Effects of Topographical Modification on the Composition and Abundance of Macrofauna in Southern Lagos Lagoon (Ikoyi)

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Abstract

The seasonal variation of macrobenthos at Ikoyi was investigated between February 1985 and January 1990. Mean values of surface water temperature, salinity, and percentage mud in sediment and total organic matter were 27.89 °C, 12.22 ‰ 20.36 %, and 5.41 %, respectively. There were no deviations from normal values in a tropical estuarine open lagoon system. Mollusca, Arthropoda, Annelida, Chordata, Nemertina and Chaetognatha were collected. The gastropod mollusc, *Pachymelania aurita*, ranked highest on all but two sampling dates, where *Tympanotonus fuscatus* and *Aloidis trigona* ranked first. Changes in salinity and sediment type were main factors contributing to reduction of species, dominance diversity and change in community structure, which were attributed to habitat modification caused by dredging and sand filling.

Introduction

Lagos lagoon is the largest brackish water body of the southern lagoon system in Nigeria. (Webb, 1958). Although various aspects of the physical properties (Hill & Webb, 1958; Olaniyan, 1969), such as plankton (Olaniyan, 1969; Nwankwo, 1990), epiphytes (Nwankwo & Akinsoji, 1992), finfish (Fagade, 1971, 1979; Fagade & Olaniyan, 1972, 1973, 1974), shell fish (Yoloye, 1974; Yoloye & Adegoke, 1977; Oyenekan, 1979; Oyenekan & Bolufawi, 1986; Ajao & Fagade, 1990a, 1990b, 1990c, 1990d, 1990e; Brown & Oyenekan, 1998), and other fauna (Hill, 1967) have been studied with inputs on pollution (Ekundayo, 1977; Akpata & Ekundayo, 1978; Akpata *et al.*, 1993; Otitoloju, 2002, 2003), as well as mining (Awosika & Dublin-Green, 1994), a census of the present status of the macrobenthic community is necessary due to increased pollution, population explosion and anthropogenic activities in and around the lagoon.

Longhurst (1958) observed bottom sediments and fauna in the West African continental shelf. Fauna classified by communities belonged to various taxa. Earlier, Smith (1871) described shells from West Africa, hitherto unidentified. Later, Webb (1958) studied the life cycle of *Branchiostoma nigeriense* in the Lagos lagoon. After this there was a dearth of information on benthos in the Lagos lagoon, until Sandison (1966) and Sandison & Hill (1966) observed effects of salinity on macrobenthic fauna in and around the Lagos harbour and adjacent creeks. Yoloye & Adegoke (1977) named a new species of *Neritina* from the Lagos lagoon. The next extensive survey on macrobenthic fauna was not carried out until the next decade when Oyenekan (1987) described the benthic macrofaunal communities of the

Lagos lagoon. He described five communities by biotype and biocenosis. More recently, Ajao & Fagade (1990a, 1990b, 1990c) also studied these communities and concluded that the major cause of reduction to extremely low diversities and densities was due to the discharge of various types of untreated wastes into the Lagos lagoon by identified industries. They also recognized a shift in the characteristic fauna in the western industrialized region and eastern unpolluted region. In addition untreated sewage and effluent is discharged into the lagoon (Nwakoro & Odiete, 1997), sand is mined indiscriminately (Awosika & Dublin-Green, 1994), and, in some areas, communities have been completely destroyed by dredging and sand filling activities.

It has, therefore, become imperative to assess the effect of habitat destabilization and modification (caused by dredging activities which evacuate the sediment bottom and sand filling over the mangrove swamp and macrobenthic community), on this localized area in the southern Lagos lagoon, with a view to assessing the problem, profer solutions and prevent further defaunation.

Materials and methods

Benthic samples were taken in the rainy season (June 1985 and 1986, and July 1987, 1988 and 1989) and dry season (February 1985 and 1986, and January 1988 and 1990) at Ikoyi (Fig. 1), using a 0.1m^2 Van-Veen grab. No samples were collected from Ikoyi in May 1996 because sand filling and dredging of the surrounding offshore sites made the area too deep to be sampled. Six grab hauls were taken at each station. Benthic fauna were retrieved from five hauls after Crisp (1971), while the sixth grab haul was used for sediment analysis. Five grab hauls were washed through a 0.5-mm mesh sieve in the field. The retained material was preserved in 5% formalin and kept in labeled jars for further analysis in the laboratory. The sixth grab haul was placed in a labeled polyethylene bag for preservation in the deep freezer in the laboratory for sediment analysis.

