

# THE STUDY OF FORAMINIFERAL DISTRIBUTION TRENDS IN THE COASTAL ENVIRONMENTS OF SOUTHWEST NIGERIA SECTOR OF THE GULF OF GUINEA

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## DEDICATION

This thesis is dedicated to the Almighty God.

OBATELMIA MOLOWING



## CERTIFICATION

This is to certify that this thesis for the award of Ph.D in Applied Geology (option in Sedimentary and Petroleum Geology) was written by Phillips Olusegun Adebayo (SCP10/11/H/0561) under my supervision.

Dr. A. A. Adepelumi (Supervisor)



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## **TABLE OF CONTENTS**

Title	Page	i
Dedic	ation	ii
Certif	Certification	
Ackno	Acknowledgement	
Table	Table of Contents	
List o	f Tables	ix
List o	f Figures	xii
List o	f Appendices	xvii
Abstr	act	xix
CHA	PTER ONE: INTRODUCTION	
1.1	Background Information	1
1.2	Statement of Research Problem	13
1.3	Objectives and Scope of the Present Work	13
CHA	PTER TWO: LITERATURE REVIEW AND ENVIRONMENTAL	
SETT	TING	
2.1.	Literature Review	15
2.2	Environmental Setting	23
2.3	Geomorphology	30
2.3.1	The Barrier-Island Complexes	32
2.3.2	Vegetated Tidal Flats	32
2.3.3	The Lower Flood Plain	33
2.3.4	The Upper Flood Plain	33
2.3.4.	1 Freshwater alluvium and levee slope soils	34
2.3.4.	2.3.4.2 Flood Plain Soils	
2.3.4.	3 Mangrove Swamp Soils	34
2.3.4.	4 Saline Sands	35



Beach Ridge Sands	36
Vegetation	37
Climate	39
Air Temperature	39
Rainfall Regime	40
Humidity	41
Oceanography	41
Sea Surface Temperature	41
Sea Surface Salinity	42
Waves	42
Current	43
Longshore Current	43
Tidal Currents	43
Rip Currents	44
Ocean Currents	44
Coastal Circulation	44
Seasonal upwelling	45
Storm Surges	46
Sediment Transport Dynamics	46
	Beach Ridge Sands Vegetation Climate Air Temperature Rainfall Regime Humidity Oceanography Sea Surface Temperature Sea Surface Salinity Waves Current Longshore Current Tidal Currents Rip Currents Ocean Currents Ocean Currents Coastal Circulation Seasonal upwelling Storm Surges

## CHAPTER THREE: MATERIALS AND METHODS OF STUDY

3.1	Materials	48
3.2	Study Area	48
3.3	Sampling Technique	50
3.4	Sample Preparation for Sedimentological Analysis	50
3.4.1	Wet Sieving	50
3.4.2	Sand-Size Granulometric Analysis	51
3.4.3	Graphical and Statistical Parameters	52
3.4.3.1	Inclusive Graphic Mean, Mz	55
3.4.3.2	Inclusive graphic standard deviation, $\Phi_{SD}$	56
3.4.3.3	Inclusive graphic skewness, $\Phi_{Sk}$	56



3.4.3.4	Graphic Kurtosis	57
3.5	Sample Preparation for Foraminiferal Analysis	59
3.6	Quantitative Analysis of Foraminifera	60
3.6.1	Multivariate Analyses	60
3.7	Analytical Procedures	61
3.7.1	Sediment Analysis	61
3.7.2	Digestion of Sediments	62
3.7.3	Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)	62
CHA	PTER FOUR: RESULTS AND DISCUSSION	

CHAI	PTER FOUR: RESULTS AND DISCUSSION	
4.1	Data on Ecological Factors	65
4.1.1	Ikate Beach	65
4.1.2	Tarkwa Bay and Lagos Harbour	67
4.1.3	Lagos Lagoon	69
4.1.4	Badagry Creek	72
4.1.5	Yewa River	75
4.1.6	Badagry Beaches	77
4.2.0	Trace Metal Concentration in Sediments	81
4.2.1	Common Trace Metal Concentration in Tarkwa Bay and Lagos Harbour	82
4.2.2	Common Trace Metal Concentration in Lagos lagoon	85
4.2.3	Common Trace Metals in the Sediments of Badagry Creek	86
4.2.4	Common Trace Metals in the Sediments of Yewa River	90
4.3	Sediments Characteristics	92
4.3.1	Textural Characteristics of Sediments of Ikate Beach (Bk labeled samples)	92
4.3.2	Tarkwa Bay (Station 'B') and Lagos Harbour (Station 'H') Sediments	98
4.3.3	Textural characteristics of Lagos lagoon Sediments	108
4.3.4	Textural Characteristics of Badagry Beach Sediments	117
4.3.5	Textural Characteristics of Sediments of Badagry Creek	127
4.3.6	Textural Characteristics of Yewa river Sediments	136
4.4	Foraminiferal Data Acquired	141
4.4.1a	Foraminiferal Data Acquired from Ikate Beach	141



