THREATS TO SPECIES OF EPIBENTHIC MACROFAUNA OF SOME MANGROVE WETLANDS IN EASTERN OBOLO, NIGERIA

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ABSTRACT: The occurrence, numerical abundance, densities, and dispersion patterns of intertidal epibenthic macrofauna of three floristically different mangrove wetlands in Eastern Obolo, Nigeria, were studied to establish their status on the basis of commoness and rarity. Six species occurred in high densities, three had moderate densities while the remaining had low densities. Of the 23 species recorded, six of these, namely *Crassostrea gasar* (mangrove oyster), *Tympanotonus fuscata* var. *radula* (gastropoda), *Periophthalmus barbarus* (mudskipper), *Clibernarius senegalensis* (hermit crab), *Uca tangeri* (fiddler crab), and *Goniopsios pelii* (purple mangrove crab) were found to be common in these wetlands. Conversely, *Sesarma elegans* (marsh crab), *Neritina glabrata* and *Melampus liberianus* (gastropoda) were found to be rare and therefore, vulnerable to extinction. These rare taxa have very low population numbers and are restricted in distribution. These mangrove wetlands should be declared special protected areas, and effective scientific monitoring of the entire ecosystem instituted by the government for the purpose of conserving this special environment and its biotic components, some of which have potentials for biotechnology-driven benefits.

INTRODUCTION

Conservation of biodiversity is generally premised on three major reasons; (i) the species may have direct economic value; (ii) it may have indirect economic value, and (iii) it may be due to its ethical value. This third reason may not appear convincing enough to those not fully involved in conservation, but it has to do with the position of Angermeier, *et al*., (1986), that a compelling argument for maintaining the integrity of ecosystems and their full complement of organisms is that perceived values of all species are dynamic, and their relative importance may change as society's technology, culture, and standards change. 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. According to Benebo, *et al*., (1999) the Niger Delta mangrove forest covers about 6,000 km^2 in a swath between 15 – 45km wide, is the third largest such ecosystem in the world, and the largest in Africa, and has lost an estimated 5–10 percent of its size to urban growth and industrial development. The authors pointed out that only a small portion of this loss is as a result of oil company activities. Whatever are the causes of the loss, the fact remains that a sizeable portion of the Niger Delta mangrove forest and its associated fauna (invertebrates and vertebrates) have been lost and might not be regained. Due to the occurrence of some exotic species of invertebrates and seaweed in the Bonny Estuary, Powell (1990) noted that since no systematic surveys have been carried out for these groups of organisms in the coastal waters of the Niger Delta, it now seems too late to ever determine with confidence the indigenous estuarine fauna of the country. It is thus evident that the Niger Delta flora and fauna are under threats of loss and dilution, both of which could lead to reduction in population sizes of the species.

Many reasons have been adduced for species' extinction including habitat loss, pollution, invasive species effect, natural catastrophes, etc. However, extinction does not seem to be a dramatic, instantaneous event in time and space, except for the much talked about extinction of the dinosaurs which is suspected to have been triggered by a meterorite during the Mesozoic Era (Snow, 1991). Species are conserved if they are of special significance, such as keystone species, evolutionarily unique species, and charismatic megafauna that are easy to sell to the public (Begon, *et al.*, 1996). Species that do not belong within this categorization are considered inconsequential and therefore, can be exterminated as nuisant species. But such species have advantageous nuisance value (see Angermeier, *et al.*, 1986). For example, the drug-induced mass mortality of vultures in Nepal, reported by the BBC in July, 2006, brought to the fore the role of vultures in check-mating outbreaks of pathogenic microbes in that country, and argues in favour of conserving even species society abhors, or does not attach economic value to presently.

A large proportion of the epibenthic macrofauna of the Niger Delta mangrove ecosystem seems to be considered as having no economic value and so may not have a place in any conservation policy of government. However, recent advances in marine biotechnology using supposedly uneconomic species such as the horseshoe crab, mollusks and fishes that are not of economic value (see Ninawe, 1995) indicate that these species may be useful in future. This report formed part of studies on aspects of the synecology of the intertidal fauna of three floristically different mangrove wetlands in Eastern Obolo, Nigeria between December, 2000 and November, 2002. The aim of the report has been to use the occurrence and density profiles of the species obtained to establish the status of the species on the basis of whether they are common or rare, as assessed by the classification scheme provided by Rabinowitz (1981).

