Eco. Env. & Cons. 16 (2) : 2010; pp. (269-276)

Surface soil and tree invertebrate macrofauna of some saline mangrove wetlands in eastern Niger Delta, Nigeria

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ABSTRACT

Characterization of the macroinvertebrate and some piscine fauna of three floristically different mangrove wetlands of Eastern Obolo, Nigeria in a two-dimensional perspective of soil and tree fauna formed part of studies carried out between December 2000 and November 2002. A minimum of 15 species was recorded in a *Rhizophora* dominated swamp, 14 species in a mixed mangrove macrophytes swamp, and 23 species in a *Nypa fruticans* (an invasive species) dominated swamp. Five species were obtained from the trees in each of the three stations, while the surface soils yielded nine species common to all three stations. Eight species were restricted to the *Nypa* swamp – five of which were non-resident species. Only one of the five phyto-faunal species is not commercially exploited, and very few of the surface soil species are commercially exploited. The ecological advantage of conserving these species, edible or non-edible, is discussed.

***Key words:** Mangrove wetlands, Tree, Surface, Soil fauna, Niger Delta*

Introduction

Mangrove wetlands occur in many places along the shores and estuaries of tropical and subtropical regions of the world, between latitudes 32°N and 38°S. Soils of mangrove wetlands are saline and water-logged because of tidal flooding (Walsh, 1974), aided by low wave energy (Ibe and Antia, 1983). The mangrove ecosystem is multidimentional, comprising aquatic, terrestrial and arboreal habitats. Organisms can be found on the sediment surface, in the sediments, on physical substrates other than the sediments, on tree stems and in the overlying water during flow tide. The shallow intertidal reaches that characterize the mangrove wetlands as well as the trees, offer habitats to a wide variety of animals (Stirn, 1981; Udoidiong, 2005). Moses (1985) and Mohanraju and Natarajan (1992) indicated that the whole complex of swamp, mudflats, mangrove trees, creeks and drain canals, together with the invertebrate and vertebrate fauna, microorganisms, and the interacting physicochemical factors of the muddy deposits, constitute the mangrove ecosystem.

The mangrove ecosystem has been described as a place where land and sea intertwine (Snedaker, 1993; Molles, 2002), thus acting as an interface between land and sea, and helping to protect coastlines from erosion, storm damage, and wave action. Mangroves act as buffers, and catch alluvial materials thus stabilizing land elevation by sediment accretion that balances sediment loss (Rodriguez, 1987). Mangrove forest detritus consisting mainly of fallen leaves and branches from the mangroves provides nutrients for the marine environment and supports immense varieties of sea life in complex food webs associated directly through detritus (Scott, 1966; Dangana, 1985), or indirectly through the planktonic and epiphytic algal food chains. According to Ibe and Antia (1983), the development of large tracts of

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swamps in this and adjacent areas is aided by a low wave energy which enhances depositional processes.

The faunal assemblages of mangrove ecosystems are important components of the local and regional biodiversity resources that also contribute significantly to global life – support systems. In Nigeria, the mangrove ecosystem which spans the entire Niger Delta has not been given the attention it deserves in scientific studies. Apart from the intense commercial exploitation of crude oil and natural gas, mangrove wetlands are seen as wastelands fit for destructive utilization including reclamation for industrial and residential purposes. Yet the lives of millions of people in this country are directly and indirectly linked with resources of these areas. The much talked about interest in conservation of the natural resources of the nation (NARESCON, 1992) does not include the diverse species of invertebrates that inhabit the mangrove wetlands of the Niger Delta.

