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Comparative Study of Benthic Macroinvertebrates in the Eastern and Western Parts of Lagos Lagoon, Nigeria

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Abstract: Comparative study of the benthic macroinvertebrates of the eastern part of Lagos Lagoon and the western, industrialised part of the Lagoon was carried out in the March, 2009. Higher dissolved oxygen and lower turbidity were recorded in eastern part than in the western part. A total of 925 individuals were sampled in the eastern part of the Lagoon accounting for 92.1% of the total individuals sampled, while 79 individuals were sampled in the western part of the Lagoon accounting for only 7.9% of the total individuals sampled during the period of study while. Pollution tolerant and opportunistic species like the polychaete worms were more abundant in the western part of the Lagoon than in the eastern part. Species diversity and abundance were generally low in the western parts of the Lagoon compared with the eastern part. This is indicative of the level of the impact by human induced stressors on this part of the Lagoon.

Key words: Benthic, macroinvertebrates, bioindicators, Lagoon, pollution

INTRODUCTION

Benthic macroinvertebrates are animals without backbone that live on or in the sediment of the water body or attached to rocks or debris at the bottom. The minimum size is 0.55 mm in diameter. They include crustaceans, molluscs, aquatic worms and larval forms of aquatic insects. They are important in the aquatic ecosystem because they form part of the aquatic food chain. They are also used to assess water quality and as pollution indicators.

Macrobenthic communities have been seen as effective tools for assessing organic pollution. They are easy to monitor because they can be sampled quantitatively and also respond to man-made disturbance (Otway and Gray, 1996). Their sedentary nature makes it possible for them to be highly impacted by any xenobiotic compounds and other stressors released into the water body (Chaphekar, 1991).

Benthic macroinvertebrates have been used as bioindicators to assess the health of the environment. Since, it is often difficult to directly monitor aspects of condition or health (e.g., disease states or longevity) of natural populations and of humans, bioindicators are often useful surrogates (Post, 2006).

Some earlier studies on the benthic macro-invertebrates of the Lagos Lagoon have been documented (Oyenekan, 1987; Brown, 1991). Researches on the seasonal and spatial distribution of the benthic macroinvertebrate, *Capitella capitata* in Lagos Lagoon were done by Ajao and Fagade (1990a). Edokpayi and Nkwoji (2007) worked on the physico-chemical and macrobenthic invertebrate characteristics of a sewage dumpsite on the western part of Lagos Lagoon and recorded a relatively high abundance of the polychaete on this part of the Lagoon. No deliberate attempts have been made to compare the western industrialised part of Lagos Lagoon with the eastern relatively undisturbed part of this Lagoon. The objective of this study is to compare the western and eastern parts of the Lagoon using the abundance, distribution and diversity of the benthic macroinvertebrates.

MATERIALS AND METHODS

Study area: The study area is part of the barrier-Lagoon complex of the Nigerian coastal zone (Fig. 1). The barrier-Lagoon complex extends eastwards for about 200 km from the Nigerian-Benin Republic border to the western limit of the transgressive mud coast. The morphology has been described in terms of coastal dynamics and drainage and largely affected by the long shore current actions (Ibe, 1988). Located between latitude 6°26 and 6°38'N longitude 3°23 and 3°43'E, the Lagoon covers an area of about 208 km^2 (FAO, 1969). It is generally between 0.5-2 m deep in most parts with a

