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Research

Physico-chemical parameters and macrobenthos of an estuarine creek and an artificial pond in Lagos, southwestern Nigeria

*Ogunwenmo, Christiana A. & Osuala, I. A.
University of Lagos, Faculty of Science, Department of Marine Sciences, Akoka, Lagos, Nigeria

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*Correspondence author <ogunwenmo@hotmail.com>

Abstract
Physico-chemical parameters, sediment type and macrobenthic fauna of an estuarine creek and artificial pond in the western region of Lagos lagoon were studied between January and July 2001. Temporal, physical and chemical parameters of the water and sediment were normal for the tropics, however the pH was alkaline throughout the study and sediment was solely silt. Succession had occurred in the artificial pond, and density and diversity of macrobenthic fauna were low. Six species belonging to the phyla Annelida, Mollusca and Arthropoda occurred. The effect of human induced stressors had resulted in an unstable physically controlled environment characterized by a low density of a few species.

Keywords: Physico-chemical characters, macrobenthos, lagos lagoon, fauna diversity, succession

Introduction
The estuarine Lagos lagoon system in southwestern Nigeria consists of numerous lagoons, mangrove swamps, rivers, creeks, and creeklets. (FAO, 1969). On the western coast of Lagos lagoon is the University of Lagos which is separated at some parts from the Lagoon by mangrove swamps in which there are creeks (Oyenekan, 1987). Macrobenthic fauna, of these creeks are similar to those found in virgin mangrove swamps (Brown and Kolabanjo, 1998). A fish pond was dug out about 3 metres from the side of a creek in the University of Lagos in 1998. A macrobenthic study was carried out in the creek and the dugout artificial pond. Fauna were absent from the pond. Subsequently in 2001 another macrobenthic study was carried out on both sites.

This paper discusses the changes in physio-chemical parameters, sediment type and community structure of two stations, a creek and artificial pond adjacent to the creek, between January and July 2001. A comparism of these factors in the two stations is also discussed.

Materials and methods
Field studies
Benthic samples were taken monthly at the station (Fig 1.) between the months of January and July 2001, using a 0.lm^2 Van-veen grab, from an anchored paddled boat. Five grab hauls were taken on each sampling date. Each haul was sieved in the field with a 0.5mm mesh sieve and preserved in 4% formalin, then taken to the laboratory for sorting.

The top portion of the sediment of the first haul at each station was preserved for sediment analysis. Water samples were collected in a water sampling bottle for analyses of physico-chemical properties.

Physico-chemical parameters
Atmospheric and surface water temperatures were obtained using mercury - in - glass thermometer depth with a paddle and graduated meter rule. Transparency was measured with a Secchi disc.

Laboratory analysis
Salinity was measured with a salinity meter bridge (model EES 15 – 35). The pH was measured using a Philips conductivity meter (model PW 405) and phos-

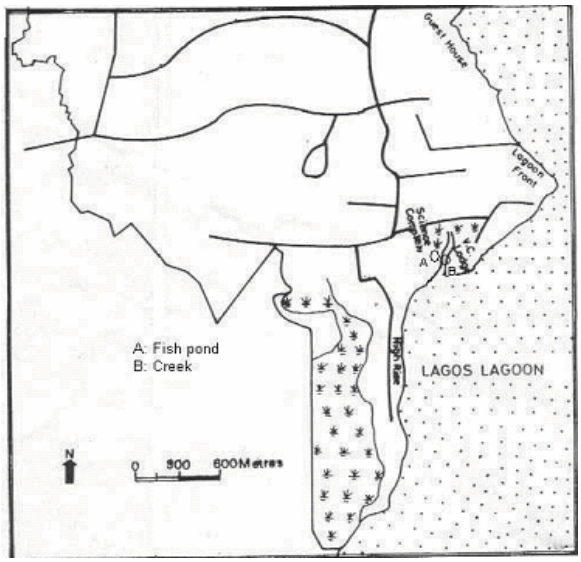

Fig.1: Map of University of Lagos showing sample stations

phate and nitrate were assessed using the Atomic Adsorption Spectrophotometer at 780 and 420nm respectively, while sulphates were analysed using the gravimetric method. The evaporation method was used to determine total solids. Chemical Oxygen Demand (COD) was determined using the Redox method and density with a density meter.

