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Aspects of the Ecology of *Tympanotonus fuscatus var fuscatus* (Linnaeus, 1758) in the Mangrove Swamps of the Upper Bonny River, Niger Delta, Nigeria

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Abstract: This study examines some aspects of the ecology of *Tympanotonus fuscatus var fuscatus* in the mangrove swamps of the upper Bonny River, Niger Delta, Nigeria. Salinity of the habitat fluctuated between 1.2 and 23.3mg/l throughout the year. The pH and dissolved oxygen content recorded were stable. Soil deposits consisted of sandy peat with little organic matter and silt. Sediment analysis however showed no significant differences for the stations. Salinity, nature of bottom deposits, water depth and currents are factors that affect their distribution. *T. fuscatus* is euryhaline, surviving in waters with wide range of salinities 0.1mg/l to 25mg/l. The two gastropods that co-habit the mud-flat with *T. fuscatus* are *Neritina adansoniana* and *Pachymelania fusca var quadriseriata*.

Key words: Bonny River, creeks, ecology, mangrove swamps, Niger Delta and *Tympanotonus fuscatus*

INTRODUCTION

The wide variety of invertebrates that inhabits mangrove communities in the brackish waters of West Africa is Molluscs. Most species inhabit shallow coastal areas particularly rocky or coral reefs and inter-tidal mud flats. Nickles (1950) stated that the prosobranch gastropods are the commonest and most dominant molluscs in the brackish waters in West Africa. The prominent amongst this is the gastropod *Tympanotonus fuscatus* popularly known as "periwinkle". They inhabit quiet waters, where the substratum is muddy and rich in detritus. Salinity, nature of bottom deposits, water depth and currents are factors that affect their distribution in the coastal areas of West Africa (Deekae, 1987). Several studies have been carried out to understand the physicochemical and biological characteristics of the Bonny Rivers system (Chindah and Sibeudu, 2003; Ideriah *et al*., 2005). Their study was limited in approach and did not provide clear understanding on its environment for effective management and development of the species.

The species is a deposit feeder, feeding on mud and digesting the detritus and other organic matter in the mud. The genus *T. fuscatus* comprises of a single species which has two varieties, *T. fuscatus* var *fuscatus* and *T. fuscatus* var *radula*. *T. fuscatus* var *fuscatus* is characterized by turrented, granular and spiny shells with tapering ends. It is bisexual and both types are found in most brackish water creeks and mangrove swamps in the Niger Delta area at the inter-tidal zone. The species is a delicacy in most riverian communities as it provides a relatively cheap source of animal protein and its shell can be used as a source of calcium in animal feeds and for construction purposes.

The wild population of *T. fuscatus* is disappearing fast as smaller sizes are being brought to the market. Powell *et al*., (1985) reported that *T. fuscatus* was over harvested from mangrove swamps in the Niger Delta. Presently, the market demand for this mollusc appears very high (FAO/FIDI, 1994; Alfred-Ockiya, 1999). It is only through increased production by means of appropriate aquaculture techniques that these species can become readily available to consumers both locally and in the foreign market. The present mode of exploitation consists of harvesting from the wild hence supply seems inadequate. It is on the basis of this that the present study examines the ecology of this economically important species in a selected habitat in the mangrove swamps of the Niger Delta area in Nigeria.

MATERIALS AND METHODS

The study area covered the mangroves swamps of the upper Bonny River, which lies between latitudes 4° 45′ to 4° 48′ North and longitudes 7° 05′ East (Fig. 1). The creeks are tide dominated embayment with little fresh water input and are characterized by extensive mangrove swamps, tidal flats, influenced by semi-diurnal tidal regime (NEDECO, 1961). The climate of the study area is sub-tropical. Heavy rainfall, high temperatures and