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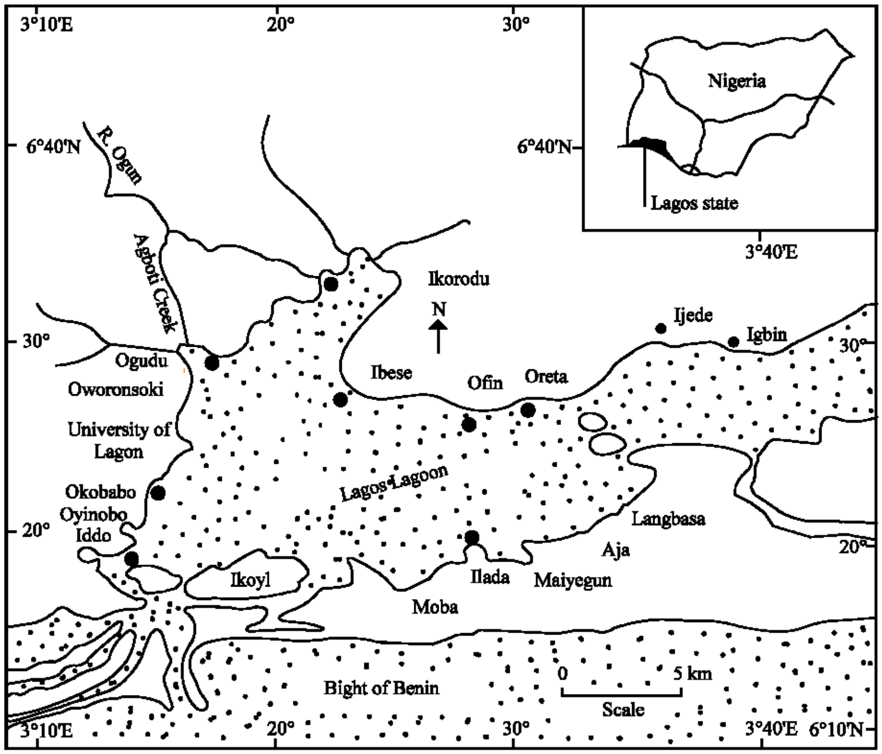

Station location	N-coordinates	E-coordinates	Station location	N-coordinates	E-coordinates
Ikate	N 06°28.228'	E 003°28.988'	Maijedun	N 06°36.383'	E 003°28.398'
Oreta	N 06°31.954'	E 003°30.664'	Iddo	N06°28.032'	E003°23.024'
Ofin	N 06°32.309'	E 003°30.003'	Okobaba	N06°29.252'	E003°23.492'
Ibese	N 06°32.116'	E 003°29.534'	Ogudu	N06°33.494'	E003°24.145'

Fig. 1: Map of the study area showing the sampling sites

maximum of about 5 m in the main Lagoon and 25 m in some dredged parts of the Lagos Harbour. The tidal range is only about 0.3-1.3 m. The interconnecting creeks are also very shallow and are sites of active silting and deposition of mud. The Lagoon sediments range between mud, sandy mud, muddy sand and sand (Ajao and Fagade, 1990b) and has a defined salinity gradient, linked with the rainfall pattern extending inland westwards and eastwards (Nwankwo and Akinsoji, 1992).

Collection and analysis of samples: Rainfall data were obtained from the Federal Meteorological Department Oshodi, Lagos, Nigeria and the measurement was in mm. Surface water samples were collected with a 1 dm^3 water samplers and stored in 1 L water bottles and analysed in the laboratory for pH, conductivity, salinity and turbidity using a multi-meter water checker (Horiba U-10). Separate water samples were collected in 250 mL dissolved oxygen bottles at each station for dissolved oxygen estimation using iodometric Winkler's method. Air and surface water temperature were measured *in situ* using mercury-in-glass thermometers.

Benthic samples were collected with the use of Van-veen grab. The sediment samples collected were sieved through 0.5 mm aperture size sieve. The materials retained in the 0.5 mm sieve were then preserved in 5% formalin. Sorting was done to get the clean samples of the benthic organisms. The sorted macro benthic fauna were identified to species level where possible. They were counted and numbers recorded. Identification was done after Edmunds (1978), Yankson and Kendall (2001), Olaniyan (1968) and Schreider (1990).

