LITTORAL MICROCRUSTACEAN IN CROSS RIVER ESTUARY, NIGERIA: ECOLOGICAL ASSESSMENT

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ABSTRACT

This study aimed at examining the abundance, composition and distribution of littoral microcrustacean in the three respective habitats of the Cross River Estuary. A total of 324 individual littoral microcrustaceans belonging to 56 species and 10 taxonomic groups were recorded in the course of the study. A one-way analysis of variance (ANOVA) revealed that there was no significant difference in the littoral microcrustacean abundance between the three stations. The number of individuals in stations 1 and 2 correlate very strongly with the sediment substrate whereas station 3 was negatively correlated with the sediment substrate. The relatively low habitat specificity of the littoral microcrustacean in the Cross River Estuary indicates that their broader use as bioindicators for various anthropogenic stressors should be investigated.

Keywords: *Littoral, Microcrustaceans, Cross River Estuary, Nigeria*

INTRODUCTION

A diverse and abundant assemblage of micro crustaceans dominated by Copepod and Cladocera, inhabit the littoral zones of most estuaries where there are important contributors to littoral secondary production. Many species are herbivorous and when abundant, they may influence periphyton dynamics (Walzeng et al., 2008; Flossner, 2000). They also commonly serve as food for macro invertebrate and fish.

Littoral microcrustaceans often constitute a significant component of the benthic community in the estuary as well as marine environment (Newell G. and Newell R., 1977) in which they are the most conspicuous element in the meiobenthos, amounting numerically to about 70-90% of the total benthos in the estuary (Warwick, 1993; Simon and Ramsay, 1997; Tait and Dipper, 1998; Prasad, 2000). Owing to their higher mass and physiological rates compared to their pelagic counterpart, littoral microcrustaceans are important phytoplankton grazer (Castro and Huber, 2005) and nutrient regenerator in the estuary (Lalli and Parsons, 1997). The physical and chemical characteristic of the estuarine system help in the distribution of estuarine microcrustaceans of which the chief factor is the salinity (Lalli and Parsons, 1997).

However, proximity to the shore and the bottom are also important for these littoral forms (Korovchinsky, 1986). Currently, species composition and community structure of littoral microcrustaceans in the estuary have not caught the interest of most researchers. Rather, a lot of researches have been carried out by various researchers on the topic in the river, streams and other environment. The distribution of many estuarine littoral microcrustacean changes seasonally and it is generally patchy. In Nigeria, Imoobe (2002, 2003) conducted research in Niger Delta region of the country and produced a preliminary checklist of the macrobenthic fauna offshore Niger Delta of which he found most microcrustacean to occur in these regions. In 2003, his investigation work of Ostracod along the entire stretch of Jamieson River, Delta State reveals a total of four species of Ostracod, three of which are newly recorded in Nigeria. Currently, knowledge of the species composition, distribution and abundance of littoral microcrustacean is lacking for the Cross River system and present study unveils the abundance, distribution and species composition of these forms in this estuarine system.

MATERIALS AND METHODS

The study area is the Cross River estuary. The Cross River estuary lies approximately between latitude 4° and 5°N and longitude 7° 30' and 10°E of the equator (Ewa-Oboho, 2006) as shown in Fig 1. It is the largest estuary along the Gulf of Guinea (Nawa, 1982; Moses, 1988; Enyenihi, 1991) covering an estimated area of 54,000km^2 and 39,000km^2 lies in Nigeria while the remaining 14,000km^2 lies in Cameroon (Enyenihi, 1991). It also has a long coastline with fringing mangrove and a characteristic muddy bottom. The Cross River estuary is the largest in the West African sub-region and is approximately 25km wide at the mouth and more than 440km long with a tidal flushing of 1.83 billion cm^3 per day (Enyenihi, 1991). Its climate and hydrology have been reported by (Akpan, 1994; Asuquo, 1998). Air temperature over the estuary shows diurnal variations, being higher during the day than at night owing perhaps to the influence of local land and sea breeze. The average temperature of the estuarine surface water is 26.7°C. The river discharge upstream (Itu) is 879m^{3}s^{-1} (dry season) and 2533m^{3}s^{-1} in wet season (Lowenberg and Kunzel, 1991).