4.4.1b Result of Principal Component Analysis (PCA) of Ikate beach samples	149
4.4.1c Result of Cluster Analysis (Ikate Beach)	155
4.4.2a Foraminiferal Data Acquired from Tarkwa Bay and Lagos Harbour	159
4.4.2b Result of Principal Component Analysis (PCA) of Tarkwa bay	168
and Lagos harbor sediments	
4.4.2c Result of Cluster Analysis (Tarkwa Bay and Lagos harbour)	168
4.4.3a Foraminiferal Data Acquired from Lagos lagoon Sediments	175
4.4.3b Result of Principal Component Analysis (PCA) of Lagos	184
lagoon Sediments	
4.4.3c Result of Cluster Analysis (Lagos lagoon)	189
4.4.4a Foraminiferal Data Acquired from Badagry Beaches	193
4.4.4b Result of Principal Component Analysis (PCA) of Badagry Beach Sample	s 207
4.4.4c Result of Cluster Analysis (Badagry Beach)	212
4.4.5 Foraminiferal Data Acquired in Yewa and Badagry Creek	216

# CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.2	225
5.3	229
	230
	252

PHEL



## LIST OF TABLES

Table		Page
1:	Phi-Millimeter Conversion Table for the Sieve Diameter Sizes used	54
2:	Summary of Graphical Measures and Standard values for interpretation (Folk and Ward, 1957)	58
3:	Data on Ecological Factors obtained from Ikate beach, Lagos, Southwest, Nigeria	66
4:	Data on Ecological Factors obtained from Tarkwa Bay and Harbour, Lagos, Southwest Nigeria	68
5:	Data on Ecological Factors obtained from Lagos lagoon, Lagos, Southwest, Nigeria	70
6:	Data on Ecological Factors obtained from Badagry Creek, Lagos, Southwest, Nigeria	73
7:	Data on Ecological Factors obtained from Yewa River, Lagos, Southwest, Nigeria	76
8:	Data on Ecological Factors obtained from Badagry Beaches, Lagos, Southwest, Nigeria	78
9:	Reference Values Provided for some Common Trace Elements by Environmental Protection Agency (EPA) of America (Prater and Anderson, 1977)	83
10:	Concentration of selected Trace Metals in Sediments of selected stations in the Tarkwa Bay and Lagos Harbour, Southwest, Nigeria	84
11:	Concentration of Selected Trace Metals in Sediments of Lagos Lagoon (Olatunji and Abimbola 2010)	87
12:	Concentration of selected Trace Metals in Sediments of selected stations in the Lagos lagoon, Southwest, Nigeria	88
13:	Concentration of selected Trace Metals in Sediments of selected stations	89



in the Badagry Creek, Southwest, Nigeria.

14:	Concentration of selected Trace Metals in Sediments of selected stations in the Yewa river, Southwest, Nigeria	91
15:	Data on Textural Parameters for Ikate Beach Samples	94
16:	Data on Textural Parameters for Lagos Harbour and Tarkwa Bay Samples	101
17:	Data on Textural Parameters for Lagos lagoon Samples	110
18:	Data on Textural Parameters for Badagry beach Samples	119
19:	Data on Textural Parameters for Badagry creek Samples	129
20:	Data on Textural Parameters for Yewa River Samples	137
21:	Absolute Numbers and Distribution of Total Benthic and Planktic	144
	Foraminiferal Fauna Recovered from Ikate beach, Lagos, Southwest Nigeria (KB1-KB9)	
22:	Suborders, Superfamilies and Genera of Foraminifera identified from the Ikate Village, Lagos, Southwest, Nigeria.	145
23:	The Frequency (Percent Composition) of the Suborders, Textulariina, Miliolina and Rotaliina of the Beach Environment of Ikate Village, Lagos, Southwest Nigeria.	146
24:	Frequency Percentages of the Total Benthic and Planktic Foraminiferal Species Recovered From Ikate Beach, Lagos, Southwest Nigeria (KB1 - KB9)	147
25:	The Principal Components (PC) for foraminiferal assemblages of Ikate Beach, Lagos, Southwest, Nigeria	151
26	Absolute number and distribution of Total Benthic and Planktic Foraminiferal Fauna recovered from Tarkwa bay and Lagos harbour (H1-B14) ('H' and 'B' are Samples from Harbour and Tarkwa Bay respectively)	162