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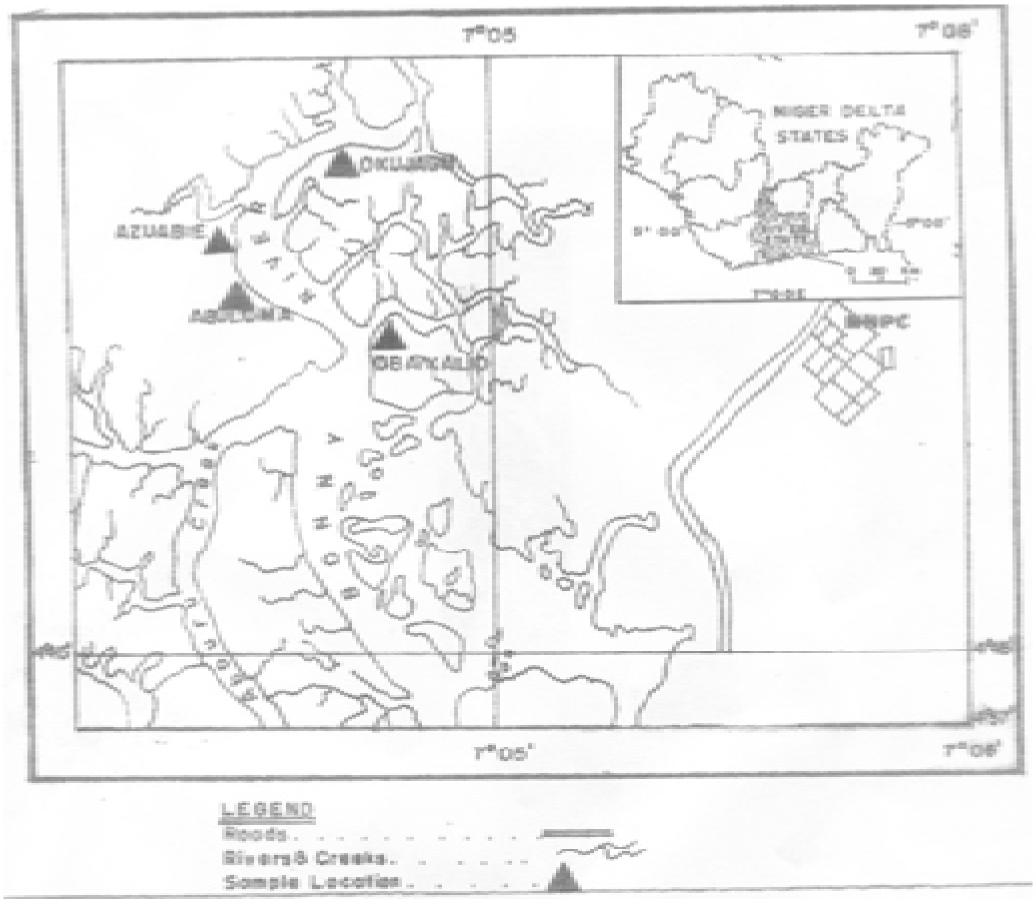

Fig. 1: Map of Niger Delta, Rivers State and Bonny River showing the study stations

relative humidity characterize the area. The vegetation consists of thick mangrove forest dominated by the red mangrove *Rhizophora racemosa* and *Rhizophora mangle.* In some areas, the white mangrove *Avicennia africana* is interspersed with *Nypa palm*. The low inter-tidal zone is usually bare of vegetation, with clay, peat and sand deposit.

Four sampling stations were established along the river system based on ecological settings, accessibility and human activities in the area. The distance between each station ranged from 500-900m apart. Sampling was done monthly. Ecological data were collected monthly between 7:00h and 13:00h from January to December 2005 in all the study stations. Water level was measured at the different sampling stations with a calibrated pole measured in meters from fixed points. The distance between the water surface and the bottom corresponded to the water level. Ambient and surface water temperature measurements were measured in-situ with a mercury-in-glass thermometer calibrated in centigrade. The pH was determined using a corning pH meter model 7. Turbidity and Salinity was determined by using a multi water measuring meter–Horiba water checker model U-10 micons. Samples of water for the estimation of Dissolved Oxygen (DO) content (mg/l) were collected from the bottom with an insulated bottle and was analysed using the modified Winkler's method.

