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OCCURRENCE, DISTRIBUTION AND DIVERSITY OF MICROFLORA IN THE INTERTIDAL MUDFLATS AND SANDBARS OF THE CROSS RIVER ESTUARY, NIGERIA

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ABSTRACT

A comparative study was carried out on the occurrence, distribution and diversity of microflora in the intertidal mudflats and sandbars at the Nsidung Beach end of the Cross River Estuary, Nigeria between February and April, 2009. Samples were analysed within six hours of collection. Identification of microflora was based on standard identification guides and texts. Altogether, 16 microflora taxa belonging to 13 genera and 5 divisions were identified. Over eighty five percent of the microflora was recorded in the mudflats while 14.0% were identified in the sandbars. Diversity indices of 1.69 and 1.59 were obtained for the mudflats and sandbars, respectively. Results of the study are discussed in relation to the differential nutrient entrapment and retention capacities of the mudflats and sandbars in the estuary.

KEYWORDS: Diversity, microflora, intertidal, mudflats, sandbars, Cross River Estuary

INTRODUCTION

Majority of the microflora in the different aquatic habits are made up of various types of planktonic algae. These play important role in the classic food web of the aquatic habitats, particularly as a source of food to other species, typically benthos, zooplankton, fin and shellfishes (Hansen *et al.,* 2001; Job, 2006; Edu *et al*., 2007). The seaweeds of the estuarine ecosystem consists mainly of subtidal mudflat or sandbar communities, depending on the current and tidal influences (Gross, 1977; Lalli & Parsons, 1993; Mann, 2000). The dominant primary producers of the intertidal mudflats and sandbars are the episamic microflora, which according to Olaniyan (1978), Goldman & Horne (1983), Lalli & Parsons (1993) and Mann (2000), are generally species of benthic diatoms, flagellates and dinoflagellates specially adapted to grow on the sediment and sandbar particles. Their productivity has been reported to inversely correlate with the grain size making up the zones, coupled with nutrient and water retention capacities (Lalli & Parsons, 1993; Mann, 2000; Castro & Huber, 2005).

The productivity of intertidal sandbars has been reported to be low especially in the absence of a cover of marsh grasses or seagrasses (Lalli & Parsons, 1993). The productivity of the intertidal sandbars has been documented to be about $10gm^{-2}$ yr^{-1}, whereas that of the intertidal mudflats is of the order of $230gm^{-2}$ yr^{-1} (Moul & Mason, 1957; Goldman & Horne, 1983; Mann, 2000). The varied grain sizes, nutrient and water retention capacities between mudflats and sandbars create disparity conditions in the types of microfloral species, abundance and diversity that occur and become distributed in these two euphotic ecological zones (Moul & Mason, 1957; Mann, 2000). Hence, it becomes imperative to investigate these euphotic ecological zones of the study area in order to provide the true picture of the species of microflora inhabiting them.

Although sizeable literature is available on the microflora species of tropical aquatic habitats (Kadiri, 1988, 1993 a & b; Ezra & Nwankwo, 2001; Edu *et al.,* 2007), no report is available on the microflora components of the intertidal mudflats and sandbars of the Cross River Estuary, Nigeria. The present study is therefore aimed at comparing the microfloral species associated with the intertidal mudflats and sandbars of the study area as well as elucidating which of the two euphotic ecological zones is richer in microfloral species.

MATERIALS AND METHODS

This study was conducted on the estuarine intertidal mudflats and sandbars of the Cross River Estuary, Nigeria (4°00' and 8°00'N and 10°00'E) located on the south-eastern end of Calabar (Fig. 1) (Ewa-Oboho, 2006). The estuary is characterized by semidiurnal tides with the climate typical of a tropical rainforest with two distinct equatorial climate types as reported by Moses (1987) and Ewa-Oboho (2006).