This report forms part of a series of reports of aspects of the synecology of the mangrove fauna of Eastern Obolo, Akwa Ibom State, Nigeria. The objective has been to document for the first time, the rich faunal resources of the mangrove environment of this part of the Niger Delta, to serve as baseline data for future studies. Egborge (1993) pointed out that the intertidal Molluscan fauna of Nigeria in the Niger Delta segment are apparently threatened by industrial pollution. A different spectrum of threat was sounded by Powell (1990) who noted that since no systematic surveys of invertebrates have been carried out in the coastal waters, it was now too late to ever determine with confidence the indigenous estuarine fauna of the country. This timely warning arose from his earlier reports of the occurrence of two exotic invertebrate species: *Macrobrachium equidens* – a large Indo – Pacific Prawn (Powell, 1987) and *Temnopleurus toreumaticus* – a sea urchin (Powell and Clark, 1990) in the Bonny Estuary. Powell's alarm is worrisome and should encourage scientific studies of our heritage before the demands of the modern age wipe out these resources to our detriment.

Materials and Methods

Study Area

The study was carried out in the mangrove wetlands of Eastern Obolo Local Government Area, located between latitudes 4°28' and 4°33' North, and longitudes 7°30' and 7°50' East (Fig. 1). It situates within the Imo River deltaic formation and has a total land area of c.a. 117,008km^2. Its shoreline stretches between the estuaries of the Imo and Kwa Iboe Rivers, covering a distance of about 84km (Uniuyo Consult, 1998). The swamps are characterized by daily tidal flooding, impaired draining in basin wetlands, a long rainy season and an organic

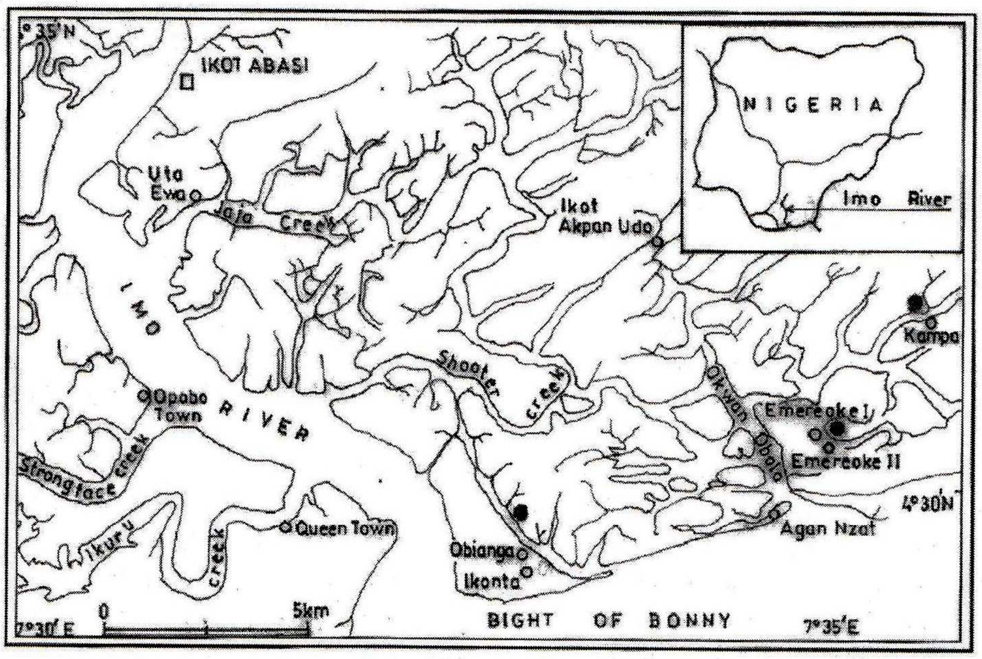

Fig. 1. Parts of the coastal basin of Imo river showing sampling sites, with closed circles. Inset: Map of Nigeria showing the position of Imo River

substrate associated with high acid conditions (Ukpong, 1976).

The Imo River Estuary and its mangroves environs share the climatic conditions that prevail in the rain forest zone of Southern Nigeria, with an annual rainfall of up to 4000mm distributed throughout the year.

Sampling stations

Samplings were carried out in three floristically different swamps described below, so as to ensure realization of the main aim of the studies.