Preliminary investigations showed that surface water temperature and bottom water temperature in the Lagos lagoon ranged between 25 °C and 28 °C. Surface water temperatures were, therefore, taken to the nearest whole number, using a mercury-in-glass-thermometer at Ikoyi in the rainy and dry seasons. Water samples were collected with a glass water sampler and stored in clear glass bottles for salinity determination using a temperature compensated hand refractometer (New S-100), in the laboratory. Sediment samples were thawed and dried for 6-8 h at 60-80 °C, to a constant weight. Grain size analysis was carried out as described by Buchanan & Kain (1971). Total organic matter (TOM) was determined using the method described by Oyenekan (1981), and the percentage of combustible material in the sediment was estimated as:

$$\frac{\text{Loss of weight on ignition}}{\text{Initial weight before ignition}} \times 100\%$$

The organisms preserved in the field were washed, sorted into taxonomic groups and counted. Faunal density was expressed as species per square metre (m^{-2}). Species were ranked and the contributions of the first five numerically dominant species were recorded.

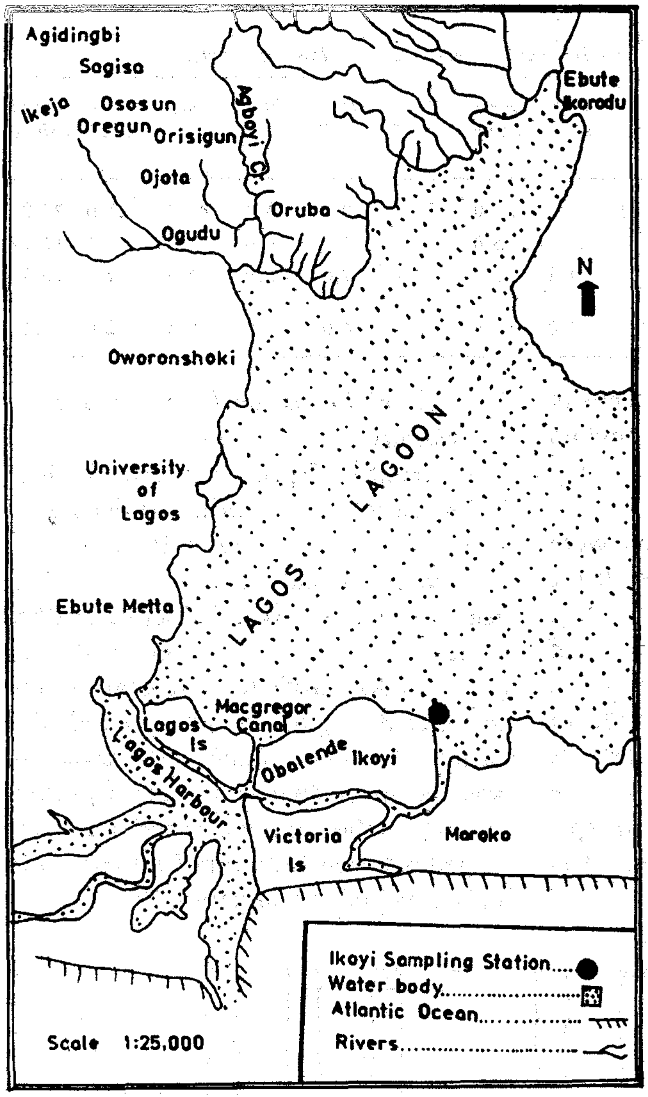

Fig. 1. Map of Lagos lagoon showing Ikoyi sampling station

Margalef's Index (Margalef, 1957), Shannon and Weaver Information Function (Shannon & Weaver, 1963), and Equitability (Lloyd & Ghellardi, 1964) were used to measure diversity in the environment.

Margalef's Index

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

d = diversity index, S = number of species, N = number of individuals, $\log_e$ = natural logarithm.