The estuary is also prone to allochthonously imposed negative changes in the environment owing principally to oiling activities located adjacent to the mouth of the estuary. The Cross River estuary, the largest in Nigeria with tidal amplitude of 3m (Asuquo, 1998) is delineated into three aquatic ecological habitat ranging from fresh water in the upstream region to brackish water in the middle reaches to the marine environment at the mouth of the estuary (downstream).Littoral microcrustaceans were sampled at three stations of the littoral zone of Cross River estuary with the use of standard zooplankton ring net with mesh size of 200µm. At each of the stations, the net were hauled out at a speed of 0.5 -1m/s and the littoral microcrustaceans filtered from the net were stored in a polyethylene container with little of the estuarine water. The polyethylene containers were air tight to avoid damage from agitation and direct sunlight during transportation from the field. For sediment study, the sediment for each of the station was taken with the help of hand trowel. The samples were then taken to the laboratory for analysis.

In the laboratory, the samples were fixed with 4% formalin buffered with borax (sodium tetra-borate). Then subsamples were taken into the Petri dish before sorting, identification and counting were done with the use of simple microscope. Grain size analyses of sediment were done granulometrically using standard sieve nets. For statistical analyses of size parameters, sediment samples were over-dried at 80°C, quartered and weighed on electronic balance to 50-100g. The weighed samples were then sieved through set half-phi interval sieve (aperture sizes 1000, 500, 350, 250, 125, 90, 63mm) in a Ro-tap machine for 24hours (15mm). The littoral microcrustaceans in the samples were all identified and counted with the aid of standard literatures like Newell G. and Newell R. (1977) and Waife and Grid (2001).

The frequency of occurrence of each littoral microcrustacean was determined by empirical method. Each species in the total littoral microcrustacean sampled was given a numerical value and used in calculating its contribution to the total composition. Inter-station comparisons were carried out to test for significant differences in the faunal abundance using One-Way Analysis of Variance (ANOVA) (Ogbeibu, 2005). Pearson's correlation coefficient (r) was used to determine the relationship between each station's faunal abundance and each station sediment samples.

RESULTS AND DISCUSSION

A total of 324 individual littoral microcrustaceans belonging to 56 species and 10 taxonomic groups which include Hypariid, Mysid, Cladocera, Ostracod, Copepod, Crustacean, Euphausiid, Amphipod, Cumacean, and Isopod were sampled in the course of the study. Eight-three individuals were sampled in station 1, 108 were sampled in station 2 while 133 individuals were sampled in station 3. Out of the 56 recorded species of littoral microcrustaceans, thirteen were sampled station in 1, seventeen in station 2 and twenty-six in station 3, were recorded (Table 1). The attached checklist has a comprehensive detail of all the species of littoral microcrustaceans recorded during the study.

Station by station variation in abundance of littoral microcrustacean shows that in all the three stations, Copepoda is the most abundant followed by Ostracoda then Isopoda and Cladocera, while Hyparid were not found in station 1 and the group is the least abundant in the study area. Species numerical abundance was far highest in station 3 followed by station 2 before station 1. Copepod, Ostracod, Isopod and Cladocera constitute 18.2%, 14.8%, 14.2% and 12.9%, respectively. Of the total number of individuals, Hyparid was the least abundant littoral microcrustacean in the study area with 1.9% of the total individuals

Although samples taken in station 3 (muddy habitat) were on average richer in individuals (c. 133) compared to other two stations (c. 108 and c. 83 for station 1 and 2 respectively, this difference was not significant (one-way ANOVA, df = 27, F = 1.807, $P < 0.05$. The correlation between total number of individuals and station sediment substrate was very strong in station 1 and 2 ($r = 0.7418$ $P<0.01$) and $r = 0.6387$, $P<0.01$ respectively. Station 3 individuals were negatively correlated with the station sediment substrate.

