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Ecological survey of soft-sediment marine benthos of the Gulf of Guinea, Nigeria

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ABSTRACT: Investigation of soft-sediment marine benthos of the Gulf of Guinea was carried out in May and June 2005. Macroinvertebrates species richness and abundance were determined along a longitudinal gradient of the study area. Three major divisions: Annelida, Crustacea and Mollusca were recorded amounting to 33 taxa. Gastropods made up the highest collections, representing 78.79 percent density occurrence. Benthos equitability distribution in the designated sampling sites was quite low. Low abundance of organisms was reflected within the shoreline sites but high in offshore sites. The pausity of soft-bottom benthos is a reflection of the frequent dredging and high siltation process in the area.

Keywords: Survey, soft sediment, benthos, continental edge, Niger-Delta.

Introduction

The Niger-Delta has been described as the zone of fastest ecological change and deterioration in Nigeria and perhaps of the Guinea coast because of the effect of the upstream development as well as those of its immediate surroundings. Oil pollution, coastal erosion, siltation and subsidence and sea level rise together with associated flooding as well as mangrove deforestation are the major hazards (NPA, 2002). This has necessitated various research studies on water quality and chemistry, copepoda, benthic studies and fish, and monitoring of the concentrations of potential pollutants affecting the aquatic ecosystems in the Niger-Delta (Egborge and Benka-Coker, 1986; Egborge, 1991; Egborge, 1994; Ndiokwere, 1984; Opute, 1990; Odiete, 1996; Olomukoro and Egborge, 2003; Imoobe, 2002).

Soft-sediment habitats are common in coastal areas throughout the world, but only a small fraction of the macrobenthos that reside on or are buried in sediments has been described (Snelgrove, 1999; Ellingson, 2001). Human activities are now known to be the primary cause of changes to marine biodiversity.

Studies on benthic fauna of Nigerian continental waters have been scanty over the past few decades. The reasons for this obvious research gap are not farfetched as research work in this region is known to be cumbersome. As a result, the soft bottom fauna of the continental shelf are probably the least studied and less understood of all marine communities.

Most surveys cannot sample large areas of marine systems, so much data relate to only small areas of the sea floor (Ward et al, 1998); and the community structure varies greatly within any latitudinal areas (Gray 2000).

Most other studies have been those carried out mainly for multinational oil companies operating in the zone to satisfy the statutory regulators requiring them to embark on baseline and Environmental Impact Assessment (EIA) studies before commencement of major petroleum exploitation activities. Such petroleum-based industries and environmental activities have spanned over three decades, accounting for 70 – 75% of total industrial activities in the Niger-Delta. Many of the studies are not published and accessibility to relevant information from such reports is limited to government agencies.

In order to fill any existing gap in research, the purpose of this study is to document the quality of the benthic macrofauna of the area for teaching and as a biomonitoring baseline data for future environmental assessment.

Materials and Methods

Study Area

The study area is the environment around the Escravos River mouth and the offshore environment in the Western Delta flanks of the Niger-Delta in the Gulf of Guinea (Figure 1). The area lies between longitude $05^0$25'E and latitude $05^0$00'N, and is characterized by a tropical monsoon climate with a high temperature of about 34^0C and high humidity ranging between 50 and 80%. Two seasons prevail within the area; the rainy season (March to November) with total rainfall between 3,000 and 3,500mm; and the dry season (December to February) when the rain diminish to about 500mm. The area experiences nine months of rainfall because of the influence of the tropical maritime air mass and the associated south-west prevailing winds. The depth of the at different sampling sites range from 5 to 22m (Table 1).

Sixteen sampling sites shown in Table 1 were covered during the sampling period which includes four sites Escravos River mouth, two along the shoreline and ten sites within offshore respectively. The fauna of the study sites consisted of macroinvertebrates inhabiting the bottom sediments. Ekman grab (0.31m x 0.21m x 0.18m) was used to collect benthic samples from the bottom of the aquatic ecosystem. The bottom samples were sieved in-situ using a set of American Standard Tyler sieves of different mesh apertures (500µm, 750µm and 1mm). All organisms collected were preserved in polypropylene sampling bottles containing 10% formaldehyde.