STUDY AREA

Location

This study was carried out in Eastern Obolo which situates within the Imo River deltaic formation between latitudes 4°28' and 4°33'N and longitudes 7°30' and 7°50' E (USIC, 2000). It has a total land area of about 117,008 km^2 and a shoreline of about 84km long and occupies the eastern Niger Delta fringe, stretching between the Qua Iboe River Estuary and the Imo River Estuary (Fig. 1).

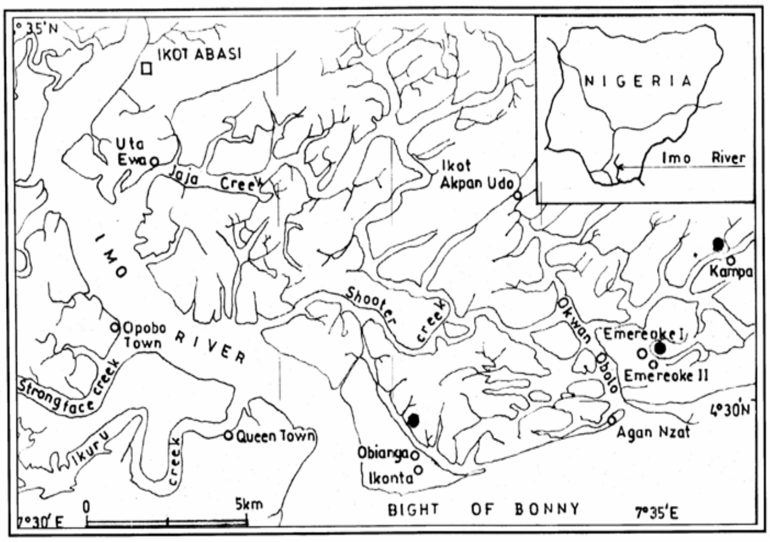

Fig. 1. Parts of the Coastal Basin of Imo River showing sampling sites, with closed circles.
Inset: Map of Nigeria showing the position of Imo River

Climate

The Imo River Estuary and environs share the climatic conditions that prevail in the rain forest belt of southern Nigeria, with annual rainfall of up to 4000 mm. According to Uniuyo Consult (1998) rain falls every month with the number of days per month varying from 3 in January to 23 in September, and monthly precipitation ranging from 39mm in January to 733mm in July. The mean annual temperature of the area is about 27°C, with the mean annual maximum approximately 30°C recorded in April or May, and a minimum of about 22°C recorded in January, giving a narrow range of about 8°C. This narrow range is attributed to the nearness of the area to the sea, which tends to prevent extremes of temperature fluctuations. The dominant factor influencing the climate in the area is the movement of the inter-tropical front which gives rise to two seasons: the wet and the dry. The wet season is characterized by high rainfall, relative humidity, and heavy cloud cover, and lasts from April to mid-November. The dry season, during which the harmattan occurs lasts for only a short period beginning in mid-November and ending in March. This period is characterized by the cold, dry, dusty wind blown from the Sahara desert.

Sampling Stations

Three floristically different mangrove zones were chosen for sampling and are described below:

Station 1: Kampa

Kampa (7°42' E and 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 tall luxuriant indigenous mangrove species, with a sprinkling of nipa palm (an exotic species). This station is very well sheltered from the Atlantic waves. Two distinct zones of sediment, clayey silt along the fringes of creeks, and peaty fibrous mud (or chikoko) at the back swamps (Wokoma, 1985) were evident. This station was termed *Rhizophora* swamp.

Station 2: Emereoke

This island (7°40' E, 4°31'N) is close to the Atlantic. Many portions of the mangrove swamps vegetation consist of a mixture of indigenous mangrove species with nipa palm in varying densities. The two soil types as in Kampa also obtain in this station described as the mixed macrophytes swamp. The portion sampled is a sheltered creek away from the direct influence of the ocean.

Station 3: Obianga

This is an island on the south-western tip of Eastern Obolo (7° 37' E, 4° 29' N) and is bounded by the Imo River on the west, the Atlantic Ocean on the south, and Okwan Obianga on the east. The indigenous *Rhizophora* and *Avicennia* species have been completely eliminated from these swamps, with only seedlings sprouting in the midst of dense canopies from tall, luxuriant nipa palms that have dominated the vegetation of this area. In many locations the nipa palm extend more than 60m into the swamps and accessibility was very difficult until transects were cut. The soil types are the same as in previous stations. This station was designated as *Nypa*-impacted swamp.