Station 1: Kampa

This village (7°42'E; 4°32'N) is located in the central part of Eastern Obolo, relatively far from the Atlantic Ocean. Here there are fairly large areas of swamp vegetation dominated by luxuriant native mangrove species, with a sprinkling of very young nipa palms. The station is well sheltered from the Atlantic waves, and has two distinct zones of sediment – clayey silt along the fringes of creeks, and peaty, fibrous mud (Chikoko) at the back swamps (Wokoma, 1985).

Station 2: Emereoke

This island (7°40' E; 4°31' N) is close to the Atlantic coast, with the Okwan Obolo Estuary being the major outlet draining its catchments area. Many portions of the mangrove swamp vegetation consist of a mixture of native mangrove species, with nipa palm and mangrove fern (*Acrostichum aureum*) in varying densities. The sediment zones are the same as at Kampa.

Station 3: Obianga

This is an island on the Southwestern tip of Eastern Obolo, and is located between 7°31' E and 4°29' N, bounded by the Imo River on the west, and the Atlantic Ocean on the South. Native mangrove macrophyte species have been completely eliminated from these swamps, which are now dominated by dense, luxuriant stands of nipa palm (*Nypa fruticans*). The palms extend more than 200 metres into the swamps, and the high density makes accessibility very difficult until transects were cut. Soil zones are the same as in the other stations.

Sampling Procedures

Samples were collected over a 24 month sampling period from December 2004 to January 2006 covering two annual cycles. Different sampling methods were employed to sample different fauna types. Surface dwelling decapod crustaceans were sampled using two types of traps: (i) unbaited conical valved basket traps (length 42-50cm; diameter of opening 14 – 17cm; mesh size 0.2 – 0.5cm), and (ii) plastic table-water bottles with screw cap (Eva brand). These were set as soon as the water receded from the swamps, and inspected just before the next flow tide. Tree dwelling mollusks were sampled using the Tack *et al* (1992) method, in which trees were zoned vertically above ground. Surface dwelling large – sized mollusks were sampled by hand - picking within 5 x 5m^2 land quadrats.

Retractile mollusk and Annelid species on the sediment surface were also sampled with 5 x 5m^2 land quadrats, but employing the ten - minute time interval sampling method described by Yakson and Kendall (2001).

Smaller sized of mollusks, Annelids, Crustaceans and other Arthropods were sampled using 0.5m^2 metal quadrats. Using the estuarine water, the samples were washed into appropriately labeled plastic vessels containing 10% formalin. The samples were then transported to the laboratory for identification and measurement. Laboratory analyses were carried out within two weeks of each sample collection. Identification was done using guides provided by Edmunds (1978), Schneider (1990), Egborge (1993), Raven and Johnson (1999) and Campbell (1996).

Data Analysis

A number of indices were used to to evaluate the macrofauna community structure. The Shannon Weiner's Diversity Index was used to calculate species diversity at the different stations. The Jaccard's Coefficient of Similarity was used to test for similarity of species communities across the sampling stations. The Margalef Index of Species Richness was used to statistically compute the number of taxa in each station, while the Simpson's Dominance Index (D) was used to calculate species dominance.

Results

Overall species Composition

Table 1 gives the overall species composition of the three swamps sampled. 15 species from 12 genera and 11 families were identified in Station 1 (*Rhizophora* swamp); 14 species from 11 genera and

Table 1. Check-list of the soil/tree categorization of the faunal assemblage of Eastern Obolo mangrove wetlands.