Benthic samples were sorted using the American Olympus binocular dissecting microscope (Model 570). Sorted organisms were examined by means of Olympus Vanox Research microscope with camera lucida and drawing tube. Identifications were made using relevant identification manuals and literature (Day, 1967; Gosner, 1971; Edmunds, 1978).

Results

A total of 33 taxa of macrobenthic fauna was recorded. The composition, distribution and the relative abundance of the fauna are shown in table 2. They represent three divisions of Annelida, Crustacean and Mollusca.

The Mollusca, which comprises Bivalvia and Gastropoda, made up the bulk of collected species with 26 taxa, representing 78.79% density occurrence. Annelida (Polychaeta) had a record of five taxa, while Crustacean (Decapoda) was represented by two taxa: *Uca tangeri* and *Callinectes annicota o*f the Mollusca species, *Tellina sp* (Bilvalve) occurred in not less than six of the study sites compared to other species and had the highest record of relative individuals of 17% density.

The four sample sites in Escravos river mouth had abundance of individual organisms which ranged between 0.00 and 7.84%, the shore line two sites ranged between 0.0 and 4.90%, while the ten off shore sites were between 0.00 and 13.73%. The shoreline sites are within 1.96% maximum density. The relative and the mean abundance of the benthos in the various sites are reflected in Figures 2 and 3.

Figure 4 shows the heterogeneity indices of the study sites. The highest abundance of benthos was reported in offshore sites and lowest in shore line sites. Also species richness was highest in the former and lowest in the latter. Shannon – Weinner diversity indices showed that values range from 0 to 0.92. Shore line sites recorded zero diversity; the highest diversity value of 0.92 was recorded in off shore site 20, while all others had < 0.80H.

Benthos equitability or evenness index indicates that most of the sample sites had values which range from 0 to 0.96, the highest being sites 3, 13, and 16, and the lowest value was recorded for all shore line sites. Usually, the index varies from zero to one. When equitability is one, it implies that all species present are evenly distributed.

Table 1: Sample collection dasta recorded in the various Sites

S/N	GPS Coordinates	Sample location & habitat type	Temp. (^{0}C)	pH	Cond. □s/cm	Media type	Depth (m)	Comments/ Observations
1	5.16031N 5.56809E	Esc. River Mouth				Sed	6.3	Sandy bottom bank covered with vegetation
2	5.18851N 5.58783E	Esc. River Mouth	30.6	7.2	31.3	Sed	11	Muddy/Sandy bottom
3	5.19344N 5.59981E	Esc. River Mouth	30.1	7.6	32.8	Sed	11	Muddy/Sandy
4	5.21565N 5.61391E	Esc. River Mouth	26.9			Sed	22	Muddy/Sandy
5	5.12119N 5.53602E	Shoreline				Sed	5	Sandy bottom
6	5.15185N 5.55470E	Shoreline	29.9	8.2	37	Sed	8.75	Sandy bottom
7	5.06059N 5.46503E	Offshore				Sed	7.2	Muddy bottom
8	5.09194N 5.53990E	Offshore	38.3			Sed	8	Muddy/Sandy
9	5.11238N 5.55541E	Offshore	28.7	7.8	32.8	Sed	8.2	Muddy bottom
10	5.06059N 5.46503E	Offshore				Sed	7.2	Muddy bottom
11	5.04082N 5.55007E	Offshore				Sed	7.5	Muddy bottom
12	5.13705N 5.56809E	Offshore	38.6			Sed	9	Muddy/Sandy bottom
13	5.17653N 5.52937E	Offshore	33.8			Sed	8	Muddy bottom
14	5.17441N 5.58994E	Offshore	39			Sed	8	Muddy/Sandy
15	5.22340N 5.61039E	Offshore	28.9	7.02	22.4	Sed	7	Sandy bottom
16	5.14293N 5.48328E	Offshore	38.3				7	Muddy/Sandy