27	Frequency Percentages of the Benthic and Planktic Foraminiferal Species identified in Tarkwa Bay and Lagos Harbour Sediments (H1 – B14).	164
28	Suborders, Superfamilies and Genera of Foraminifera identified from the Tarkwa Bay and Lagos Harbour, Lagos Southwest, Nigeria.	165
29	The frequency (Percent Composition) of the Suborders Textulariina, Miliolina and Rotaliina present in the Sediments of Tarkwa Bay and Lagos Harbour, Southwest Nigeria.	166
30:	Absolute Number and Distribution of Total Benthic and Planktic Foraminiferal Fauna Recovered From Lagos lagoon, Southwest Nigeria	178
31:	Suborders, Superfamilies and Genera of Foraminifera Identified from Lagos lagoon Sediments, Southwest Nigeria	180
32:	The Frequency (percent composition) of the suborders Textulariina, Miliolina and Rotaliina present in the sediments of Lagos lagoon, Southwest Nigeria.	181
33:	Frequency percentages of the Benthic and Planktic foraminiferal species identified in sediments of Lagos lagoon, Southwest Nigeria	183
34:	The Principal Component (PC) for foraminifera assemblage of Lagos lagoon sediments, Southwest Nigeria.	185
35:	Absolute Numbers and Distribution of Total Benthic and Planktic Foraminiferal Fauna of the Study Area (Samples taken from the Badagry Beach face) BB2A – BB17A	195
36:	Frequency Percentages of the Total Benthic and Planktic Foraminiferal Fauna of the Study Area (Samples taken from Badagry Beach Surface) BB2A – BB17A	199
37	Suborders, Superfamilies and Genera of Foraminifera Identified from Badagry beach, Badagry, Southwest, Nigeria	203
38	The Frequency (percent composition) of the suborders Textulariina, Miliolina and Rotaliina present in Badagry beach, Southwest, Nigeria.	204
39	The Principal Components (PC) for Foraminiferal Assemblages in	208



Badagry Beach Sediments, Southwest Nigeria

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## LIST OF FIGURES

Figur	e	Page
1:	The Map of Lagos Showing the Investigated Portion of Southwestern Nigeria Coast	6
2:	The Map Showing the Connection between Yewa River and Badagry Creek and the Sampled Stations Investigated, Southwest, Nigeria.	7
3:	The Map Showing Badagry Beach and the Investigated stations, Lagos, Nigeria	8
4:	The Location Map of Maroko- Ibese Area Showing Sampling Points, Lagos, Nigeria.	9
5:	The Map Showing Lagos Harbour which connects the Atlantic Ocean to Lagos Lagoon, Nigeria.	10
6:	The Location Map of Lagos Lagoon Showing Connection of Network of Rivers and Creeks, and the Atlantic Ocean, Nigeria.	11
7:	The Map Showing Sampled Stations in Ogun River Estuary and the Entrances into Lagos Lagoon from the River Ogun and Majidun Creek, Southwest, Nigeria coast.	12
8:	Megastructures of the Gulf of Guinea in Early Cretaceous times (After Burke <i>et al.</i> , 1972).	24
9:	Map of the Gulf of Guinea Showing the Coastal Basins, the Continental Shelf, Upper Continental Slope and deep seated Faults (Adapted from Emery <i>et al.</i> , 1975).	27
10:	Simplified Illustrative Diagram of the Components Layout of Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES)	1 64
11:	Probability Cumulative Frequency Plot for Ikate Beach Sediment (Sample BK4).	95
12:	Probability Cumulative Frequency Plot for Ikate Beach Sediment (Sample BK6).	96