Species	Station		
	1	2	3
Soil fauna			
Clibernarius chapini	+	+	+
Clibernalius senegalensis	+	+	+
Bostrychus africanus	-	-	+
Periophthalmus barbarous	+	+	+
Melampus liberianus	-	-	+
Semifusus morio	+	+	+
*Cardisoma armatum**	+	-	+
Goniopsis pelii	+	+	+
Sesarma elegans	-	-	+
Neritina glabrata	-	-	+
Uca tangeri	+	+	+
*Penaeus notialis**	-	-	+
*Penaeus kerathurus**	-	-	+
*Callinectes amnicola**	-	-	+
*Callinectes pallidus**	-	-	+
Tympanotonus fuscata var. radula	+	+	+
Menippe nodifrons	+	+	+
Panopeus africanus	+	+	+
Tree fauna			
Littorina angullifera	+	+	+
Thais callifera	+	+	+
Thais coronate	+	+	+
Thais haemastoma	+	+	+
Crassostrea gasar	+	+	+
Total number	**15**	**14**	**23**

* Non-resident fauna; + Present; - Absent

10 families were recorded in Station 2 (mixed macrophytes swamp), while 23 species distributed among 18 genera and 16 families were recorded in Station 3 (*Nypa* swamp). Station 3 comprised eight species (34.78%) more than Station 1; these were *Bostrychus africanus, Melampus liberianus, Neritina glabrata, Sesarma elegans, Penaeus kerathurus, Penaeus notialis, Callinectes amnicola* and *Callinectes pallidus.* It comprised nine species (39.13%) more than Station 2, with same species as in Station 1 plus *Cardisoma armatum.*

The family Muricidae was the most diversified, with 13.0% contribution to the total species richness from three species. This was followed by the Diogenidae, Grapsidae, Penaeidae, Portunidae and Menippidae with 8.7% contribution from two species each. The remaining families each had a single species with 4.3% contribution each.

Soil/Tree Categorization

Table 1 also lists the species on the basis of above categories. The mangrove surface soil as habitat yielded more species than the trees. i.e. In terms of species diversity, the soil epibenthic macrofauna were more than the tree fauna. Five species namely the periwinkle, *Littorina angullifera,* the three dog whelk species – *Thais callifera, T. coronata* and *T. haemastoma,* and the mangrove oyster *Crassostrea gasar,* were obtained from the trees in all stations. The tree invertebrate fauna on the other hand exhibited higher numerical strength of individual species. Conversely, the soils in Stations 1 and 2 yielded 10 and 9 species respectively, whereas 18 species were obtained as soil fauna from Station 3 (Tables 1 and 2). The numerical abundance and biomass data are shown in Table 2. There were no statistically significant differences ($p>0.05$ in each case) in the soil organisms between the three stations both in abundance and biomass. However, the abundance and biomass data between tree and soil fauna were significantly different ($p<0.05$ in each case), indicating that the abundance and biomass of tree fauna were

Table 2. Species richness, numerical abundance and biomass among soil and tree fauna of Eastern Obolo mangrove wetlands.

Habitat	Station		
	1	2	3
	Number of Species		
Soil	10	9	18
Tree	5	5	5
	Numerical Abundance		
Soil fauna	418.8 ± 497.29	505.5 ± 547.89	297.9 ± 475.09
Tree fauna	701.0 ± 457.7	709.0 ± 515.4	675.2 ± 492.6
	Biomass		
Soil fauna	86.47 ± 134.21	99.93 ± 140.77	58.73 ± 109.66
Tree fauna	353.04 ± 678.99	414.49 ± 831.43	498.88 ± 1028.82

greater than those of soil fauna. The higher numerical abundance of tree fauna can be attributed to the contributions from the mangrove oyster (*Crassostrea gasar*) and the dog whelk (*Thais*) species. Although these mangrove wetlands are different floristically, their major faunal components are similar. All three have *Tympanotonus fuscata* var. *radula*, *Periophthalmus barbarus*, *Uca tangeri* and *Goniopsis pelii* as dominant soil fauna, while *Crassostrea gasar*, *Littorina angullifera* and *Thais* species are the dominant phytofauna.