Table 2: The composition distribution and relative abundance of macrobenthic invertebrate of the sample sites

Taxonomy	Study Sites															
	Escravos R. M.				Shoreline		Offshore									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ANNELIDA																
Polychaeta																
Arenicola sp. (Arenicodae)								1	1		1					
Capitella sp. (Capitallidae)										1						
Glycera sp. (Glycerdae)			1													
Oweniid sp. (Oweniidae)		1														
Neries sp. (Neridae)		4	2			2				3	1					
CRUSTACEA																2
DECAPODA																2
Uca tangeri(Ocypodidae)		1														
Callinectes amnicola(Partunidae)		2														2
MOLLUSCA																
BIVALVIA																
Aequipeden phrygium																1
Anadara sp. (Arcidae)	2															
Brachidautes recuruns (Mytilidae)																
Cardita sp. (Cardiidae)	1											1	1			
Cardium sp. (Cardiidae)			2													
Cardium costatum (Cardiidae)	1															
Iphigenia sp.(Donacidae)			1													
Labiosa sp. (Mactridae)										3						
Madra sp. (Mactridae)					1											
Macra glabrata										3						
Mactra nitidae (Mactridae)			1								4					
Mactra rostrata (Mactridae)							3					1				
Neculana sp.													1			
Modiolus sp.																1
Pitar tumerus (Veneridae)								2	2					4		
Solen viridis (Solenidae)												2	2			
Tellina sp. (Tellinidae)							3	3	3		2	4		2		3

Taxonomy	Study Sites															
	Escravos R. M.				Shoreline		Offshore									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
GASTROPODA																
Buccinium sp. (Buccinidae)																1
Bullia sp. (Nassariidae)							1				3					
Buccinium tottenii (Buccinidae)																
Colus sp. (Muricidae)							4				1	1				
Cylinchna oryza										1						
Hydrobia sp. (Hydrobiidae)							1									
Hydrobia minuta (Hydrobiidae)													2	2		
Neptunea sp. (Buccinidae)							2									
Terebra sp. (Cerithiidae)																1
TOTAL/0.065m2	4	8	7	-	1	2	14	6	6	11	12	9	6	8		9
No of Species	3	4	5	-	1	1	6	3	3	5	6	5	4	3		9
Margalef's index (D)	1.44	1.44	2.06	-	0.00	0.00	1.89	1.12	1.12	1.67	2.02	1.83	1.67	0.96	-	3.03
Shannon-Wienner (H)	0.45	0.53	0.67	-	0.00	0.00	0.73	0.44	0.44	0.65	0.71	0.62	0.58	0.45	-	0.92
Evenness (E)	0.94	0.88	0.96	-	0.00	0.00	0.94	0.92	0.92	0.93	0.91	0.89	0.96	0.94	-	0.96