13:	Unimodal Frequency Distribution as Exhibited by Sample BK1 at Ikate Beach	97
14:	Bimodal Frequency Distribution as Exhibited by Station H3 in	
	Lagos Harbour.	102
15:	Bimodal Frequency Distribution as Exhibited by Station H6 in Lagos Harbour.	103
16:	Bimodal Frequency Distribution as Exhibited by Station H11 in Lagos Harbour.	104
17:	Probability Cumulative Frequency Plot for Sediments of Lagos Harbour (Station H2).	105
18:	Probability Cumulative Frequency Plot for Sediments of Lagos Harbour (Station H8).	106
19:	Probability Cumulative Frequency Plot for Sediments of Lagos Harbour (Station B5).	107
20:	Unimodal Frequency Distribution as Exhibited by Sample L1	
	from Lagos Lagoon.	112
21:	Unimodal Frequency Distribution as Exhibited by Sample L4	
	from Lagos Lagoon.	113
22:	Unimodal Frequency Distribution as Exhibited by Sample L7	
	from Lagos Lagoon.	114
23:	Probabilty Cumulative Frequency Plot for Lagos Lagoon Sediment (Station L1).	115
24:	Probability Cumulative Frequency Plot for Lagos Lagoon Sediment (Station L23).	116



25:	Unimodal Frequency Distribution as Shown by Badagry Beach Sediment (Station 12B).	123
26:	Unimodal Frequency Distribution as Shown by Badagry Beach Sediment (Station 1A).	124
27:	Probability Cumulative Frequency Plot for Badagry Beach Sediment (Station 1A).	125
28:	Probability Cumulative Frequency Plot for Badagry Beach Sediment (Station 30A).	126
29:	Polymodal Frequency Distribution Plot Displayed by Sediment from the Porto-Novo end of the Badagry Creek (Station BL4).	131
30:	Bimodal Frequency Distribution Plot Displayed by Sediment near the Entrance of Yewa River into the Badagry Creek (Station BL5).	132
31:	Unimodal Frequency Distribution Plot Displayed by the Fluvial Dominated	
	Area in Badagry Creek (Station BL31).	133
32:	Probability Cumulative Frequency Plot for Sediment of Badagry Creek (Station BL2).	134
33:	Probability Cumulative Frequency Plot for Sediment of Badagry Creek (Station BL53).	135
34:	Polymodal Frequency Distribution Plot Displayed by Sediment from Yewa River (Station BL8).	138
35:	Probability Cumulative Frequency Plot for Yewa River Sediment (Station BL20)	139
36:	Probability Cumulative Frequency Plot for Yewa River Sediment (Station BL26).	140
37:	Ternary Plot of Frequency of the Foraminiferal Suborders Miliolina,	
	Rotaliina and Textulariina for Ikate Beach, Lagos, Southwest Nigeria (Adapted from Murray, 1973).	148



38:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Ikate Beach, Lagos, Nigeria (Component 1 Plotted against Component 2)	152
39:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Ikate Beach, Lagos, Nigeria (Component 1 Plotted against Component 3).	153
40:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Ikate Beach, Lagos, Nigeria (Component 2 Plotted against Component 3).	154
41:	Dendrogram of Q-Mode Cluster Analysis of Ikate Beach based on the Total Abundance of Foraminiferal Species higher than 5% (Bray-Curtis Coefficient was used here).	156
42:	Dendrogram of R-Mode Cluster Analysis of the Species in Sediments of Ikate Beach, Lagos, Nigeria, based on the Total Abundance higher than 5% (Bray-Curtis is the Similarity Measure used).	157
43:	Dendrogram of R-Mode Cluster Analysis of the Species in Sediments of Ikate Beach, Lagos, Nigeria, (Euclidean Similarity Measure used).	158
44:	Ternary Plot of Frequency of the Foraminiferal Suborders Miliolina, Rotaliina and Textulariina for Tarkwa Bay and Lagos Harbour, Lagos, Nigeria (Adapted from Murray, 1973).	167
45:	PCA Scree Plot for the Significant Components of Foraminiferal Fauna in Sediments of Tarkwa Bay and Lagos Harbour, Southwest Nigeria.	169
46:	PCA Scatter Diagram of Grouping of Foraminiferal Taxa in Sediments of Tarkwa Bay and Lagos Harbour, Nigeria (Component 1 against 3).	170
47:	PCA Scatter Diagram of Grouping of Foraminiferal Taxa in Sediments of Tarkwa Bay and Lagos Harbour, Nigeria (Component 1 against 2).	171
48:	PCA Scatter Diagram of Grouping of Foraminiferal Taxa in Sediments of Tarkwa Bay and Lagos Harbour, Nigeria (Component 2 against 3).	172
49:	Dendrogram of Q-mode Cluster Analysis of Sediments of Tarkwa Bay and Lagos Harbour based on Total Abundance of Foraminiferal Species higher than 5% (Euclidean Similarity Measure used).	173