Community structure analysis

Species richness index (d): The Margalef's index (d) was used to determine the species richness (Valiela, 1995). The equation below was applied and results were recorded to two decimal places.

$$d = \frac{(S-1)}{\text{Log}_e N}$$

Where:

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

Shannon and wiener diversity index (H): Shannon and Weiner diversity index (H) given by the equation:

$$Hs = \Sigma \text{ Pi } 1n \text{ Pi}$$

Where:

Hs = 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

RESULTS AND DISCUSSION

Water chemistry: There were no significant differences ($p>0.05$) in the values of air and water temperatures between the two parts of the Lagoon. The highest pH value (8.01) recorded at Iddo sampling station was very close the value (7.9) recorded in Ikate. The highest salinity (32.0%) was recorded in Iddo, while the least (6.60%) was recorded in Ogudu sampling stations both in the western axis.

The highest turbidity value was recorded in Ogudu, while the least were recorded in Ikate and Oreta sampling stations. The least value for D.O was recorded in Iddo sampling station in the Western axis of the Lagoon (Table 1 and Fig. 2). The mean turbidity, Dissolved Oxygen and salinity in the two parts of the Lagoon is presented in Table 1.

Abundance and distribution of benthic macro-invertebrates: A total of 79 individuals were sampled in the western part of the Lagoon accounting for 7.9% of the total individuals sampled during the period of study, while 925 individuals were sampled in the eastern part accounting for 92.1% of the total individuals sampled. The highest number of species (10) was recorded at Oreta sampling station in the eastern axis of the Lagoon, while the least (3) was sampled at Ogudu sampling station in the western axis. The polychaetes *Nereis* sp. and *Capitella capitata* were dominant in the western axis of the Lagoon, while the bivalves, *Aloides trigona* and *Iphigenia truncate*, as well as the gastropods *Pachymelania* sp. and *Neritina glabrata* were dominant in the Eastern part of the Lagoon. Species diversity and abundance were generally low in the western part of the Lagoon compared to the eastern part (Table 1).

The results of the air and water temperatures obtained during the period of study showed that temperature differences in the two parts of the Lagoon are highly negligible. The result of Webb (1960), Nwankwo (2004) and Edokpayi and Nkwoji (2007) showed that temperature in the tropics is conservative. Natural variations in the temperature of the tropical waters have not been used as an index of pollution. There was no incidence of thermal water introduction in any of the sampling stations and hence, no remarkable change in temperature was recorded. The differences in the salinity of the water were related to the closeness of the station to the Atlantic Ocean. Nwankwo and Akinsoji (1992) has linked the salinity gradient of the Lagoon to the distance from the sea. Iddo sampling station, which recorded the highest salinity was closest to the sea than any other station. Conductivity and salinity had a direct relationship in this study (Table 1). Conductivity and salinity have been previously reported as associated factors (Onyema and Nwankwo, 2009; Edokpayi and Nkwoji, 2007). The western part of the Lagoon was generally more turbid than the eastern part. This might be as a result of human activities in this part of the Lagoon. The sewage dump at Iddo, the wood shaves at Okobaba and the discharge of waste waters at Ogudu are greatly

Table 1: Numerical abundance and occurrence of the benthic macroinvertebrates

	Eastern axis				Western axis			
Parameters	Ikate	Oreta	Ofin	Ibese	Majidun	Iddo	Okobaba	Ogudu
Mytilus edulis	-	11	2	-	2	1	-	-
Aloides trigona	1	101	65	21	-	-	7	-
Iphigenia truncate	12	119	28	3	1	-	-	-
Tympanotonus sp.	-	14	2	2	2	-	9	-
Pachymelania aurita	26	12	245	3	-	-	1	1
Neritina glabrata	5	102	69	4	-	1	2	-
Neritna senegalensis	-	2	60	-	6	-	-	-
Nereis sp.	-	1	-	1	4	12	5	3
Capitella capitata	-	2	-	1	5	2	4	7
Tellina nymphalis	1	4	-	-	2	-	-	-
Clibanarius africana	3	-	3	-	-	-	2	-
No. of species (S)	6	10	8	7	7	4	7	3
No. of individual (N)	48	368	474	35	22	16	30	11
Margalef's index (d)	1.29	1.52	1.14	1.69	1.94	1.08	1.76	0.83
Shannon-wiener index (Hs)	1.25	1.54	1.40	1.34	1.80	0.82	1.74	0.86