MATERIALS AND METHODS

Sampling

The soil fauna were sampled by the use of 0.5m^2 quadrats as described by Udodiong (2005a, 2005b, 2006). For the tree fauna different methods were used: the method of zoning trees vertically above ground level for sampling (Tack, *et al*., 1992) was used to sample *Crassostrea gasar.* A vertical height of 30 cm of encrusted area was sampled both on mangrove and nipa plants. Three such measurements were made within each 5 x 5 m^2 quadrat and all encrusted individuals removed by scraping with a knife (nipa palm samples), or the encrusted portion cut off with the animals on them (mangrove prop roots), and later separated from the substrate. Density was expressed as the number of oysters colonizing the 30 cm vertical height, and mean densities estimated from three replicate substrates. Specimens of *Thais* and *Littorina* were obtained from three 5 x 5 m^2 quadrats by hand-picking within ten minutes timed search (Yankson and Kendall, 2001). Densities were calculated on the basis of the quadrat dimensions.

Distribution Pattern

The method of Jackson (1968) as described by Odum (1971) was used in assessing the distribution patterns (dispersion) of the macrofauna in the intertidal areas studied. Mean density values and variances were calculated, as well as the variance/mean ratios. By this method if, on the application of standard significance tests, the variance/mean ratio is found to be significantly greater than I, the distribution is clumped; if it is significantly less, the distribution is regular; if not different from 1, the distribution is random (Odum, 1971).

Commonness and Rarity

Rabinowitz (1981) devised a classification of commonness and rarity based on combinations of three factors (i) the geographic range of a species (extensive versus restricted); (ii) habitat tolerance (broad versus narrow); and (iii) local population size (large versus small). The interpretation supposes that small geographic range, narrow habitat tolerance, and low population density are attributes of rarity and species influenced by these factors are vulnerable to extinction. Conversely, extensive geographic range, broad habitat tolerance, and large population are attributes of the most common in the biosphere. However, some species combine attributes of these two extremes and thus are neither common nor rare.

RESULTS

The overall numerical and relative abundances of the species obtained in this study are shown in Table 1. A minimum of 15 species distributed among 12 genera and 11 families were recorded at Station 1 (*Rhizophora* swamp); 14 species from 11 genera and 10 families at Station 2 (mixed macrophytes swamp), and 23 species from 18 genera and 16 families at station 3 (*Nypa* – impacted swamp).

Station 3 comprised eight species (34.78%) more than station 1, and nine species (39.13%) more than station 2. The family Muricidae (with a single genus, *Thais*, and three species), was the most diversified, with 13.0% contribution to the total species richness. Higher taxa analysis of the data resolved the species into four groups: Bivalvia, Decapoda, Gastropoda, and Pisces. A consistent hierarchical trend in abundance (with different proportional representations per station), was exhibited in all stations with the gastropoda being the most abundant, followed by the decapoda, the bivalvia, and lastly the pisces.

Mean densities of the fifteen species common to the three stations are shown in Table 2, with results of the Kruskal-Wallis test to decipher differences between them. The lower five species had very low densities in all stations. The mangrove oyster (*Crassostrea gasar*), the winkle (*Tympanotonus fuscata* var. *radula*), the West African fiddler crab (*Uca tangeri*), the mudskipper (*Periophthalmus barbarus*), the periwinkle (*Littorina angulifera*), and the purple mangrove crab (*Goniopsis pelii*), all occurred in high densities. Densities of the three dog whelk (*Thais*) species were moderate. The patterns of distribution of these macrobenthic fauna are shown in Table 3. In all stations most species were distributed regularly (13 species: 86.6% at station 1), 11 species (78.6%) at station 2, and 17 species (73.9%) at station 3. Very few species occurred in random and clumped patterns of distribution.

Based on occurrence, numerical abundance and densities, the species were allocated to five of the eight possible combinations from Rabinowitz's classification (Fig. 2). Of the 23 species from this study, four are not permanent residents of the mangrove habitat. They are *Penaeus kerathurus, P. notialis, Callinectes amnicola and C. pallidus.* These have not been considered in this classification. *Crassostrea gasar*, *Tympanotonus fuscata* var. *radula*, *Periophthalmus* *barbarus, Uca tangeri, Goniopsis pelii*, and the hermit crab *Clibernarius senegalensis*, are the most common species in these mangrove wetlands and do not show any of the three attributes of rarity. *Cardisoma armatum* is not common in the swamps but makes periodic incursions possibly to feed or flee attacks either by conspecifics or predators. It definitely has narrow habitat tolerance. The three muricid gastropod (*Thais*) species and the periwinkle (*Littorina angulifera*), have small local populations as an attribute of rarity. The lumpy stone crab (*Menhippe nodifrons*), the African mud crab (*Panopeus africanus*), the giant hairy melongena (*Semifusus morio*), the eleotrid mudfish (*Bostrychus africanus*), and the hermit crab (*Clibernarius chapini*) are all considered rare because of their small local populations and possibly, narrow habitat tolerance. Three species have been assessed as the rarest in these environments because they show all attributes of rarity. They are the marsh crab (*Sesarma elegans*), and the two tiny gastropods (*Neritina glabrata and Melampus liberianus*).