The biological communities of littoral zone are characterized by a far greater complexity than, for instance, the planktonic community of the pelagic zone (Korovchinsky, 1986). The sampling for the littoral microcrustacean was performed in three different localities though few distance apart. Owing to the very large sample size as well as geographical overlay in sampling sites, no specie that was restricted to either of the three habitat types were found. On the contrary, patterns in frequency of species occurrence were surprisingly similar in three different habitats. Further, there was a strong correlation between the numbers of individuals in each station with the sediment substrate, although station 3 negatively correlate (See table 4-6).

There are several possible explanations for the lack of significant differences in species composition between the three habitat types. First, it may be that the organisms have fairly broad feeding habits or are able to use multiple habitats, consistent with suggestion of Paterson (1993). Specifically, herbivores copepods and Cladocerans feed on the surface of aquatic sediment, and to some extent on phytoplankton and periphyton attached to the vegetation (Fryer, 1975; Smirnov, 1971). Without substantial diet specialization, habitat association should be fairly weak. Further, mobility does not limit the habitat used by microcrustaceans. Although many Cladocerans are substratum dwellers, most can also swim, indeed, could have only caught those individuals that swim or crawl upward on surface. Cyclopods that are generally good swimmers are still often bottom dwellers that actively colonize sediment interstices (Dole-Olivier et al., 2000).

Secondly, the lack of difference suggests that, at least in estuary, littoral microcrustacean assemblages are not much affected by wind exposure.

Thirdly, the result suggests that predation has less of an effect on the composition of littoral in comparison with pelagic microcrustaceans. Perhaps the small size of the animals and complexity of the habitat accounted for a reduced sensitivity to predation, along with their ability to hide in sediments during the day.

CONCLUDING REMARK

The abundance, distribution and composition of the littoral microcrustacean in Cross River estuary were studied at three stations using 200µm mesh-size ring net. A total of 324 individual littoral microcrustaceans belonging to 56 species and 10 taxonomic groups were recorded. Copepod, Ostracod, isopod and Cladocera dominated the samples. Hypariid and crustacean larvae were the least dominant in the sample. Station 1 and 2 individual littoral microcrustacean abundance were positively correlated with the sediment fraction of the respective stations, while station 3 showed negative correlation.

Given the shallow depth, the shoreline proximity, the littoral zones of the estuaries are quite vulnerable to many contemporary anthropogenic stressors, including land clearing and other riparian zone alteration, wider level fluctuations and climate warming. Given their diversity, and thus ecological information content, and their relative insensitivity to confounding effects of habitat, a continued exploration of the value of littoral microcrustacean as ecological indicators appears to be warranted. Their relative low habitat specificity may also indicate that their broader use as bioindicators for various anthropogenic stressors should be investigated.

Checklist of Littoral Microcrustacean species in Cross River Estuary

Class: Crustacea
Subclass: Branchiopoda
Order: Diplostraca
Suborder: Cladocera

Evadne spinifera
E. tergestina
E. nordmanni
Podon polyphemoide
Penilia avirostris

Subclass: Ostracoda
Order: Myodocopa
Suborder: Cypridiniformes
Euphilomedes intespunita
Parasterope muelleri
Philomedes lilljeborgi
Suborder: Halocypriformes
Caenchoecia elegans
C. imbricate
Euconchoecia chierchie
Conchoecia lophura
Conchoecia daphnoides
C. obtusata
Subclass: Copepoda
Order: Calanoida
Family: Acartiidae
Acartia negligens
Acartia tonsa
Family: Paracalanidae
Paracalalanus parvus
Paracalalanus scotti
Family: Pseudocalanidae
Clausocalanus paululus
Ctenocalanus vanus
Calanus finmarchicus
Order: Cyclopoda
Onceae venusta
Isias clavipes
Oithona nana
Order: Harpaticoida
Euterpina acutifrans
Microsetella narvegica
Miracia efferata
Parathalestris croni
Subclass: Malacostraca
Order: Mysidacea
Praunus flexuosus
Siriella armata
Paramysis arenosa
Praunus neglectus
Neomysis integer