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50:	Dendrogram of R-Mode Cluster Analysis of Species contained in Sediments of Tarkwa Bay and Lagos Harbour Southwest Nigeria (Euclidean Similarity Measure used).	174
51:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Lagos Lagoon, Southwest, Nigeria (Component 1 against 2).	186
52:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Lagos Lagoon, Southwest Nigeria (Component 1 against 3).	187
53:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa from Lagos Lagoon, Southwest Nigeria (Component 2 against 3).	188
54:	Dendrogram of Q-Mode Cluster Analysis of Sediments of Lagos Lagoon, Southwest Nigeria (Euclidean Similarity Measure used).	190
55:	Ternary Plot of Frequency of Foraminiferal Suborders Miliolina, Rotaliina and Textulariina for Sediments of Lagos Lagoon, Southwest Nigeria (Adapted from Murray, 1973).	192
56:	Ternary Plot of Frequency of Foraminiferal Suborders Miliolina, Rotaliina	
	and Textulariina for Badagry Beach Sediment, Southwest Nigeria (Adapted from Murray, 1973).	206
57:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa in Badagry Beach Sediments, Southwest Nigeria (Component 1 against 2).	209
58:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa in Badagry Beach Sediments, Southwest Nigeria (Component 1 against 3).	210
59:	PCA Scatter Diagram of the Grouping of Foraminiferal Taxa in Badagry Beach Sediments (Component 2 against 3).	211
60:	Dendrogram of R-Mode Cluster Analysis of Species contained in Badagry	
	Beach Sediments (Bray-Curtis Similarity Measure used).	214



61: Dendrogram of R-Mode Cluster Analysis of Species contained in Badagry

Beach Sediments (Euclidean Similarity Measure used). 215



### LIST OF APPENDIXES

#### Appendix Page Ι Systematic Paleontology 253 Π **Description of Plates** 277 III Primary Data obtained from Sieve Analysis of Ikate Beach Samples 291 IV Frequency Distribution of Sediments in Different sizes for Ikate Beach 293 Samples V Cumulative Phi Curves for Ikate Beach Samples 295 VI Primary Data obtained from Sieve Analysis of Tarkwa bay and Lagos 297 harbour Samples VII Frequency Distribution of Sediments in Different sizes for Lagos 300 harbour and Tarkwa bay Samples VIII Cumulative Phi Curves for Lagos harbour and Tarkwa bay Samples 303 IX Primary Data obtained from Sieve Analysis of Lagos lagoon Samples 305 Х Frequency Distribution of Sediments in Different sizes for Lagos lagoon 312 Samples XI Cumulative Phi Curves for Lagos lagoon Samples 318 XII Primary Data obtained from Sieve Analysis of Samples from Badagry 324 Beach XIII Frequency Distribution of Sediments in Different sizes for Badagry 336 **Beach Samples** XIV Cumulative Phi Curves for Samples from Badagry Beach 347 XV Primary Data obtained from Sieve Analysis of Badagry creek Samples 358



XVI	Frequency Distribution of Sediments in Different sizes for Badagry creek Samples	364
XVII	Cumulative Phi Curves for Badagry creek Samples	370
XVIII	Primary Data obtained from Sieve Analysis of Yewa River Samples	376
XIX	Frequency Distribution of Sediments in Different sizes for Yewa river Samples	380
XX	Cumulative Phi Curves for Yewa River Samples	384



#### ABSTRACT

This study established the distribution trends of foraminiferal assemblages in relation to the parameters influencing the trends in the coastal environments of some parts of southwest Nigeria sector of the Gulf of Guinea. This was with a view to characterizing the surface sediments in the various environments using benthic foraminiferal population.