Sediment type was measured using the sediment profile method, and Total Organic Matter using the method described by Oyenekan, 1981. The percentage combustible material in sediment was estimated as:

Loss of weight on ignition/Initial weight before ignition x 100

Fauna preserved in the field was washed, sorted into taxonomic groups with suitable text (Olaniyan 1968, Campbell 1977), classified and counted. Margalef's Index (Margalef, 1957), Shannon-Weaver Index (Shanon & Weaver, 1963) and Equitability/Evenness (Lloyd & Ghellardi, 1964) were used to classify the environment.

Results

Physical and chemical parameters of stations A (fish pond) and B (Creek) are shown in Table 1. Salinity ranged between 2.46 and 25.13‰ at Station A and 2.28 and 23.37‰ at station B. Atmospheric temperature was between 20 and 34^{o}C while surface water temperature was highest (34^{o}C) in April at Station B and lowest in January at Station A. Also in station A, depth was lowest in March (18cm) and highest in February (47cm), while at station B the lowest value was recorded in April (69cm) and the highest in March (110cm). Phosphate values ranged between 0.074 and 0.81mg/l. Nitrate values ranged from 2.46 to 6.20mg/l, and sulphate values between 203 and 6509.8mg/l. Electrical conductivity was between 3.30 x 10^{2} and 6.10 x 10^{-2} at station A and 3.25 x 10^{-2} and 5.64 x 10^{2} at station B. The pH values ranged between 7.20 and 8.40 at station A and 7.30 and 9.20 at station B. Chemical Oxygen Demand values were lowest (34mg/l) in January and highest (54mg/l) in April, while density values ranged from 0.944 to 1.58g/cm^{3} and transparency between 6 and 29cm (Table 1).

Sediment at the two stations consisted of mud made up of silt and clay. At station A silt content ranged between 72% (January and April) and 80% (June), while clay was between 20% (June) and 28% (January and April) (Table 2a). Total organic content (TOC) varied between 13.9% in April and 16.8% in May. At station B clay content was lowest (26%) in July and highest (32%) in January and April. Silt was 68% in January and April, 70% in March, May and

Table 1. Variation of physico-chemical parameters in stations A and B between January and July 2001

Parameter	January		February		March		April		May		June		July	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Salinity ‰	21.26	21.62	25.13	23.37	22.14	21.62	21.97	20.56	16.87	16.48	4.92	5.45	2.46	2.28
Surface water temp. (^{0}C)	27	29	28	29	32	32	32	34	31	31	29	28	28	28
Depth (cm)	30	95	47	86	18	110	24	69	37	105	23	87	35	100
$PO^{5}{}_{4}$(mg/1)	0.81	0.81	0.39	0.47	0.34	0.32	0.34	0.32	0.36	0.34	0.083	0.110	0.074	0.092
NO_3 (mg/1)	4.67	4.69	5.88	6.20	5.58	5.63	5.72	5.40	5.49	5.62	2.62	2.86	2.46	2.68
$SO^{2}{}_{4}$(mg/1)	31.58	3162	2799	2770	4571.33	6509.8	4429.1	3975.9	2853.2	2756.4	203	284	894	813.7
Electrical conductivity Scm^{-1}	3.60 $x10^{-2}$	3.81 $x10^{-2}$	4.53 $x10^{-2}$	5.64 $x10^{-2}$	3.89 $x10^{-2}$	5.02 $x10^{-2}$	6.10 $x10^{-2}$	4.83 $x10^{-2}$	3.30 $x10^{-2}$	3.25 $x10^{-2}$	4.40 $x10^{-2}$	7.9 $x10^{-3}$	5.8 $x10^{-3}$	4.8 $x10^{-3}$
pH	7.2	7.3	7.7	9.2	7.9	9.0	8.0	9.2	7.80	9.0	8.40	8.20	8.10	8.30
COD (mg/1)	34.0	35.0	42	51	46	49	54	47	40	43	36	42	36	40
Density g/cm^{3}	1.008	1.010	1.269	1.581	1.002	1.016	0.974	0.971	0.984	0.976	0.991	1.001	0.944	1.010
Transparency (cm)	12	20	11	18	6	16	10	21	14	12	6	29	11	16
Atmospheric temp. ^{0}C	27	28	28	28	29	28	33	30	29	20	34	34	30	30