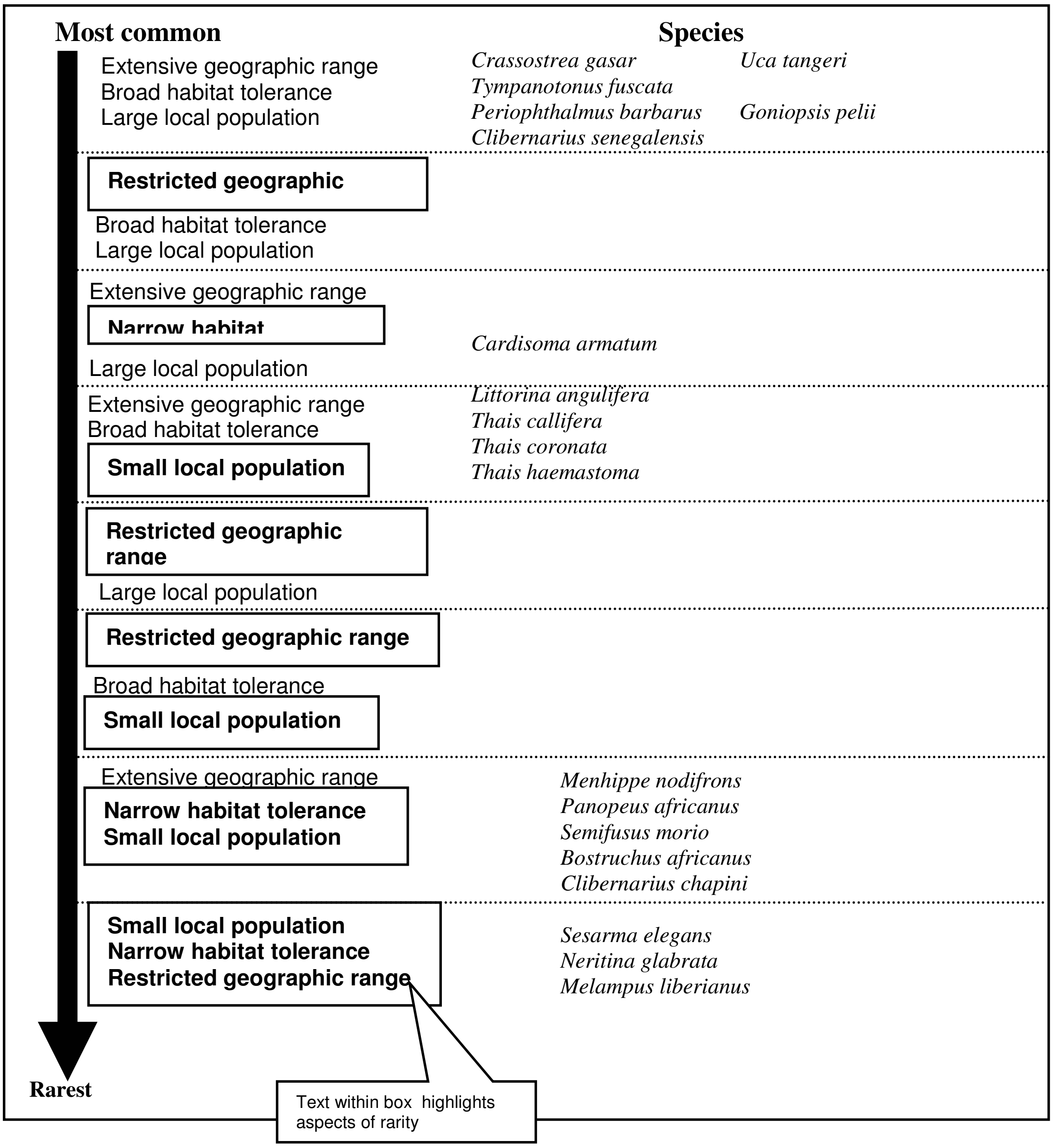

Fig. 2. Classification of commonness and rarity according to Rabinowitz (1981) with placement of species from this study