Sediment samples were collected at the bottom along the inter-tidal flat at low tides using the Eckman bottom sampler (ATSM, 1990; Topouoglu *et al.,* 2002). The samples were placed in labeled polythene bags sealed and transported to the laboratory. The samples were air-dried at room temperature and homogenized. In the laboratory the following parameters were analyzed: sediment pH, organic carbon, soil texture and total hydrocarbon content. The sediment pH was determined using the electrometric method (Jackson, 1964). Organic carbon was determined by the wet combustion method (Walkey and Black, 1934) modified by Jackson (1964). The soil texture was determined by the Bouyoucous hydrometer method modified by Day (1965). The soil was dispersed with a solution of sodium hexamtaphosphate (Calgon 44g/L) and sodium carbonate (8g/L). The pH of the solution maintained at about 8.3. The textural class was determined using the textural triangular diagram. The total hydrocarbon content of the sediments were determined by shaking 5.0g of representative sediment with 10ml of toluene and the oil extracted determined at 420nm wave length in spectronic 21–D spectrophotometer. Oil concentrations in the sample were calculated using standard factors and the absorbance (Odu *et al.*, 1985).

RESULTS

Ecology: The monthly variation in water level of tidal pools for the stations during the study period is shown in Fig. 2. The topography of the river bottom was not uniform, water level varied between 0.8 and 2.0m with a mean of 1.46 ± 0.04m for the stations and with the seasons. Abuloma station recorded lower values ranging between 0.8 and 1.2m, while Azuabie station had the highest values of 1.4 and 2.0m. The wet months were May to October, while the dry November to April. The seasonal variation recorded higher values of 1.496 ± 0.053m for wet season and 1.398 ± 0.068m for dry season.

The temperature of the water was high and varied between 28.5 and 30.0 ºC (Fig. 3), the highest temperatures of 30 ºC occurred in the months of January and February. Generally, temperature values were stable between the stations and for the seasons. The hydrogen ion concentration (pH) of the water varied between 6.30 and 7.47 for the stations during the sampling period (Fig. 4). The pH ranges obtained shows an acidic to alkaline condition of the study area. Mean seasonal values were higher during the wet season (6.994 ± 0.040) than the dry season (6.808 ± 0.043). Wet season pH ranged between 6.30 and 7.40 while it was 6.30 and 7.61 for the dry season.

Changes in turbidity values for the study period at the sampling stations are presented in Fig. 5, values ranged between 0 and 7. Following the seasonal trend, wet season values were higher (2.018 ± 0.197) than dry season (1.700 ± 0.233). The dissolved oxygen (DO) had maximum values of 5.30 and minimum value of 3.22mg/l respectively (Fig. 6). Slight variations for the stations and seasons were observed. The lowest value of 3.22mg/l was obtained in October for Azuabie station while, the highest value was recorded in Abuloma station in November.

Salinity ranged between 3.6 and 22.5mg/l. The lowest value of 3.6mg/l was obtained in October and the highest value of 22.5mg/l was obtained in December (Fig. 7). There was noticeable variation in the station and within the months. Salinity also decreased downstream with Oba/Kalio station having the highest range of 7.0 to 22.5mg/l, while the lowest range of 3.6 to 17.4mg/l was recorded at Azuabie. The river system is brackish (salinities >1.0mg/l) through its main course. Seasonal variation is related to the rainfall regime.