S E A
5° 10E
5° 15E
5° 40N
5° 00E
5° 35N
5° 30N
5° 30N
5° 35N
5° 40N
5° 10E
5° 15E
5° 00E

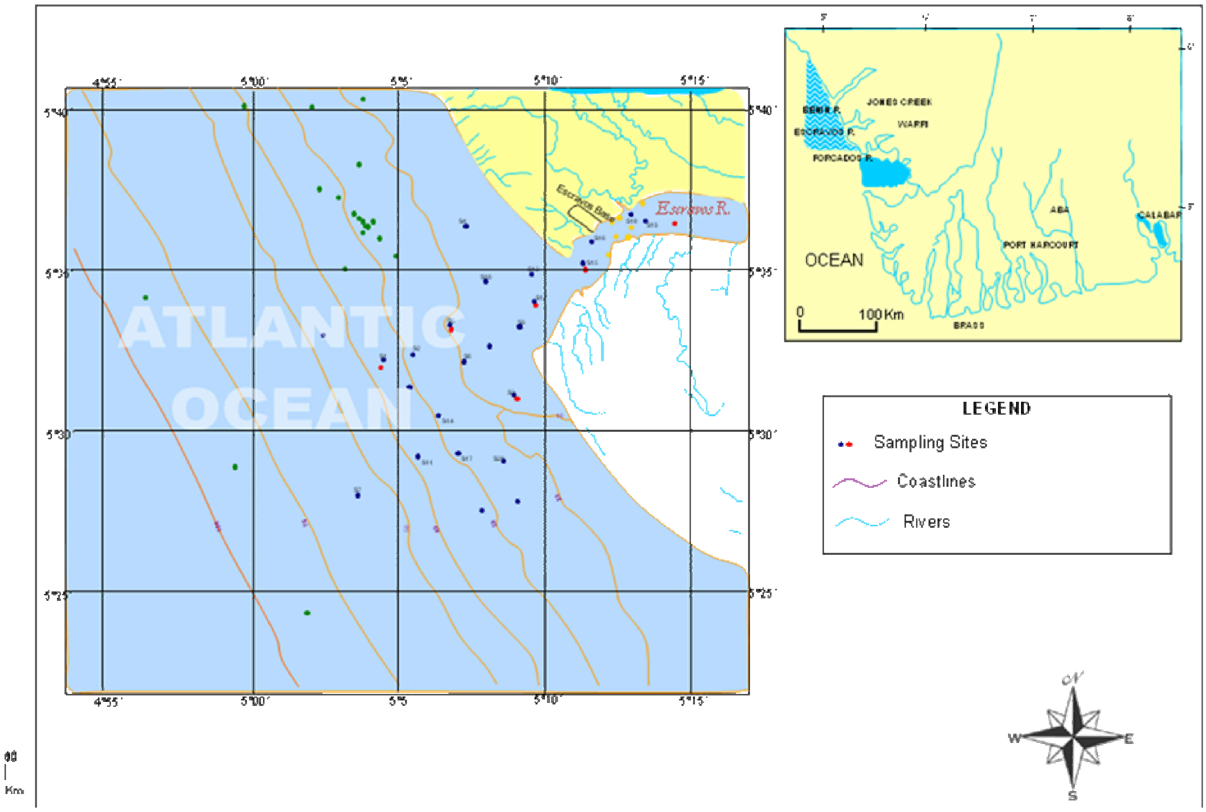

FIG.1: MAP OF STUDY AREA SHOWING THE SAMPLED STATIONS