Table 1: Numerical and relative abundances of species obtained from the three stations between December, 2000 and November, 2002

Family/Species	**Stations**						**Pooled**		**Mean (±SD)**
	1		**2**		**3**				
Clibernarius chapini	58	0.0075	44	0.0054	97	0.011	199	0.0081	66.33 ± 27.46
Clibernarius senegalensis	192	0.025	223	0.028	573	0.036	988	0.040	329.33 ± 211.59
Bostrychus africanus	0	0	0	0	5	0.00057	5	0.0002	1.67 ± 2.89
Melampus liberianus	0	0	0	0	105	0.012	105	0.0043	35 ± 60.62
Semifusus morio	6	0.00078	8	0.00099	67	0.0077	81	0.0033	27 ± 34.65
Cardisoma armatum	3	0.00039	0	0	4	0.0046	7	0.00028	2.33 ± 2.08
Periophthalmus barbarus	902	0.117	1030	0.127	1020	0.117	2952	0.120	984 ± 71.19
Goniopsis pelii	850	0.110	916	0.113	778	0.089	2544	0.104	848 ± 69.02
Sesarma elegans	0	0	0	0	1	0.00011	1	0.00004	0.33 ± 0.58
Littorina angulifera	1184	0.154	1211	0.149	1099	0.126	3494	0.142	1164.67 ± 58.4
Thais callifera	409	0.053	412	0.051	334	0.038	1155	0.05	385 ±44.19
Thais coronata	345	0.045	279	0.035	302	0.034	926	0.04	308.7 ± 33.5
Thais haemastoma	355	0.046	316	0.039	324	0.037	995	0.041	331.7 ± 20.59
Neritina glabrata	0	0	0	0	84	0.0096	84	0.0034	28 ± 48.49
Uca tangeri	855	0.111	907	0.112	936	0.107	2698	0.11	899.3 ± 41.0
Crassostrea gasar	1213	0.158	1328	0.164	1317	0.151	3858	0.16	1286 ± 63.46
Penaeus notialis	0	0	0	0	4	0.00046	4	0.00016	1.33 ± 2.31
Penaeus kerathurus	0	0	0	0	1	0.00011	1	0.00004	0.33 ± 0.58
Callinectes amnicola	0	0	0	0	3	0.00034	3	0.00012	1.0 ± 1.73
Callinectes pallidus	0	0	0	0	2	0.00023	2	0.00008	0.67 ± 1.15
Tympanotonus fuscata	1293	0.168	1388	0.171	1596	0.183	4277	0.174	1425.7 ± 154.9
Menhippe nodifrons	11	0.0015	4	0.00049	18	0.0021	33	0.0013	11 ± 7.0
Panopeus africanus	18	0.0023	30	0.0037	68	0.0078	116	0.0047	38.67 ± 26.1
Total Number	**7694**	**-**	**8096**	**-**	**8738**	**-**	**24528**	**-**	

Clibernarius senegalensis	1.59	1.87	4.67	13.129 p< 0.05
Periophthalmus barbarus	17.46	21.57	25.53	13.149 p<0.05
Goniopsis pelii	13.27	11.42	9.64	16.351 p <0.01
Littorina angulifera	16.45	16.82	15.32	ns
Thais callifera	5.72	6.24	4.65	ns
Thais coronata	4.81	3.87	4.19	ns
Thais haemastoma	4.96	4.43	4.54	ns
Uca tangeri	19.37	22.89	24.98	19.148 p<0.001
Crassostrea gasar	110.1	130.0	178.0	22.519 p<0.001
Tympanotonus fuscata var. *radula*	45.07	46.05	58.74	15.191 P<0.001
				d-test
Clibernarius chapini	0.5	0.37	0.81	1&2; 2&3; 1&3; ns
Semifusus morio	0.08	0.11	0.66	1&3; 2&3; p<0.01 1&2; ns
Cardisoma armatum	0.023	-	0.03	ns
Menhippe nodifrons	0.12	0.05	0.19	1&3; 1&2 ns 2&3; p<0.05
Panopeus africanus	0.19	0.34	0.66	1&2; 2&3; ns 1&3; p<0.05