Shannon and Weaver Information Function

$$Hs = p_i \log_e p_i$$

S = total number of species; p_i = observed proportion of individuals that belong to the i^{th} species.

Equitability

$$J = \frac{Hs}{\mathrm{Log}_2 S}$$

J = equitability measure

Hs = Shannon and Weaver Information Function

S = number of species in sample or community

Results

Physical and chemical properties

Surface water temperature was narrow (26-30 °C) with a mean of 27.89 °C, salinity values were between 0‰ (June and July), and 29‰ (February) with a mean of 12.22 ‰. Total organic matter was low (< 20.0%) while percentage mud in sediment ranged between 1.3% in February 1986 and 83.2 % in February 1985 and had a mean of 5.41‰ (Table I).

Major animal taxa

The seasonal distribution of phyla at Ikoyi shows a community dominated by molluscs (gastropods and bivalves), which contributed between 77.1% (January) and 100.0% (February 1986) of total fauna collected at

TABLE 1

Variation in some physico-chemical parameters during 1985 to 1990

Sampling dates / *Parameters*	*Feb 1985*	*June 1985*	*Feb 1986*	*June 1986*	*July 1987*	*Jan 1988*	*July 1988*	*July 1989*	*Jan 1990*	*Mean valuea*
Surface water temp. (°C)	27.0	27.0	30.0	27.0	26.0	30.0	28.0	28.0	28.0	27.89
Salinity (‰)	29.0	0.0	27.0	5.0	3.0	21.0	0.0	1.0	24.0	12.22
Mud in sediment (%)	83.2	39.4	1.3	3.7	22.7	19.0	6.9	4.3	2.7	20.36
Total organic matter in sediment (%)	17.8	19.1	1.0	0.5	2.0	4.0	1.0	1.3	2.0	5.41

Ikoyi. (Fig. 2). There was a higher density of gastropods than bivalves. The phylum Annelida contributed between 0.5% (July 1989) and 18.7% (February 1985) of fauna collected. Crustacean arthropods were present and contributed between 0.1% (February 1986) and 23.8% (February 1985). Phylum Nemertina contributed to 4.8% of the sample collected in February 1985. Phylum Chordata contributed 0.1% of sample collected in February 1986 and 0.3% of sample collected in January 1990. The phylum Chaetognatha (*Sagitta* sp.) contributed 0.1% of sample collected in June 1986 (Fig. 2).

Species richness and abundance of individuals

The number of species per m^2 was highest in February 1985 (26/m^2). The density of species collected in January 1990 and July 1988 were 11 and 12, respectively. The density of individuals varied between 10/m^2 (June 1985) and 60, 104/m^2 (February 1986) (Table 2). A total of 37 different fauna were collected during the sampling period. The gastropod mollusc, *Pachymelania aurita*, was the most abundant species present throughout the sampling period. Densities ranged between 120/m^2 in February 1985 and 60,056/m^2 in February 1986.

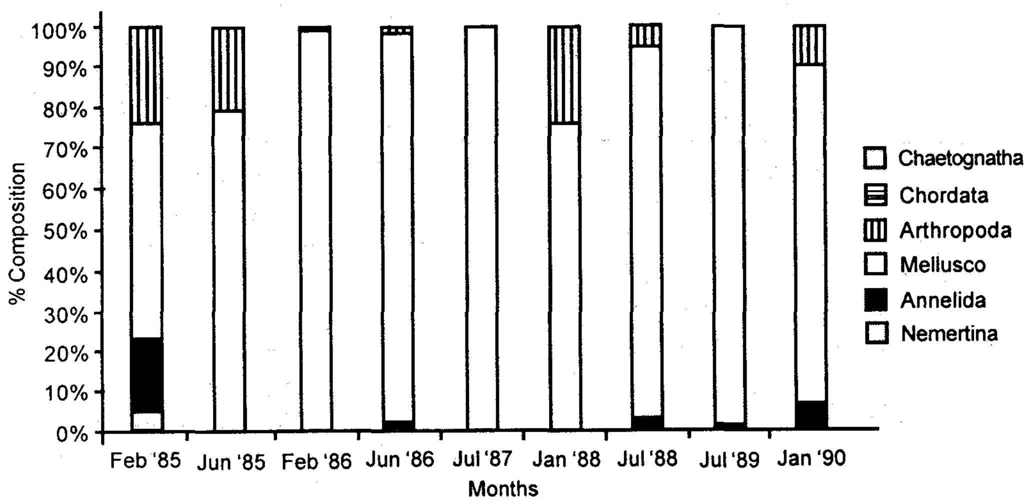

Fig. 2. Seasonal distribution of phyla at Ikoyi

TABLE 2

Density of macrofauna per m² at Ikoyi for wet and dry seasons between February 1985 and January 1990