Sediments: Sediments pH exhibited both spatial and seasonal variation (Table 1). The soils are generally acidic with pH values ranging from 2.90 to 3.80 in the top

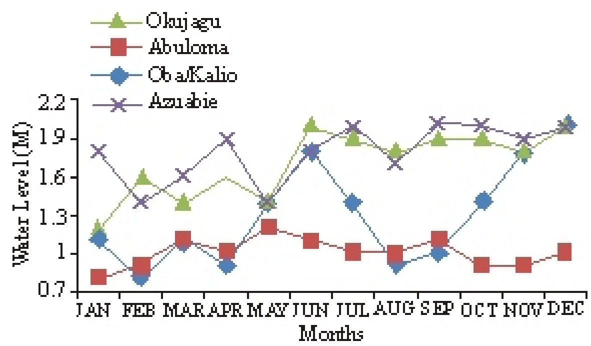

Fig. 2: Monthly variation of water level at the study stations

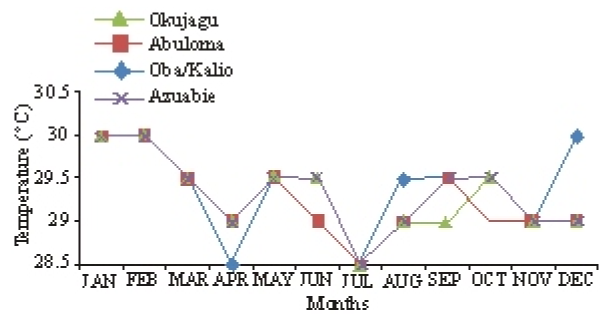

Fig.3: Monthly temperature variations at the study stations.