Two hundred surface-sediment samples were collected from Ikate beach, Tarkwa bay, Lagos harbour, Lagos lagoon, Badagry creek, Yewa river and Badagry beaches in southwest, Nigeria. Bottom water was collected for pH and salinity measurements; and water depths measured where necessary. Sediment samples were used for granulometric, chemical and foraminiferal analyses. Granulometric analysis involved the calculation of grain size percentages and generation of probability cumulative frequency curves from which various textural parameters were calculated. Aqua regia digestion of <75 µm sediment fractions was done for 0.5 g of relevant samples and Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) was used to measure concentration of trace metals. Also, 30 g was taken from each sample and washed over 63 µm sieve for foraminiferal analyses. The foraminifera were picked, stored in cellules, identified, counted, described and assigned to families, genera and species. The data generated were subjected to various multivariate analyses using the Paleontological Statistics (PAST) software package (including two similarity indices, the "Q" and "R" modes) and abundance variation of the foraminifera.

The identified assemblages in decreasing order of abundance were *Textularia sagittula*, Ammonia beccarii, Eponides cribrorepandus, Quinqueloculina padana and Hanzawaia boueana (Ikate beach assemblage); Hanzawaia boueana, Textularia sagittula, Florilus atlanticus, and Meloni padana (Tarkwa bay and Lagos harbour assemblages); Ammonia beccarii, Florilus



atlanticus, Hanzawaia boueana, and Textularia sagittula (Lagos lagoon assemblage); Textularia sagittula, Eponides cribrorepandus, Hanzawaia boueana, Florilus atlanticus, Quinqueloculina padana and Q. vulgaris (Badagry beach assemblage). Textularia sagittula, seemed to register most abundant occurrence throughout the study area but confined to only sand dominated substrates in the microhabitats of Lagos lagoon. The Total Foraminiferal Number (TFN) was highest at Lagos harbour and lowest at Badagry beach based on favourable sediment texture identified in Lagos harbour. The harbour sediment was mainly fine sand whereas the Badagry beach was mostly coarse sand. The trace metal concentrations were below background levels at the Tarkwa bay and Lagos harbour but constituted moderate pollution in Lagos lagoon, Badagry creek and Yewa river. Water depth and pH seemed to have significance on few stations in Lagos harbour and lagoon. Salinity also played prominent role but was masked by the nature of the substrates at the northwestern end of Lagos lagoon where mono-specific assemblage was encountered. The non-saline to extremely low salinity condition imposed as a result of the overwhelming fluvial activities might account for the non-recovery of foraminifera in sediments of Badagry creek and Yewa river. Also, low pH made these environments uninhabitable for for a stests of calcareous hyaline and porcellaneous were easily decalcified at pH < 7.5.

The study concluded that the processes that defined the substrates strongly correlated with the species abundance and variation, and hence determined the pattern of distribution of foraminifera.



### CHAPTER ONE

### **INTRODUCTION**

#### **1.1 Background Information**

The principal characteristic of coastal environments is that they occur at the transition between continental and marine realms i.e. estuaries, lagoons, marshes, swamps, and are subject to high fresh water input (see Debenay *et al.*, 2000). These environments undergo strong stresses resulting from the drastic changes during each tide cycle. They include full strength penetration of sea water during flood-tide which can be almost entirely replaced by fresh water during ebb tide; immersion of the intertidal area. Consequently, there will be changes in temperature, salinity, pH, and oxygen content of the interstitial waters.

Owing to a poor knowledge of the impact of natural variables, the use of bioindicators merits many more studies. This need is particularly critical in estuaries and coastal lagoons that are on one hand, subject to tidal and seasonal changes in natural variables and, on the other hand, heavily exposed to a number of chemicals, including industrial pollutants, sewage and agricultural pesticides. These environments have great economic potential, particularly as tourist areas and for fisheries. The choice of bioindicators depends on the ecosystem (Wilson *et al.*, 1995; Shear, 1996; Yazvenlco and Rapport, 1996). In coastal settings, large numbers of foraminifers can be collected in small sample volumes. Moreover, the abundance of the living forms and tests of the dead specimens which are often preserved in sediments usually allow comparison between anthropogenic and pristine conditions. Also, several forms are widespread in



estuaries and lagoons, allowing comparative studies between these environments. Biomonitoring, based on foraminifera, will deal with:

- a.) species or group of species indicating pollution impact by their absence, presence, abundance or dominance; and
- b.) study of individuals with morphological abnormalities due to chemical contamination (Alve, 1991; Yanko *et al.*, 1994; Bresler and Yanko, 2000), which is being used to complement the earlier method (a.), because of the controversies arising from it.