*P = level of significance of difference between stations, K – W = Kruskal Wallis
ns = not significant

DISCUSSION

Moses (1985) categorized mangrove swamp fauna which are important as food into two categories viz: permanent members and members that move in and out with the tide (non-permanent or itinerant members). This categorization can be extended to describe all species within this mangal ecosystem. From the present study, four species namely, *Penaeus notialis, P. kerathurus, Callinectes amnicola, and C. pallidus* are non-permanent members of the swamp community. These are tide-dependent immigrants. *Cardisoma armatum* is not a true member of the swamp assemblage, as it inhabits the adjoining dry land but makes periodic incursions into surrounding swamp areas during ebb tides. The permanent (resident) species constituted 78.26% exclusive of *C. armatum*, and 82.61% with the inclusion of this species. These mangrove wetlands have a relatively rich epibenthic macrofauna when compared with species richness of other mangrove swamps. For instance, Ajao and Fagade (1991) obtained 24 species of epibenthic macrofauna comprising 3 species of gastropoda, 8 species of bivalvia, and 13 species of crustacea in a Lagos mangrove wetland. Chukwu and Nwankwo (2004) obtained a minimum of 8 species of benthic macrofauna comprising 2 species of bivalvia, 2 species of gastropoda, 1 species of crustacea and 3 species of polychaete from Porto Novo creek in Lagos, Nigeria. Sasekumar and Chong (1986) reported a minimum of 15 species comprising 6 species of bivalves, 3 species of gastropoda, >4 species of crustacean and > 2 species of pisces in the Pulau Tengah mangrove swamps of Peninsular Malaysia. A minimum of 10 species of epibenthic macrofauna comprising 3 species of benthic fishes, about 3 species of crustacea and 4 species of mollusks were reported from the mangrove swamps of Unguja islands, Zanzibar (Ngoile and Shumula, 1992). In the present study the 23 species of epibenthic macrofauna recorded consisted of 12 species of decapoda, 8 species of gastropoda, 2 species of pisces and 1 species of bivalvia. Both the numerical dominance of the gastropods, and the species dominance of the decapods, agree with the report of Ajao and Fagade (1991), but is at variance with the report of Chukwu and Nwankwo (2004) in which low abundances were recorded. This was attributed to stress imposed by land-based pollutants (effluents) as well as substrate instability.

3. Mean densities and spatial distribution patterns of the macrobenthos

es	**Station 1**			**Station 2**			**Station 3**		
	Mean	**Variance**	**Distribution**	**Mean**	**Variance**	**Distribution**	**Mean**	**Variance**	**Dist**
narius chapini	0.5	0.202	Regular	0.37	0.096	Regular	0.81	0.372	Regu
narius senegalensis	1.59	0.865	Regular	1.87	1.346	Regular	4.67	7.129	Clur
chus africanus	-	-	-	-	-	-	0.05	0.006	Regu
pus liberianus	-	-	-	-	-	-	0.87	3.842	Clur
sus morio	0.08	0.017	Regular	0.11	0.032	Regular	0.66	0.36	Regu
oma armatum	0.025	0.002	Regular	-	-	-	0.03	0.012	Regu
hthalmus barbarus	17.48	9.548	Regular	21.57	14.669	Regular	25.53	9.486	Regu
osis pelii	13.27	2.161	Regular	11.42	3.459	Regular	9.64	2.624	Regu
a elegans	-	-	-	-	-	-	0.008	0.0009	Regu
na angulifera	16.45	8.066	Regular	16.82	8.585	Regular	15.32	5.76	Regu
allifera	5.72	3.960	Regular	6.24	7.129	Random	4.65	4.121	Regu
coronata	4.81	5.198	Random	3.87	2.161	Regular	4.19	2.958	Regu
aemastoma	4.96	2.822	Regular	4.43	2.756	Regular	4.54	6.35	Clur
a glabrata	-	-		-	-	-	0.7	2.102	Clur
ngeri	19.37	1.416	Regular	22.89	7.562	Regular	24.98	11.834	Regu
strea gasar	110.1	469.59	Clumped	130.0	445.21	Clumped	178.0	996.66	Clur
s notialis	-	-	-	-	-	-	0.03	0.008	Regu
s kerathurus	-	-	-	-	-	-	0.0008	0.000006	Regu
ctes amnicola	-	-	-	-	-	-	0.017	0.004	Regu
ctes pallidus	-	-	-	-	-	-	0.017	0.004	Regu
notonus fuscata	45.07	14.364	Regular	46.05	54.317	Random	58.74	71.572	Ranc
ope nodifrons	0.118	0.032	Regular	0.05	0.01	Regular	0.19	0.058	Regu
eus africanus	0.19	0.073	Regular	0.34	0.096	Regular	0.66	0.449	Regu