Similarity (Overlap)

Similarity values are given in Table 3. The soil fauna in Stations 1 and 2 had a very high similarity of species, with an index value of 0.9 (90.0%), whereas Stations 1 and 3 as well as 2 and 3 had moderate similarities with an index value of 0.5 (50.0%) in each case. A hundred-fold similarity was obtained between above station pairs for the tree fauna, since all of them had the same number of species.

Table 3. Mean faunal similarity/dissimilarity among soil/tree fauna of Eastern Obolo mangrove wetlands.

Station pair	No. Species common	Similarity	Dissimilarity
Soil fauna			
1 & 2	9	0.9000	0.1000
1 & 3	9	0.5000	0.5000
2 & 3	9	0.5000	0.5000
Tree fauna			
1 & 2	5	1.0000	-
1 & 3	5	1.0000	-
2 & 3	5	1.0000	-

Resident and Immigrant fauna

Some of the species of soil fauna in these intertidal mangrove wetlands (especially Station 3) are not permanent residents of the mangrove swamps. These are *Callinectes amnicola*, *Callinnectes pallidus*, *Penaeus kerathurus* and *Penaeus notialis*. These species move into the swamps with the flow tides and leave with the ebb tides; but some are left behind in saline pools as the water ebbs. *Cardisoma armatum* (the Lagoon land crab) is also not a resident species of the swamps. It inhabits adjoining terrestrial lands, but could make periodic incursions into the swamps.

Goniopsis pelii

This species commonly known as the *purple mangrove crab*, lives in holes in the swamp, on the soil surface, and on trees. Many individuals spend long hours on trees, and have been described as amphibious crabs. It is the most dynamic of the mangrove crabs, and can be regarded as both a soil and tree fauna. The arboreal behaviour may not be explained solely on the "escape theory", whereby the crabs indulge as a way of escape from a disturbance with a fatal potential. It may have trophic significance, since the mangrove trees harbour ants and other insects which may prove to be favoured food items. These theories need investigation.

Discussion

Nine species of the soil fauna were common to all three swamps, each had also the same number of five tree species. Udoidiong (2005) has shown that the soils of these swamps were quite homogeneous on the basis of fifteen soil variables analyzed, with no significant statistical differences between them. Therefore, that each of the three station pairs (1&2; 1&3; 2&3) had nine (9) species in common is thus understandable. The high similarity value of 0.9 or 90% between Stations 1 and 2 could be explained on this basis. However, the moderate and equal similarity value of 0.5 or 50% between the Station pairs 1&3 could not be explained on the basis of soil characteristics. Stations 1 and 2 are relatively far from the direct influence of the ocean water, whereas Station 3 is very close to the mouth of the Imo River and the Ebon Okwan Obolo estuary. This enables the station to receive tide-dependent immigrants into the swamps in accordance with tidal pulses. Moreover, the structure of mature nipa palms provides them with numerous microhabitats for species to hide and therefore escape predators. Some species of crabs obtain refuge in the axils of the palms during ebb tide whenever they miss their holes on the approach of an intruder. The bases of the palm leaves also provide large surface areas for encrustation by the tree fauna. These and other structural attributes collectively enhance species diversity through habitat heterogeneity at Station 3.

Of the species of soil fauna recorded from these swamps (excluding non-resident species), only *Tympanotonus fuscata* var. *radula* and *Periophthalmus barbarus* are commercially exploited and occur in large numbers. However, exploitation pressure on *P. barbarus* has led to significant reductions in stocks and sizes. Existing stocks (especially at Station 1) seem to be recovering. Exploitation pressure seems not to affect populations of *T. fuscata* especially in the back swamps where accessibility is often difficult. Although the Andoni (Obolo) people do not eat *Goniopsis pelii,* women from Ibibio communities adjoining Station 1 do hunt for the species up to Station 2 in the night and sell them the following day in local markets. The non-resident soil species (especially the Penaeid shrimps) are all edible and are of commercial value, with a flourishing artisanal shrimp fisheries at the nearby (Station 3) Imo River Estuary. However, *Cardisoma armatum* seems to be negligibly exploited for subsistence. *Bostrychus africanus* is a fin fish that is edible, but it is rare in these swamps. The giant hairy melongena, *Semifusus morio* is a highly priced delicacy among the coastal populations. It is somewhat rare and appears to be substantially imported into the swamps especially by spring tides. They are actively hunted for at the ebb of every spring tide and seems to be exploited for subsistence since available stocks do not support commercialization.