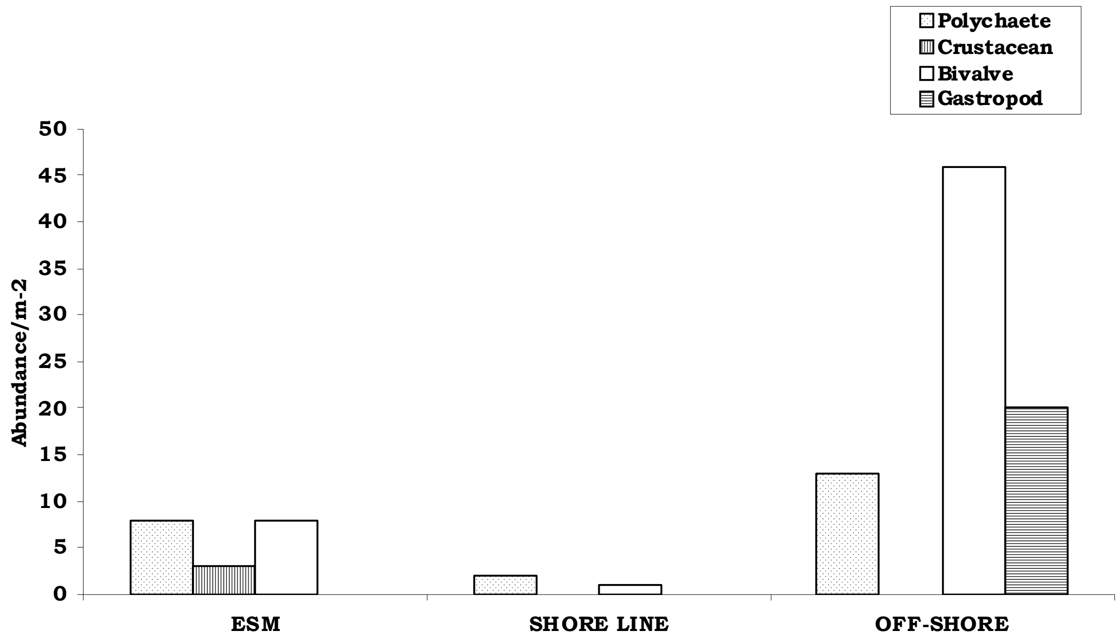

Fig.2: The Relative Abundance of the Major Benthos in the Various Sampling Sites.

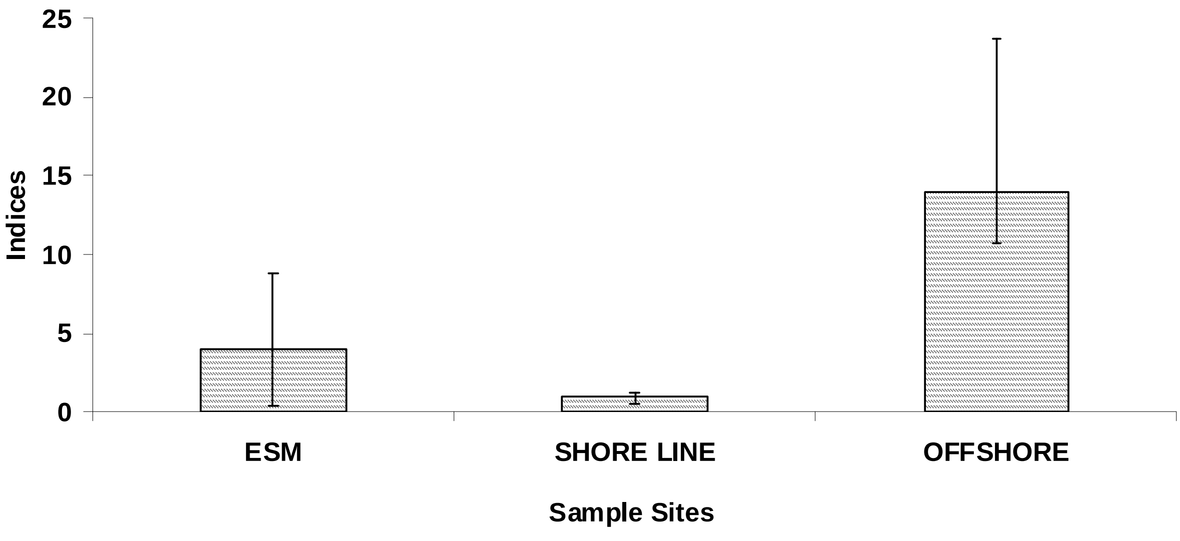

Fig.3:The Mean Abundance of the Benthos in The Study Sites.