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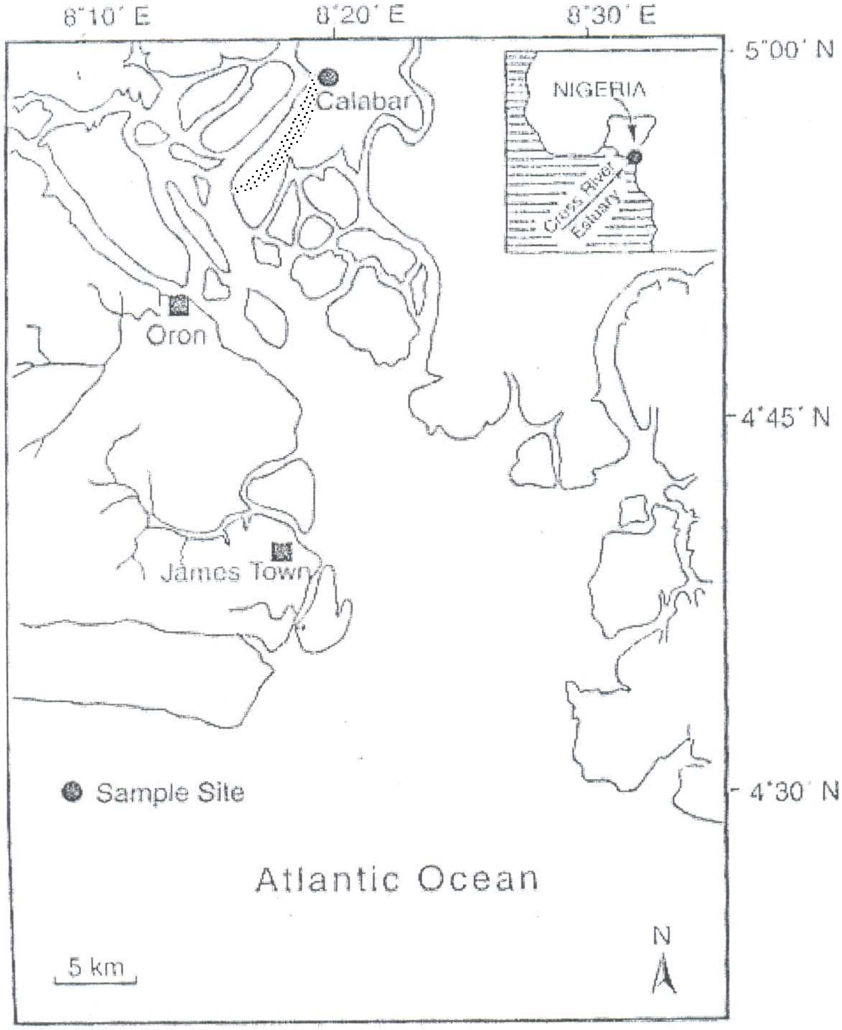

Fig. 1: Map of Cross River Estuary, Nigeria showing study location

Samples Collection and Analysis

Surface layers ($1cm^2$) of the intertidal mudflats and sandbars were collected by scrapping with a hand trowel during low tides at Nsidung Beach end of the Cross River Estuary, between February and April, 2009, and stored in 250mls glass bottles and transported immediately, to the Marine Biology, Laboratory, University of Calabar, Nigeria. Samples were analysed within 6 hours of collection using a light microscope Model: CHC AX 5079 Tokyo, Japan of X 40 objectives after diluting with distilled water and stained with 1ml of Lugol's solution based on recommendation by UNESCO (1998).

Identification of microfloral species was based on identification schemes of Edmonton (1959), Prescott (1970), Newell & Newell (1977), Olaniyan (1978), Sharma (1986), Mann (2000), Ekpenyong (1996 & 2006), and Sverdrup *et al.,* (2006). Abundance of the microflora species from the two ecological zones was determined by direct enumeration following Hodgkiss & Songhui (2004) and relative abundance (%RA) calculated according to the equation below:

$$\%R_A = \frac{a(100)}{b}$$ (Ekpenyong, 1996, 2006)

where a= number of individual microfloral species in each division and ecological zone,

b = the total number of all microfloral species

Diversity of the microfloral species in each of the ecological zones was estimated using the Shannon's diversity index (H^I):

$$H^1 = \sum_{i=1}^{s} pi \ln pi$$ (Ogbeibu, 2005)

where pi is the proportion of individuals found in the species

(i.e. $pi = \frac{ni}{N}$ being the total abundance (Ogbeibu, 2005)

RESULTS

Altogether, 16 microfloral species belonging 13 genera and 5 Families were identified from the two ecological zones of the Cross River estuary, Nigeria. The microflora exhibited varying numerical and relative abundance as shown in Table 1. Among the Bacillariophyceae were *Nitzchia pungens* with 30154 Individuals (73.96) in the mudflats and 11063 (65.3%) in the sandbars, *Eucampia zodiacus* 2612 (6.41%) in the mudflats and 3807 (22.47%) in the sandbars, *Bidulphia pelagic* 8005 (19.63%) in the mudflats and 3807 (22.47%) in the sandbars. The Dinophyceae consisted of *Dinophysis accuta* with 1573 individuals representing 11.39% in the mudflats and 403 (10.78%) in the sandbars, *Gymnodinium abreviatum* 1340 (9.70%) in the mudflats and 264 (7.06%) in the sandbars, *G. simplex* 1143 (8.27%) in the mudflats and 631 (76.88%) in the sandbars; *Protoperidium gassipes* 1650 (11.94%) in the mudflats and 413 (11.05%) in the sandbars, *Gonyaulax spinifera* 1536 (11.12%) in the mudflats and 269 (7.19%) in the sandbars, *Ceratium furca* 1956 (14.16%) in the mudflats and 359 (9.60%) in the sandbars, *Ceratium* sp 2602 (18.83%) in the mudflats and 699 (18.69%) in the sandbars and *Prorocentium micans* 2015 (14.59%) in the mudflats and 701 (18.75%) in the sandbars.