	Feb 1985	*June 1985*	*Feb 1986*	*June 1986*	*July 1987*	*Jan 1988*	*July 1988*	*July 1989*	*Jan 1990*
NEMERTINA									
Nemertina	28								
ANNELIDA									
Capitella capitata	30								
Glycera convoluta	2						4		
Diopatra neapolitana	10								
Lumbrinereis sp.	12								
Mercierella enigmatica	4								
Nephtys sp.									4
Nereis pelagica				20					
Nereis sp.	12								
Nereis succinea							16	2	46
Phoronis muelleri	2								
Prionospio sp.	2								
Polydora sp.	20								
Syllidae	8								
Tubifex sp.	8								
MOLLUSCA									
Pachymelania aurita	120		60056	1350	1535	1380	564	398	406
Tympanotonus fuscastus	168								
Neritina glabrata			2	68		5	72	16	130
Aloidis trigona	4	4	4			10	6		
Mytilus edulis					5				
Brachyodontes puniceus	4						4		
Cultellus tenius	6	4							
Diplodonta sp.	2								
Iphigenia truncata	2								4
Crassostrea gasar	4			72		5	20	2	16
ARTHROPODA									
Balanus pallidus	14		32			400			10
Callinectes latimanus	16								
Sersarma huzardi							2		
Clibinarius africanus	32			4		15	8	14	44
Pachygrapsus transversus							2		2
Calappa rubroguttata							4		
Caprella linegris	72								
Corophium insidiosum	4								
Peneaus notialis							12	12	6
Unidentified amphipod	2	2		10					
CHORDATA									
Branchiostoma nigeriense	32								2
CHAETOGNATHA									
Sagitta sp.				2					
Species	26	3	4	7	2	6	12	6	11
Individuals	588	10	60,104	1526	1540	1815	714	444	670

P. aurita ranked first in density among all species collected on all sampling dates except February 1985 when it ranked second to *Tympanotonus fuscatus*. Other high-ranking fauna were *Neritina glabrata, Aloidis trigona, Crassostrea gazer, Nereis succinea, Caprella linegris, Capitella capitata, Nemertina, Cultellus tenius,* unidentified amphipod, *Balanus pallidus, Branchiostoma nigeriense, Nereis pelagica, Mytilus edulis, Clibinarius africanus* and *Peneaus notialis*. (Table 3). During the dry season (February 1986), a lagoon visitor, *B. nigeriense* ranked second along side *Balanus pallidus*, while *M. edulis* also a marine species ranked second in July 1987.

Faunal indices

Margalef's Index values ranged between 0.14 in July 1987 and 3.92 in February 1985 (Table 4). Shannon and Weaver Information Function values were highest in February 1985 (2.29) and lowest in February 1986 (0.1) (Table 4). The equitability of individuals ranged from 0.01 (February 1986) to 0.66 (June 1985). (Table 4).

Discussion

The average surface water temperature at Ikoyi was 27.49 °C. This value was higher than that of earlier workers. Fagade (1969) obtained a surface water temperature of 24.8 °C in July 1967 off Ikoyi, while Oyenekan (1987) obtained a temperature of 26 °C in October 1974. Salinity was lower in the wet season months (June and July) than the dry season months (January and February). Similar results were obtained from earlier workers (Fagade, 1969; Oyenekan, 1987; Brown, 1998).