However, Powell (1990) reported that among the benthic fauna at Funiwa (during the Funiwa – 5 blowout of 1980), gastropods and the wood-boring bivalves (the shipworm *Psilotoredo*) survived the spill in even the worst areas. This might give the impression that these effluents are more toxic than hydrocarbon. According to Egborge (1993), intertidal molluscan fauna of Nigeria in the Niger Delta segment are apparently threatened by industrial pollution.

Generally the species occurred in lower densitites in station 1 relative to the other stations. This could be ascribed to factors such as distance from the coast and exploitation pressure on edible species. Station 1 is farthest from the coast while station 3 is nearest to the coast. Nevertheless, densities of *Tympanotonus fuscata* var. *radula, Crassostrea gasar*, *Periophthalmus barbarus, Goniopsis pelii*, *Littorina angulifera* and *Uca tangeri* were high. For example, Ekweozor, *et al*., (1989) reported baseline densities of 10 and 18 crabs/m^2 at Port Harcourt, 5 crabs/m^2 at Okrika, 32 crabs/m^2 at Ford Point, and < 5 crabs/m^2 at Bonny for the fiddler crab (*Uca tangeri*) during a study on the effects of chronic oil pollution in the central Bonny Estuary. Results of the present study, measured per $0.5m^2$ gave higher density values for the fiddler crab in all the stations over those reported by Ekweozor, *et al*., (1989). Higher densities of the animals at station 3 relative to other stations is at variance with notions of a deleterious effect of *Nypa fruticans* (an invasive palm species) (Moses, 1985, 1990; King and Udo, 1997), which is the dominant vegetation here, on these mangrove fauna.

Odum (1971) stated that random distribution pattern is relatively rare in nature, and would occur where the environment is very uniform in the absence of a tendency to aggregate. The rarity of random distribution of species in the present study agrees with this claim. The environments are homogeneous and food resources are abundant (Udoidiong, 2005a). Jackson (1968) reported randon distribution of the clam, *Mulinia lateralis* on an intertidal mudflat, as well as age-specific distribution of the clam, *Gemma gemma* on an intertidal mudflat, where second year individuals were randomly distributed but not the first year individuals, nor the total population of *Gemma*, which were clumped because of the ovoviviparous reproduction in the females. Odum (1971) pointed out that environmental homogeneity and less severe interspecific competition favour random dispersion in the mudflat ecosystem. However, the report of age-dependent dispersion patterns point to the fact that both intra-and inter-specific differences in dispersion patterns are likely, even in a homogeneous environment as the intertidal mudflats.

Species that exhibit all three attributes of rarity (small local population, narrow habitat tolerance, and restricted geographic range), are vulnerable to extinction, while those that exhibit one attribute are endangered. According to Begon, *et al*., (1996), a species that is restricted in occurrence but has high densities in such habitat is at risk because changes in land use may threaten such special habitat. The present results show that *Crassostrea gasar, Tympanotonus fuscata, Periophthalmus barbarus, Clibernarius senegalensis, Uca tangeri* and *Goniopsis pelii* are common in these swamps. Each of them has extensive geographic range, broad habitat tolerance, and large local population. Conversely, *Sesarma elegans*, *Neritina glabrata,* and *Melampus liberianus* are vulnerable to extinction, whilst the others are endangered. The observation by Begon, *et al*., (1996) that a feature of animals that are collected for ornamentation is that their value to collectors goes up as they become rarer, with no safeguard of a density-dependent reduction in consumption rate at low density, is applicable to edible species in these swamps. Most affected are *Semifusus morio* and *Thais* species, which are collected without regard to size, and without any regulation of exploitation pressure. The natural rates of mortality and capacities for reproduction though not yet investigated, may not sustain the present rate of exploitation. Overexploitation is avoidable if the necessary conservation safeguards are implemented and enforced.