The Cyanophyceae (Blue-green algae) consisted of two microflora species: *Phormidium sp and Oscillatoria rubenscens* with 1341 and 468 individuals in the mudflats and sandbars representing 33.65% and 38.98% in and 2644 and 734 individuals representing 66.34% in the mudflats and 61.06% in the sandbars, respectively. Two microflora species were also recorded in the Rhodophyceae family. These were *Bostrychia radicans* and *B. binderi* which respectively contained 5213 (62.49%) and 3129 (37.51%) in the mudflats and 298 (64.36%) in the sandbars while in the family Cladophoraphyceae, only one microflora *Cladophora limicola* was recorded. This consisted of 3566 and 968 individuals in the mudflats and sandbars, respectively and represented 100% each of the microfloral population in the two ecological zones of the estuary (Table 1).

Table 1: Relative percentage contribution of microflora in the intertidal mudflats and sandbars in the Cross River Estuary, Nigeria (February – April, 2009).

A	**Bacillariophyceae**	**Ecological Zones**	
		Mudflats	**sandbars**
1.	*Nitzohia pungens* Hasie		
2	*Eucampia zodiacus* Ehr		
3	*Bidulphia pelagic* Schröder		
B	**Cladophoraphyceae**		
1	*Cladophora limicola* Etilers		
C	**Cyanophyceae**		
1	*Phormidium sp.* Kutz		
2	*Oscillatoria rubenscens* de Candolla		
D	**Dinophyceae**		
1	*Dinophysis ocuta* Ehr		
2	*Gymnodinium abreviatum* Kofold & Swezy		
3	*G. simplex* (Lohmann) fofoid & Swezy		
4	*Protoperidium crassipes* (Kofoid & Balech)		
5	*Gonyaulax spinifera* Diesing		
6	*Ceratium furca* Ehr		
7	*Ceratium sp Ehr*		
8	*Protocenrum micans* Ehr		
E	**Rhodophyceae**		
1	*Bostrychia radicans* Montagne		
2	*B. binderi* Harvey		

80- 100% abundance
60 - 79% abundance
40 - 59% abundance
20 - 39% abundance
1 - 19% abundance