Apart from *Littorina angullifera* which is not yet exploited for food (though edible), the remaining tree fauna species are highly cherished food items heavily harvested. Though exploitation pressure has greatly reduced the sizes of these species at harvest, a major problem likely to lead to declines in stocks is habitat destruction and fragmentation. The rate at which mangrove trees are cut yearly is not ecologically friendly. A recent trip to Station 1 which had appreciable expanse of tall, luxuriant *Rhizophora* trees revealed massive felling of the trees for logging and firewood. The loss of one tree leads to the loss of several prop roots which serve as substrates for encrustation by the tree faunal species.

Non-edible Fauna

About nine species of the soil fauna are presently not utilized for food. This may not mean that they are toxic; rather they have relatively less meat which does not encourage exploitation in the midst of better alternatives. These species are not useless in the ecosystem because they have no food value. They all contribute to ecological integrity of these wetlands through other ecosystem functions linked to local and regional life – support systems. Moreover, Angermeier, *et al.*, (1986) pointed out that a compelling argument for maintaining the integrity of ecosystem and their full complement of organisms is that perceived values of all species are dynamic, and their relative importance may chang as society's technology, culture, and standards change.

On Saturday July 29, 2006 and incident was reported to have occurred in Nepal that greatly substantiated above statement. In a BBC news bulletin, it was reported that in Nepal scientists were worried about the rapid decline in the population of vultures in the country. This decline was attributed to a drug used by veterinary doctors to treat animals. The drug became highly toxic to the vultures through feeding on carcasses of animals treated with the drug. The worrisome aspect of this incident was not the mass mortality of the vultures *per se*, but the effect of the mass mortality on the human population in Nepal.

The vultures occupied a significant position in the food chain (or web) of the Nepalese ecosystem (urban or rural), by consuming carcasses abandoned on the streets or bushes. By feeding on those carcasses the vultures were carrying out their ecological role of ridding the environment of a health nuisance. With the mass mortality of the vultures, pathogens that invaded the decomposed carcasses, infected man and assumed epidemic proportions. This incident has demonstrated the ecological importance of vultures in the environment that favourably affects humans, though they are repugnant to man in many cultures as they are regarded as birds of omen. But they occupy an important position in disease control in Nepal, and may play a similar role in other countries. This role was largely unknown to the people of Nepal until the incident occurred. According to a Nepalese official interviewed by the BBC correspondent, efforts have now been geared toward breeding the vultures to increase their population in the country. The invertebrate fauna of our mangrove wetlands are playing yet-to-be appreciated ecological roles in these habitats and we should not wait until a major disaster strikes before we are woken to our responsibility of proactive conservation of these resources.

Intertidal mangrove fauna are useful to society in many ways other than food value. For instance, Smith, *et al.*, (1991) showed that reductions in crab abundance led to increased sulphide and ammonium concentrations in the soil, and to reduced productivity and reproductive output by the mangroves.

Bertness (1985) found that experimental reduction of fiddler crab density of a single growing season decreased above ground production by 47%, and burrowing by the crabs increased soil drainage, soil oxidation – reduction potential, and the *in-situ* decomposition of below ground plant debris. In the Niger Delta generally, pressure on mangrove areas is increasing as a result of land fills, oil and industrial pollution, deforestation and habitat fragmentation, etc. Unless the various tiers of the Nigerian government take proactive measures in conservation of biodiversity, we may be robbed of the resources and ecological significance of the mangrove ecosystems and their associated beneficial effects in the near-shore waters.

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