Order: Cumacea

Pseudocuma longicornis
Leptostylis villosa
Diastylis tumida

Order: Amphipoda

Phthisica spp
Rhabdosoma sp

Family: Hyperiidae

Parathemisto compressa
Parathemisto gaudichaudii
P. gracilipes

Order: Isopoda
Suborder: Flabellitera
Family: Cirolanidae

Eurydice gimaldii

Family: Idoteidae

Idotea emarginata
Idotea linearis
Synisoma acuminatum

Family: Gnathidae

Gnathia maxillaries
Paragnathia formica
G. Abyssarum
G. dentata

Superorder: Eucarida
Order: Euphausicea

Thynoessa inermis
Meganyctiphanes longicandata
Nyetiphanes cauchi
Thynoessa raschii

Crustacean Larvae
Subclass: Cirripedia
Balanus balanoide
Subclass: Malacostraca
Order: Euphalisiacea

Meganyctiphanes norvegica

Order: Decapoda
Suborder: Natantia
Tribe: Paguridae
Family: Paguridae

Pagurus bernhordus

Table 1: Abundance of Littoral microcrustacean Species in Cross River Estuary

Taxa	Station 1	Station 2	Station 3	Total
Hypariid	0	2	4	6
Mysid	6	11	14	31
Cladocera	12	14	16	42
Ostracod	14	15	19	48
Copepod	18	19	22	59
Isopod	12	16	18	56
Euphausiid	10	14	16	40
Amphipods	6	8	8	22
Cumaceans	4	6	10	20
CrustaceanLarva	1	3	6	10
Mean	8.3	10.8	13.3	
Mean Total	83	108	133	324

Source: Fieldwork, 2009

Table 2: ANOVA Summary Table

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	F-critical
Abundance	2	125.00	62.50	1.807	3.35* 5.49*
Error	27	933.80	34.585		
Total	29	1058.8			

*(P<0.05) and *(P<0.01)

Checking the Critical value of the F-Distribution at (P<0.05) and Treatment or Numerator Df = 2 and Error or Denominator Df = 27

$F_{0.05\ (1),\ 2,\ 27} = 3.35$

$F_{0.01\ (1),\ 2,\ 27} = 5.49$

Table 3: Grain-Size scale for sediments

Sand Station 1	Silt Station 2	Mud (Clay &Silt) Station 3
0.59	0.088	0.031
0.50	0.074	0.0156
0.42	0.0625	0.0078
0.35	0.053	0.0039
0.030	0.044	0.0020
0.25	0.037	0.00098
0.210	0.031	0.00049
0.177	0.0156	0.00024
0.149	0.0078	0.00012
0.105	0.0039	0.00006

Source: Fieldwork, 2009

Table 4: Correlation Coefficient table for Station 1

Sand (X)	groups (Y)	X^2	Y^2	XY
0.59	0	0.3481	0	0
0.50	6	0.25	36	3
0.42	12	0.1765	144	5.04
0.35	14	0.1225	196	4.9
0.030	18	0.09	324	5.4
0.25	12	0.0625	144	3
0.210	10	0.441	100	2.1
0.177	6	0.3204	36	1.074
0.149	4	0.0222	16	0.596
0.105	1	0.0110	1	0.105
3.053	83	1.15896	997	25.215

Pearson's, correlation coefficient (r) = 0.7418 $r_{0.05(2)8}$ = 0.632; $r_{0.01(2)8}$ = 0.765

Table 5: Correlation Coefficient table for Station 2

Silt (X)	groups (Y)	X^2	Y^2	XY
0.088	2	0.0077	4	0.176
0.074	11	0.0055	121	0.814
0.0625	14	0.0039	196	0.875
0.053	15	0.0028	225	0.795
0.044	19	0.0019	361	0.836
0.037	16	0.0014	256	0.592
0.031	14	0.0010	196	0.434
0.0156	8	0.0002	64	0.1248
0.0078	6	0.0001	56	0.0468
0.0039	3	0.0000	9	0.0117
0.4168	108	0.0245	1468	3.8303

Pearson's, correlation coefficient (r) = 0.6387 $r_{0.05(2)8}$ = 0.632; $r_{0.01(2)8}$ = 0.765