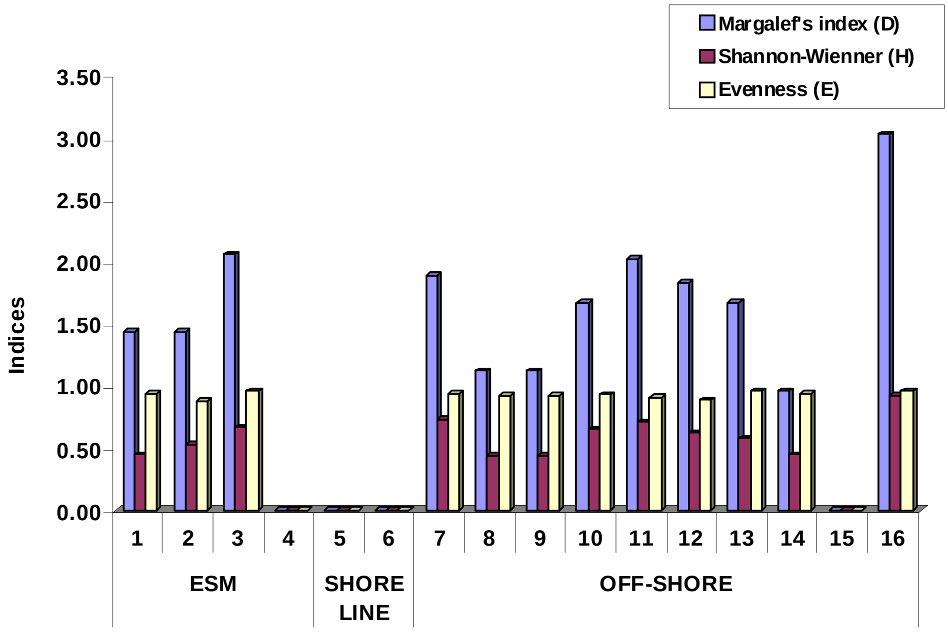

Fig. 4: The spatial variation in the biotic index measurement of the benthos diversity in the various sites

Discussion

The benthic macro invertebrate community comprised three divisions viz: Annelida, Crustacea and Mollusca. These benthos made up not less than ninety – eight per cent of deposit feeders of which Mollusca, particularly Bivalve-Mollusca constitute the highest occurrence species and individual organisms. In this study, Mollusca were observed to be the most taxonomy group and had the highest proportion of species, and also were more restricted in their distribution than the other taxonomic groups. According to Brown (1984), it is quite unlikely that all areas are equally favourable for all species in the ecosystem, and it is realistic to assume that the differences in abundance and spatial distribution are primarily the result of different requirements and tolerance. The bottom of the study area, from all indications, is covered in fine, muddy sediment; and such benthic environment is suitable for deposit feeders that depend mostly on substratum rich in organic matter.

In general, diversity and abundance increase with substrate stability and the presence of organic detritus (Allan, 1995). However, species reduction was quite evidence in the sites within the Escravos River mouth and the shoreline areas compared to the off shore sites. The paucity of benthos abundance could be attributed to few environmental consequences prevailing in the area. Firstly, sample were collected during the rainy season and scent of up welling of the water and consequent high siltation process due to the influx of run – off from the up-stream or Escravos River, and adjoining creeks and creek-lets into the sea. Secondly, an increase in human activities which include multinational oil prospecting companies localized within the banks of Escravos River mouth may have also made an impact on the benthic community stability. Human activities, directly or indirectly, are now the primary causes of changes to marine biodiversity, especially in coastal areas (Ellingsen, 2001) and the present rate of habitat degradation in marine ecosystems is alarming (Gray, 1997). Frequent release of effluent discharges with high suspended solid load coupled with organic waste dump, may have caused smothering processes of the bottom sediment. Although silt, in small amounts may benefits at least some taxa particularly the polychaete worms. Thirdly, the shoreline may suffer erosion problem due to the frequent impact of wave action and consequent effect on the bottom substrate.

The Escravos Rivers among others is a very important sea way through which general and specialized cargo is channeled to inland ports. The channel was subjected to a capital dredging exercise in 1980 – 82 and periodic maintenance dredging between 1986 and 1996 (Egborge, 2002).

Over the years, the channel has shoaled up due primary to deposition of both traction and suspended sediments along the river channel and formation of a barrier bar across the entrance to the Escravos Estuary by the reworking effect of both the long shore and tidal currents along the coast.

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