The following are examples of the controversies generated:

- a.) the high variability of test morphology exhibited by epiphytic species such as *Rosalina globularis, Lobatula lobatula* and *Planorbulina mediterranensis* as a result of irregularity of the substrate (Boltovskoy and Wright, 1976). Hence, abnormal specimens of these species cannot be used to indicate environmental stress;
- b.) globular chamber formed by some planktonics (Bé *et al.*, 1983)or benthic species (Hottinger *et al.*, 1993) are not induced by environmental conditions hence good knowledge of biology is required;
- c.) severe abnormalities may also be brought about by mechanical trauma (Bé and Spero, 1981); they are generally easy to distinguish by scanning electron microscope (SEM) investigation because they are often characterized by the presence of scars, irregular contours of crushed or repaired chambers, or by the construction of new chambers in a coiling plane different from the original ones (Boltovskoy, 1957, 1965; Boltovskoy and Wright, 1976). These deformations



result either from strong hydrodynamics or from the action of predators (Akturk, 1976; Vilela and Koutsoukos, 1992).

d.) majority of malformations (protuberance on spiral side near proloculus, abnormal size or shape etc) are observed in natural environments characterized by fluctuations in salinity (Geslin *et al.*, 2000).

The study area is a network of creeks, rivers and lagoons which connects to the sea through the Lagos harbour. The harbor and lagoons at the West African coast possesses an unusual combination of physical characteristics of particular interest to the ecologist. Lagos harbour is situated at the centre of a system of marginal lagoons extending 160 miles from Cotonou in Republic of Bénin to the Niger Delta and is the only major outlet for exchange of fresh water from creeks, rivers and lagoons and marine water from the Atlantic Ocean (Hill and Webb, 1958). Besides salinity, many of the physical features of the area are comparatively stable e.g. relatively constant temperature throughout the year; light intensity being of the same order and constant length of the day (approximately 12 hours). Exceptionally, low tidal range i.e. never greater than 4 ft. and usually much less has been recorded for Lagos in the Gulf of Guinea Coast (Hill and Webb, 1958).

Foraminifers are sensitive to subtle changes in ambient environmental conditions and therefore have emerged as potential tools for assessing climatic/environmental changes (Bhala *et al.*, 2007). In the last four decades, investigators (e.g. Asseez *et al.*, 1974; Adegoke *et al.*, 1976; Salami, 1982; Dublin-Green, 1999; 2004; Okewole, 2007; Phillips *et al.*, 2010; 2012; Olayiwola and Odebode, 2011) have studied Quaternary



benthic foraminiferal species diversity in the southwestern Nigeria sector of the Gulf of Guinea.

Asseez et al. (1974), having worked on the ecology of the Ogun river estuary, recovered the assemblages constituted by *Ammobaculites crassus A. dilatatus, Haplophragmoides wilberti, Miliammina earlandi, M. fusca* and *Ammonia beccarii.* The study of pollution indicating foraminifera in Lagos lagoon (Nigeria) undertaken by Okewole (2007) recorded an assemblage of *Ammonia tepida, A. parkinsonia, A. inflata, Cribroelphidium deciphens and Textularia sagittula.* Also, Phillips et al. (2012) studied the distribution of benthic foraminifera in Lagos lagoon and reported abundance and common occurrences of *Ammonia beccarii* and *A. tepida*; and rare occurrence of *Eggerella scabra, Cribroelphidium semistriatum, Hastigerina pelagica* and *Marginulina sp.* 

Benthic foraminifera have also been used as sediment provenance and transport tracers in Victoria Island beaches in the south-west Nigeria coast (Phillips, 2008). Despite the recent contributions of these workers to the study of foraminifera in the study area, the possible influence of the adjoining environments on the physicochemical conditions that could produce a change in foraminiferal fauna composition has not been considered. Besides temperature, pH, salinity and depth, parameters such as chemical pollutants, sediment texture and biological interactions which could also affect the distribution of benthic foraminifera, making them useful for ecological and environmental interpretation were not considered in the areas investigated.

Therefore, the main objectives of the present study are to characterize the population of benthic foraminifera in surface sediments, establishing a relationship of