Table 2a: Sediment analysis for station A Jan - Jul 2001

	Ja	Fe	Ma	Ap	Ma	Ju	Jul
TOC (%)	15.4	14.9	14.4	13.9	16.8	15.1	15.8
Clay %	28	24	20	28	26	20	24
Silt %	72	76	80	72	74	80	76

Table 2b: Sediment analysis for station B Jan - Jul 2001

	Ja	Fe	Ma	Ap	Ma	Ju	Jul
TOC %	13.5	18.1	13.9	13.4	16.8	14.3	21.1
Clay %	32	28	30	32	30	30	26
Silt %	68	72	70	68	70	70	74

June, 72% in February and 74% in July (Table 2a). TOC varied from 13.4% in April to 21.1% in July at station B, Table 2b.

Macrobenthic fauna consisted of annelids, molluscs and arthropods. In the fish pond *Tympanotonus fuscatus* var. *radula* ranked highest in number followed by *Pachymelania aurita*, *Neritina glabrata*, *Aloidis trigona* and the polychaete *Nereis succinea*. *Clibinarius africanus* was also collected. (Table 3a & b). In the creek, molluscs were similar to those present in the pond. *Nereis succinea* was absent in May and June but *Clibinarius africanus* was not collected.

Table 3a: Composition and abundance of macrobenthic fauna per 0.5 m^2 collected from station A Jan - Jul 2001

Species	Ja	Fe	Ma	Ap	Ma	Ju	Jul
Tympanotonus fuscatus var. *radula*	6	14	17	28	9	42	16
Pachymelania aurita	7	4	10	8	5	20	5
Neritina glabrata	2	5	5	4	2	8	6
Aloidis trigona	1	2	2	1	1	2	2
Nereis succinea	1	2	4	1	-	2	-
Clibinarius africanus	3	4	2	2	4	3	5

Table 3b: Composition and abundance of macrobenthic fauna per 0.5m^2collected from station B Jan – Jul 2001

Species	Ja	Fe	Ma	Ap	Ma	Ju	Jul
Tympanotonus fuscatus var *radula*	23	71	135	100	200	191	38
Pachymelania aurita	3	5	18	12	35	38	25
Neritina glabrata	6	10	8	6	8	10	8
Aloidis trigona	2	1	4	2	5	8	5
Nereis succinea	2	2	3	1	-	-	1
Clibinarius africanus	-	-	-	-	-	-	-

Margalef's Index values at the fishpond ranged between 1.13 (July) and 1.67 (January) (Table 4a). Values at the creek were lower and ranged from 0.54 to 1.12 in January (Table 4b).

The highest value of Shannon and Weaver Index at station A was 1.54 (January), while the least was 1.12 (April) (Table 4a). At station B the index was 0.61 in April, 0.64 in May, 0.72 in February and March and 0.73 in June. The index was 1.11 in January and 1.18 in July (Table 4b).

Table 4a: Diversity indices for station A Jan – Jul 2001

Index	Ja	Fe	Ma	Ap	Ma	Ju	Jul
Margalef	1.67	1.46	1.36	1.32	1.31	1.15	1.13
Shannon/W.	1.54	1.20	1.49	1.12	1.39	1.24	1.38
Lloyd&G.	0.86	0.67	0.83	0.62	0.87	0.69	0.86

Table 4b: Diversity indices for station B Jan – Jul 2001

Index	Ja	Fe	Ma	Ap	Ma	Ju	Jul
Margalef	1.12	0.89	0.78	0.83	0.54	0.54	0.92
Shannon/W	1.11	0.72	0.72	0.61	0.64	0.73	1.18
Lloyd&G.	0.69	0.45	0.45	0.38	0.46	0.46	0.73

Lloyd and Ghellardi Index (species richness) at the fish pond (station A) was least (0.62) in April and highest (0.87) in May. At the creek (station B), species richness was 0.69 in January, 0.45 in February and March, 0.38 in April, 0.46 in May and June and 0.73 in July.

