figure 20. *Average transparency of the study area.*

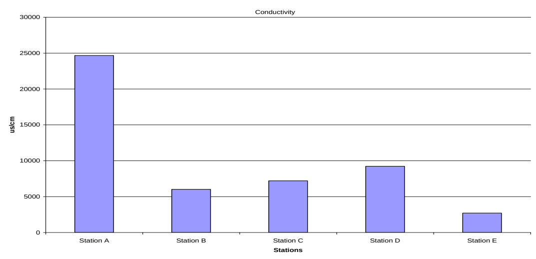

Figure 21. *Average Conducivity of the study area.*

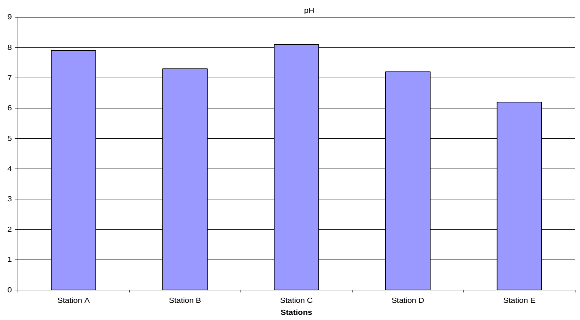

Figure 22. *Average pH of the study area.*

Macrobenthic Fauna Characteristics

Two hundred and ninety nine species (299 species) comprising two phyla, Three (3) classes, Seven (7) families. Table 2 gives the composition, classification and number of benthos, collected per station per month at the study area. A total of seven (7) species were obtained throughout the study period. They all belong to phylum Mollusca and phylum Arthropoda, three (3) classes; Gastropoda, Bivalvia and Insecta. Percentage abundance by major taxonomic keys is presented in Figure 24. *N. glabrata* species recorded 7.94% of the benthic composition. *A. trigona* recorded the highest percentage of occurrences during the sampling period while *E. fischeri* recorded the lowest percentage. Gastropoda namely *Tympanotonus fuscatus, Pachymelania aurita* and *Neritina glabrata* and three species of Bivalvia; *Iphigenia truncate, Eulima fischeri* and *Aloidis trigona* were encountered throughout the study period. Species diversity is therefore very low around the study area.

The highest species diversity was recorded in August (Station B), while the lowest species diversity was recorded in May (station D). In terms of species abundance (N), September (station A) recorded 25 individual organisms while the lowest value was three (3) recorded in May (station D) and August (station E). The highest Shannon-Weiner index was recorded in August (station D) while the lowest was recorded in September (station A). The highest Evenness was recorded in May (station D) and in August (station E), while the lowest was recorded in September (station A). *Chironomus* was recorded in station A, B and C but was not in station D and E.

Discussion/Conclusion

The physico-chemical parameters measured in the study area (Ikorodu Axis) of the Lagos lagoon had been found to be under the influence of local climatologically, hydrological and oceanographic regime and that of the surrounding states (Hill and Webb, 1958, Oyewo, *et al*, 1982, 1998, Sandison and Hill, 1966). However, the physico-chemical measurements also reflected the conditions of the study area are affected by the human activities and thermal influence.

High temperature has been associated with thermal stations and this was observed at all the stations during the study period. The temperature ranged between 24°C and 33°C. The impact of temperature on water physico-chemistry and benthic organisms has been well documented (Roessler and Durbin 1974; Pandey, 1983). Temperature observed was low due to average heavy down pour neutralizing the temperature level of the study area at the period.

The influence of temperature on the spawning of benthos has been discussed by several workers, (Mitchell, 1994 and Oyenekan, 1981).

The hydrogen ion index (pH) of the water sample ranged between 4.4-8.8. It varied very little throughout the study period. pH changes can drastically affect the structure and function of the ecosystem both directly and indirectly. It could lead to increasing concentration of trace metals in water through increased leaching from sediments [Oyenekan 1987, 1988].

Biochemical oxygen demand (BOD) is a measure of the amount of dissolved oxygen that could be depleted from the water during natural biological assimilation or degradation of organic compounds by the organism present especially bacteria, [Oyenekan, 1979]. The BOD values were low indicating that the available dissolved oxygen was high compared to the amount needed for biodegradation.

The chemical oxygen demand was averagely lower than the biochemical oxygen demand. There was a strong positive correlation between the two. Chemical oxygen demand is used to measure the extent of pollution of a water body. The values recorded ranges from 2-18mg/L. The lagoon water at the stations measured can therefore be said to be highly polluted.

Low salinity value was recorded throughout the study period at all stations due to the high rainfall. Conductivity is a measure of the amount of hydrogen ions present in solution. It therefore shows a very higher conductivity level in the study area.

The low transparency recorded at all stations means that there are particles in high concentration in water. This reduces light penetration and also reduced productivity, (photosynthesis), (Ajao, 1990a, 1990b, 1990c).

The total solid is the amount of particulate matters that are in water column. This may be in form of soluble nutrients or pollutants from the dredging and sand mining activities along the study stations. The stations chosen were influenced by activities, as it is very near from the shore. The total acidity ranged between 3.0mg/l, and 9.0mg/l with very low fluctuations.

Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Manganese (Mn^{+}) values recorded throughout the period were very low than the Na^{+} and K^{+} value were averagely higher.

The benthic macro fauna of the study area is numerically dominated by the species gastropod. It was predominant at all stations. The number (315) of benthic species recorded in the study area in Lagos lagoon is almost the same compared with that (124) recorded for Lagos lagoon by Brown (2000). The community of benthic macrofauna represented also showed the same with those reported for Lagos lagoon by Oyenekan (1987), with the *Pachymelania* community observed. Taxa recorded in the study area which are listed as members of the *Pachymelania* community by Oyenekan (1987) include *P.aurita* the nominate member of the community which occurred in large number and *Neritina glabrata*.

Uwadiae (2009) described the response of benthic macroinvertebrates community to salinity gradient in Epe lagoon and corroborated the reports of Olaniyan (1975) which stated that it is inevitable that there must be some zonation in the distribution of lagoon fauna varying from animals with low salinity tolerance to those with high salinity tolerance in areas where change is great. The first groups are the marine animals which can tolerate a limited drop in salinity, and freshwater animals which can tolerate a limited rise in salinity. In the third group are the true brackish water animals with the necessary adaptations for life in the brackish water. The occurrence of three categories (freshwater, brackish and marine water) of fauna in the study area (Uwadiae, 2009) is a further proof of the existence of zonation.

Dredging was observed at all the study stations area during the sampling period and this change in the sediment type could also be associated with loss of diversity at the stations. The anthropogenic perturbations have contributed immensely to the low diversity of the benthic macroinvertebrates in the study area.

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