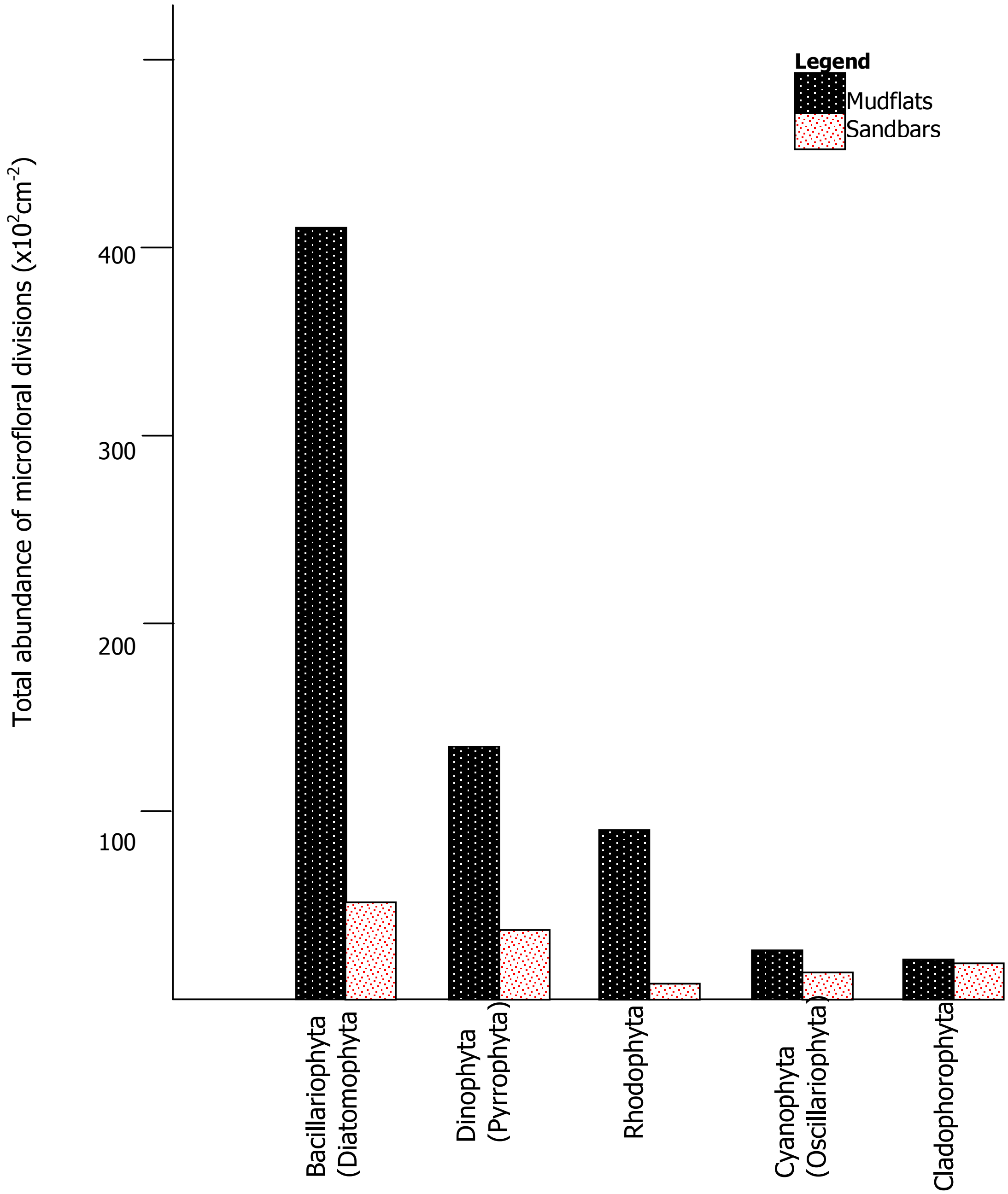

Fig. 2: distribution of the microfloral families in the intertidal mudflats and sandbars of the cross river estuary, nigeria.

DISCUSSION

The results of the study have revealed greater abundance of microflora in the intertidal mudflats than in the intertidal sandbars of the Cross River Estuary. Mudflats are generally known to have higher water and nutrient retention capacity than sandbars (Pamatma, 1968; Gross, 1977; Lalli & Parsons, 1997; Mann, 2000, Castro & Huber, 2005). This is therefore an enhancing force that encourages the rapid multiplication of microflora in the presence of solar energy than what occurs in the intertidal sandbars. This is because sandbars are known to possess a poor retention capacity for water and nutrients for the microflora to utilize for primary productivity (Nwadiaro, 1989 & Mann, 2000). This results in the building up (or otherwise) of higher standing crop of the microflora as earlier observed by Palmer & Round (1967) in benthnic microflora of than Estuary, Aberdeenshire, Scotland.

The building up of higher standing crop of microflora in the intertidal mudflats rather than in the sandbars, is as a result of nutrients entrapment capacity by the former than the latter (Hobbie & Wright, 1965; Palmer & Round, 1967; Pamatma, 1968). According to Pennock and Sharp (1986), such nutrient entrapment and retention had caused an increase in the standing crop of phytoplankton in the subtidal mudflats of Delaware estuary in United States of America. Also, the association of higher numbers of microflora in nutrient-rich waters, derived from river discharges has previously been reported in the sediment of Marion Lake, (Hargrave, 1969), in the sediment of River Pamlico, North Carolina, (Lukatelich & McComb 1986), in South Western Australian estuarine system, (Pennock & Sharp, 1986) and in Delaware Estuary, United States of America (Pennock & Sharp 1986). Sharp *et al*., (1982) had also previously documented that nutrient-rich sediments and intertidal mudflats provide a suitable habitat for microflora, which according to Pennock (1985), Mann (2000) and Castro & Huber (2005), is one of the factors that influences and regulates microflora biomass in intertidal mudflats and sandbars.

Eutrophication is a common phenomenon which undoubtedly is a key factor stimulating microfloral growth (Mann, 2000; Prasad, 2000; Wetzel, 1964). This again, involves the entrapment of water molecules rich in both inorganic and organic nutrients. The fine silty nature of mudflats plays a vital role in nutrient entrapment for enhanced primary productivity. This provides the moving force for the microflora to multiply faster and in large numbers in the mudflats than in the sandbars (Pennock, 1985; Mann, 2000; Castro & Huber, 2005) as was observed in the Cross River estuary, Nigeria.

CONCLUSIONS

The differential biomass of the microfloral cells in these ecological zones may not be unconnected with the capacity of the two zones to entrap and retain nutrient which encourages the differential cell growth of the microflora.

In view of the importance of the intertidal areas in estuarine ecology, there is need for further studies to be conducted on the epibenthic algal production in these zones of the estuary.

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