Hilton-Taylor (2000) in the 2000 IUCN (International Union for the conservation of Nature and Natural Resources) Red List of Threatened Species, reports large numbers of threatened invertebrate species (1,928). He stressed the need for a stronger focus on the invertebrate groups, and pointed out that the Species Survival Commission (SSC) of the IUCN is developing a strategy to address this problem. There is unevenness in the assessments of species of invertebrates under threats across the taxa, although, Hilton-Taylor (2000) claims that the list of invertebrates assessed is slowly increasing, with the most significant changes taking place among the mollusks. Moreover, less than five percent of mollusks is said to have been assessed, and these assessments have largely been confined to the terrestrial and freshwater species, and relate to the better known regions such as the USA, Europe, Australia and recognized areas of endemism on islands. Little has been said about the Nigerian species, many of which are currently under various threats.

The IUCN Red List categories according to Rabb (1997) are meant to identify species that are threatened with extinction by highlighting taxa that: (i) experience significant population declines, (ii) are restricted in distribution, (iii) have very low population numbers, or (iv) exhibit any combination of these factors as shown in Fig. 2. The red list according to him, shows that habitat reduction, fragmentation, and degradation are unquestionably the most significant threats to the majority of species at risk of extinction. Another causative factor of animals threatened with extinction (and recognized by the Red List) is the introduction of non-native species. This he pointed out often leads to competition, predation, disease, parasites, hybridization, and the alteration of ecological communities. All the factors listed above are at work against many animals and plant species in the Niger Delta mangrove ecosystem, and Powell (1990), Powell and Clark (1990), Powell, *et al.*, (1990), reported the occurrence of three exotic species: *Marcrobrachium equidens* **,** a large Indo – Pacific prawn; *Ulvaria oxysperma* – a seaweed, and *Temnopleurus toreumaticus,* a sea urchin, in the Bonny Estuary. The sea urchin is reported (Powell, 1990) to be a pest of artisanal fisheries in the Bonny Estuary, taking bait from long-line hooks, consuming fish caught in nets, and entangling cast- and set-nets. He pointed out that since no systematic surveys have been carried out for these groups of organisms in the coastal waters, it now seems too late to ever determine with confidence the indigenous estuarine fauna of the country.

Rare species, single species genera and endemics are of conservation concern. Rare species are those whose populations have reduced to a level approaching the lowest limits of viable breeding populations. Removal of individuals from such populations for whatever purpose, might lead to an early extinction of the species. In monotypic genera, the entire genetic diversity of the respective genus resides in the single species. The loss of such species is said to include the loss of the genetic distinctiveness of the whole genus and its contribution to regional and global life-support system. Therefore, the large percentage of monotypic genera in these swamps (especially those with small population sizes) is of conservation concern, as catastrophic environmental perturbation can lead to the obliteration of whole genera and species.

The intensity of subsistent and commercial exploitation of these animal resources and the floral component has rendered these areas inconsistent with primary wildlife management objectives. This situation is worsened by the absence of transboundary exploitation laws, which makes these areas free-for-all natural exploitation milieus. Conservation of the mangrove fauna draws importance in the fact that any loss of biodiversity is undesirable from aesthetic, ethical, or ecological perspective (Angermeier, *et al*, 1986). The glaring shortsightedness on the part of policy makers concerning what constitutes "wildlife" in Nigeria has been disturbing. From all indications (NARESCON, 1992), wildlife begins and ends with large mammals, birds, and reptiles. The rich invertebrate fauna of the transition zones between the sea and rivers and the environments are good only for destructive exploitation since they are rated as "wastelands." In this technology- driven age, biotechnology has opened up incredible possibilities for the study of species that were hitherto considered useless. Potent drugs have been produced from such species as the Florida manatee (*Trichechus manatus*) and the Madagascan rose periwinkle, *Catharanthus roseus*. It is likely that our local aquatic fauna have not been subjected to this line of research yet, and might possibly have potentials for such benefits.

RECOMMENDATIONS

- There should be a legislation setting aside the mangrove ecosystem of Eastern Obolo as a special protected area.
- Exploitation of the mangrove fauna should be controlled.
- Harvesting of immature individuals should be banned to ensure sustainable exploitation.
- Logging of *Rhizophora* trees should be banned. Excessive logging reduces available prop roots which serve as substrates for encrustration by tree fauna.
- Scientific monitoring of the entire ecosystem should be instituted by government for the purpose of conserving this special area and its biotic components. Monitoring will detect the presence of exotic species and proffer immediate solution.
- The bill establishing a Niger Delta 'protected area' which is before the National Assembly should be given accelerated hearing and be holistic in scope.
- The Niger Delta wetlands should be listed as a wetland of International importance, since Nigeria is a member of the Ramsar Convention.

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