The *Pachymelania* community was one

TABLE 3

Ranking of macrofauna at Ikoyi between February 1985 and January 1990

	Feb 1985	*June 1985*	*Feb 1986*	*June 1986*	*July 1987*	*Jan 1988*	*July 1988*	*July 1989*	*Jan 1990*
Pachymelania aurita	2		1	1	1	1	1	1	1
Tympantonus fuscatus	1								
Neritina glabrata			4	3		5*	2	2	2
Aloidis trigona		1	3			4			
Crassostrea gazar				2		5*	3	5*	5
Nereis succinea							4	5*	3
Caprella linegris	3								
Capitella capitata	4								
Nermertina	5								
Cutellus tenuis		2							
Unidenified amphipod		3		5					
Balanus pallidus			2*			2			
Branchiostoma nigeriense			2*						
Nereis pelagica				4					
Mytilus edulis					2				
Clibinarius africanus						3		3	4
Peneaus notialis							5	4	

* Same ranking

TABLE 4

Faunal indices at Ikoyi

	Margalef's Index	*Shannon & Weaver Information Function*	*Equitability*
Feb. '85	3.92	2.29	0.49
June '85	0.87	1.05	0.66
Feb. '86	0.27	0.01	0.01
June '86	0.83	0.38	0.13
July '87	0.14	0.02	0.02
Jan '88	0.67	0.64	0.25
July '88	1.67	0.99	0.27
July '89	0.82	0.50	0.19
Jan '90	1.54	1.23	0.35

of the five communities described by Oyenekan (1987) in the Lagos lagoon; others were Mangrove, Estuarine, Venus and Estuarine rock communities. The *Pachymelania* community inhabited the main part of the Lagos lagoon and consisted of *Pachymelania aurita, Aloidis trigona, Iphigenia truncata, Neritina glabrata, Branchiostoma nigeriensis, Glycera convoluta, Nereis succinea, Lumbrinereis* sp., *Diopatra neapolitanea* and crustaceans, *Clibinarius africana* and *Heteropanoe caparti. Tympanotonus fuscatus, Tagellus angulatus* and *Cultellus tenuis* were also present. Presently in the modified *Pachymelania* community that had reduced in density and diversity from that recorded by Oyenekan (1987), Mollusca, Annelida and Arthropoda co-existed alongside Nemertina and Chaetognatha. The latter two were previously absent from this ecosystem. In addition, crabs (*Sersarma huzardi, Pachygrapsus transversus* and *Calappa rubroguttata*) were also collected. Their presence in the open lagoon is unusual and suggests a possible change in habitat, which could have been brought about by sand filling the Mangrove Park at Ikoyi Island. The marine visitor (*Branchiostoma nigeriense*) reported at Ikoyi (Webb, 1958; Brown & Oyenekan, 1998) was also collected at Ikoyi during the dry season months. *Balanus pallidus* (a typical mangrove species and fouling organism) also showed abundance during dry season samplings.

One Nemertina, 11 Annelida, three Mollusca and three Arthropoda species collected at Ikoyi in February 1985 were absent at later sampling dates. The change in community structure from *Pachymelania* community to mangrove community indicates a change in either density or diversity of macrobenthic fauna at Ikoyi. These changes are not independent of physico-chemical factors. Oyenekan (1987) observed muddy fine sand at Ikoyi; this later changed to sandy mud (Ajao, 1990d). This could have been attributed to the high diversity observed in February 1985, which dwindled in later sampling dates when the substrate became sandier. Similar reductions in habitat diversity from changes in substrate, current flow and depths (Gordan & Carr, 1978) have also been implicated for shifts and reductions in the number of invertebrate species (Morris *et al.*, 1968).

In addition to substrate type, salinity also determines diversity and density of fauna (Brown & Oyenekan, 1998). The salinity at Ikoyi in February 1985 (29.0‰) was the highest collected from all sampling dates. Subsequently, lower salinities (0-27‰) and species diversity (2-12 species/m^2) were recorded.

The dredging and sand filling activities at

Ikoyi have pollution implications as they alter bottom conditions over sizeable areas (Ajao & Fagade, 1990e) and destroy mollusc settlement areas (Cole, 1977). These have brought about variations in some physico–chemical parameters and a significant reduction in species, and dominace diversity as well as change in community structure.

Conclusion

The present metamorphosis in community structure provides baseline information on physical, chemical and biological data in southern Lagos lagoon at Ikoyi. This could provide scientific basis for monitoring future ecological changes in the lagoon.

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