Discussion

High atmospheric and surface water temperatures (20 – 34^{o}C) were in consonance with results of earlier workers in and around Lagos Lagoon (Fagade, 1979; Oyenekan, 1987; Ajao & Fagade, 1990a, b, c & d; Brown & Oyenekan, 1998). The salinity was normal for a brackish water body in the tropics (Hill & Webb, 1958; Sandison, 1966; Brown & Oyenekan, 1998). The creek and pond exhibited the usual alkaline properties with pH values ranging between 7.20 and 8.40 for the pond and 7.30 and 9.20 for the creek. In earlier studies on the same sites during the same season the water was acidic pH 5 – 6.6 (Brown & Kola-Banjo, 1998).

Sediment type was clayey – silt in both sites representing the black loamy sediment of the mangrove swamp (Longhurst, 1958; Oyenekan, 1987), however, a shift in sediment composition had occurred. Sandy sediment present in 1998 had changed to silt by 2001 during the course of this study. Temporal sediment change has not been reported before in southwestern Nigeria, however, in and around Lagos Lagoon, Oyenekan (1987) reported spatial sediment changes over short distances in the Lagos Lagoon.

Annelids, molluscs and arthropods are reported for the first time in the artificial pond since construction. In 1998, a similar study showed that succession had not yet started in the pond. Species present were similar to those collected by earlier benthic ecologists in and around Lagos Lagoon (Oyenekan, 1987; Ajao & Fagade, 1990a, b, c & d; Brown & Oyenekan, 1998; Brown & Kolabanjo, 1998). Macrobenthic species (*Balanus pallidus*, *Gryphea gasar*, *Mercierella enigmatica* and *Hydroides uncinata*) were members of the primary mangrove swamp recorded by Sandison (1966) and

Sandison and Hill (1966). They were probably absent in the present study due to defaunation caused by deforestation of the mangrove species as well as other environmental stressors such as pollution (effluent discharge, runoff and air pollution emissions), land and resource use (population concentration, urbanization, dredging resulting in increased sediment runoff and habitat loss), invasive species (causing changes in community structure), extreme events (coastal storms, floods, droughts and algal blooms) and climatic change (rising water temperature and currents, and stratification of water bodies). A reduction in density and diversity of macrobenthic fauna was recorded in this study as *Mercierella engmatica*, *Pachymelania fusca* var. *quadriseriata*, *Iphigenia truncata* and *Balanus pallidus* recorded in the creek in an earlier study (Brown & Kolabanjo, 1998) were absent. Since benthos are sediment specific (Oyenekan 1987, Brown & Oyenekan, 1998) the change in benthos composition could be due to the change in sediment type from sand to clayey-silt. Change in benthic composition is also important as variations in faunistical composition, densities and biomass of organisms are used in biotype mapping to zone habitats in estuaries like the Bonny River in Niger Delta (Zabi and Leloeuff, 1993).

Diversity indices also signified low density and diversity of macrobenthic fauna. Species richness was high in January in the fish pond while evenness of spread of individuals among the species present was highest in May when five species were collected. Results at the creek showed that Margalef''s Index was also highest in January, diversity index highest in July and evenness highest in July. All these results show low diversity and density of species in the fish pond and creek. Low species populations are not strange to West Africa as Zabi and Leloeuff (1993) reported low species in a macrobenthic populations found in Senegambia (Senegal, Gambia and Casamance) Rivers.

The apparent change in the composition of macrobenthic fauna in this ecosystem shows an unstable estuarine system with low diversity of a few species. This represents an unstable but stressed environment synonymous to the physical controlled environment of a small number of species with low density described by Sanders (1968).

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