Table 6: Correlation Coefficient table for Station 3

(Clay & Silt) (X)	groups (Y)	X^2	Y^2	XY
0.031	4	0.00961	16	0.124
0.0156	14	0.000234	196	0.2184
0.0078	16	0.000061	256	0.1248
0.0039	19	0.000015	361	0.0741
0.0020	22	0.000004	484	0.044
0.00098	18	0.000001	324	0.01764
0.00049	16	0.000000	206	0.00784
0.00024	8	0.000000	64	0.00192
0.00012	10	0.000000	100	0.0012
0.00006	6	0.000000	36	0.00036
0.0622	133	0.009925	2093	0.72962

Pearson's, correlation coefficient (r) = 0.1601 $r_{0.05(2)8}$ = 0.632; $r_{0.01(2)8}$ = 0.765

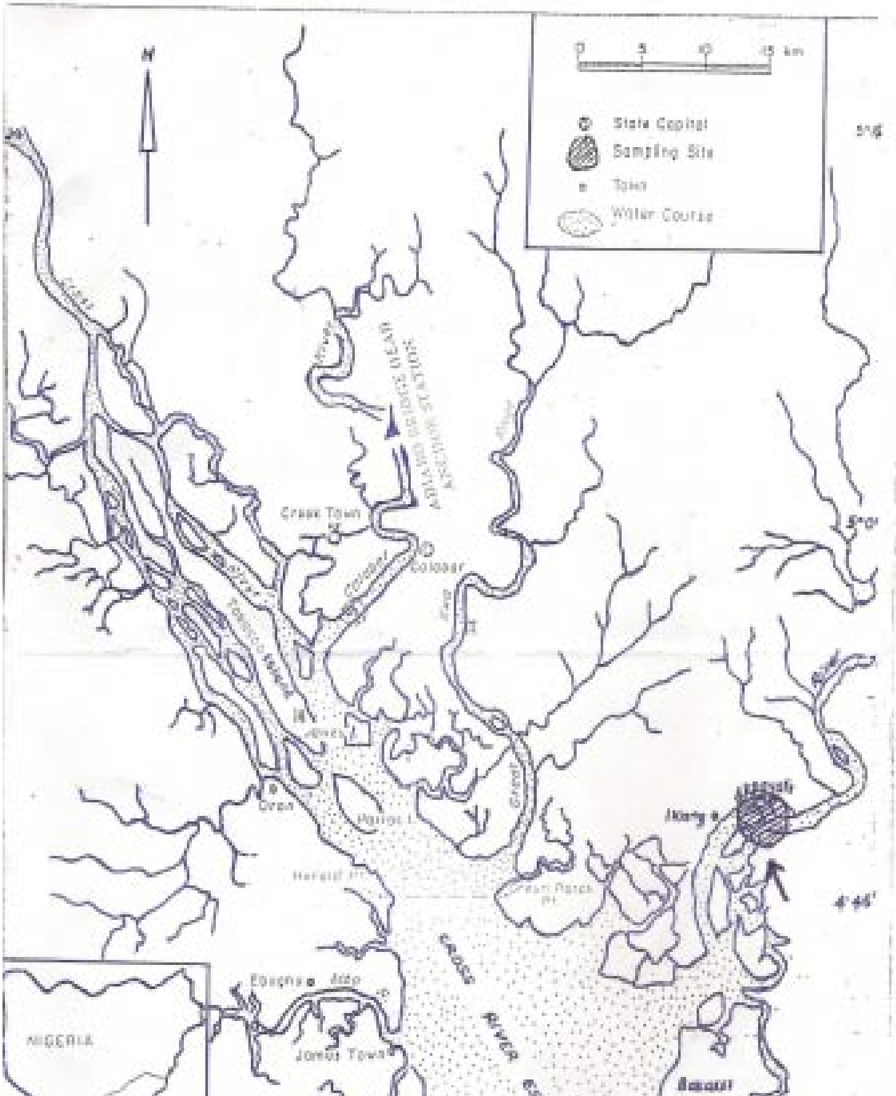

Fig 1: Map of Cross River Estuary showing the sampling sites

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