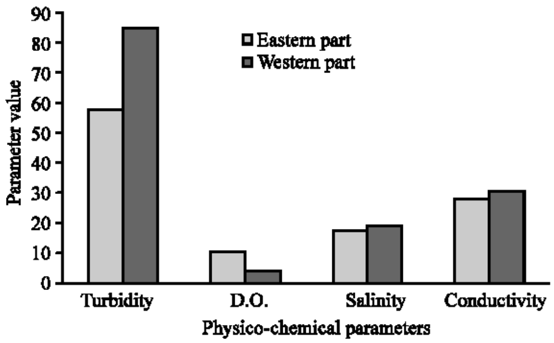

Fig. 2: Mean turbidity, D.O, salinity and conductivity in the two parts of the Lagoon

responsible for the high turbidity recorded in these areas. The high turbidity recorded at Ofin and Ibese sampling stations of the eastern part of the Lagoon was caused by the dredging activities around these areas during the period of study. The low dissolved oxygen recorded in the western part of the Lagoon was indicative of the abundance of biodegradable wastes and other land-based organic pollutants. Chukwu and Nwankwo (2004) stated that high load of biodegradable wastes was the major cause of low dissolved oxygen.

The abundance and distribution of benthic macro-invertebrates in the study area were greatly influenced by the physical and chemical characteristics of the water. This was in agreement with Brown and Oyenekan (1998) who assert that the abundance and diversity of the benthos are generally affected by the physico-chemical qualities of the water, availability of food and immediate substrate of occupation.

The class gastropoda recorded the largest number of species during the period of the study. Greater number (546) was recorded in the eastern part of the Lagoon accounting for 96.13% of all the gastropods sampled during this study. The class bivalvia was the second largest (374) taxa collected in this study with the eastern part of the Lagoon accounting for 97.1% of all individuals of that class sampled for both parts during the period of study (Table 1).

However, the polychaete worms were more abundant in the western part of the Lagoon in this study. Pearson and Rosenberg (1978) had identified the cosmopolitan endobenthic polychaete *Capitella capitata* (Fabricius) as an indicator for organically polluted and disturbed marine environments. A total of 42 polychaete species were collected in the western part of the Lagoon accounting for 89.4% of the total number of polychaetes collected in both parts of the Lagoon during the period of study. Edokpayi and Nkwoji (2007) had identified the polychaete worms as abundant species in the western part of the Lagoon. Brown (1991) had identified *Nereis succinea* as the dominant polychaete species in this part of the Lagoon.

The low abundance of pollution sensitive species like *Pachymelania* sp. in the western part of the Lagoon is a reflection of the pollution status of this part of the Lagoon. Only 2 individuals of this species were sampled in the western part during the period of study accounting for only 0.69% of the total number of *Pachymelania* sampled in both parts of the Lagoon.

There was an indication of a general defaunisation of this Lagoon for which reasons including pollution of the Lagoon are plausible. The overall low abundance and diversity in the western part of the Lagoon compared with the eastern part is as a result of the impacts of human induced stressors on this part of the Lagoon.

CONCLUSION

The result of this study shows great differences between the assemblage and diversity of the benthic macroinvertebrates in these two parts of the Lagoon. The high abundance of some sensitive species like *Pachymelania aurita* in the eastern part of the Lagoon and their low abundance in the western part show that the former is relatively clean compared to the later. The relatively high abundance of tolerant and opportunistic species like the Polychaete worms in the western part of the Lagoon is indicative of organic pollution of this part of the Lagoon. The overall low abundance and diversity of the benthic macroinvertebrates in the western part of the Lagoon is an indication that this part of the Lagoon is more exposed to human induced stressors and organic forms of pollution than the eastern part.

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