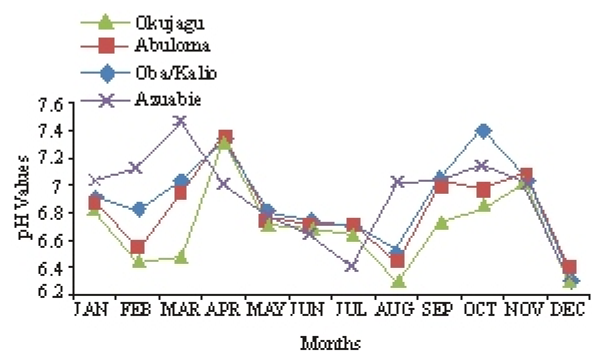

Fig. 4: Monthly variations of pH at the study stations

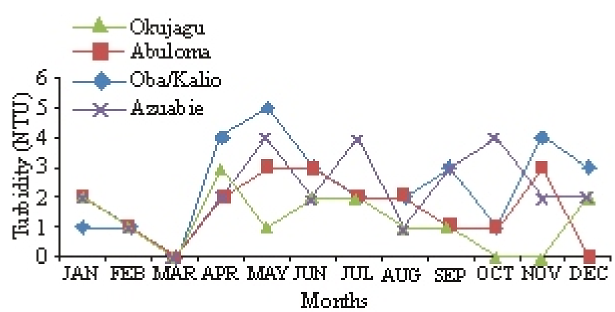

Fig.5: Monthly variations of turbidity at the study stations

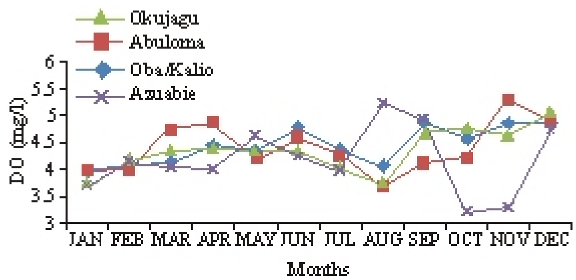

Fig. 6: Monthly variations of dissolved oxygen at the study stations

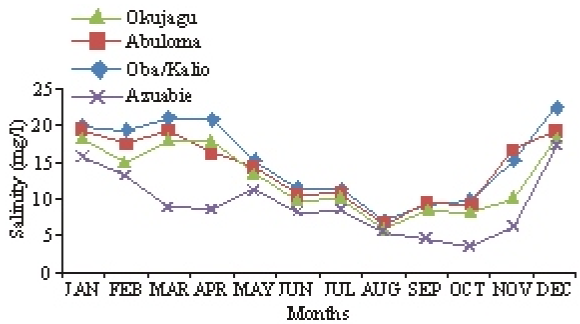

Fig.7: Monthly variations of salinity at the study stations

Table 1: Data on seasonal sediment Analysis of study stations

Parameters	Sampling stations							
	Oba/Kalio		Abuloma		Okujagu		Azuabie	
	Wet	dry	wet	dry	wet	dry	wet	dry
Soil pH	3.60	3.80	3.70	3.50	3.70	3.10	2.90	3.20
Organic Carbon	2.22	3.04	3.16	2.11	2.96	2.34	2.42	3.04
THC (mg/kg)	1047	988	1336	473	1116	176	1732	148
Textural class	C/L	C/L	C/L	C/L	C/L	C	S/L	L

C=Clay, L=Loam, S=Sandy

30cm. The lowest value of 2.90 was obtained during the raining season for Azuabie station, while the highest value of 3.80 was recorded for Oba/Kalio station during the dry season. The organic carbon content of the soil was generally low, values ranging between 2.11 and 3.16. The total hydrocarbon values were moderately high ranging from 148 to 1732mg/kg. The lowest value was obtained during the dry months while the highest value was recorded for the wet months. Black mud deposits having high silt and organic matter was dominant at all the sampling stations. Soil texture was predominantly clay with sandy and coarse loamy surface layer over fine clayey subsoil.

A survey of the macro fauna of *T. fuscatus var fuscatus* was undertaken in order to determine the type of interaction within the ecosystem. The two gastropods that co-habit the mud-flat with *T. fuscatus var fuscatus* are: *Neritina adansoniana* and *Pachymelania fusca* var *quadriseriata*. Some other animals that associate with it in the mudflat are *Callinectes latimanus, Uca tangeri, Periophthalmus papilio, Pachymelania aurita,* and *Sesarma species*. The most dominant was *Uca tangeri* in all the stations, the rare species that occurred was *Calinectes latimanus.*

Flora associated with *T. fuscatus var fuscatus* are: some filamentous green algae which do grow on the shells of some individuals. The vegetation is dominated by the red mangrove *Rhizophora racemosa* and *R. mangle*. In all the stations, the white mangrove *Avicennia africana* is interspersed by *Nypa palm*. The rare species that occurred was *Drepanocarpus lunatus*. *T.fuscatus var fuscatus* was found in abundance at the mid – intertidal zone of the mudflat, an area always exposed at low tide; where the soil deposits consist of sandy peat with little organic matter and silt. The *T. fuscatus var fuscatus* variety is dominant in all the study areas. The species are found active at both low and high tides, they show greater activity at low tides when they crawl about rasping detritus and organic matter from the mud.

DISCUSSION

Water depth is known to affect the productivity of the aquatic ecosystem. The water level of (0.8m to 2.0m) obtained in this study compares to results obtained by Ideriah *et al.* (2005) for the upper Bonny River. According to Ikusima *et. al.* (1982), seasonal variation in the water level are usually associated with rainfall pattern. There was a tendency for an increase in water depth downstream. Direct and indirect rainfall inputs in the river catchments areas caused flooding hence the increase in depth during the wet season. The influence of semi-diurnal tidal regime also affected the water levels daily. The tidal amplitude was between 1.5 to 2m in normal tide and water level increases and decreases depending on the lunar circle.

Temperature values recorded is considered normal with reference to its location in the Niger Delta which is described as humid/semi hot equatorial climate (NEDECO, 1961). The water temperatures which remained relatively stable throughout the period of observation, indicates that temperature has no effect on the ecology of *T. fuscatus var fuscatus*.

The hydrogen ion concentration (pH) fluctuated during the period of observation. The slight variation is as a result of the buffering action of the brackish water condition however, values are within the range reported on the Niger Delta by Scott (1966), Oyenekan (1975) and Egonmwan (1980).

Turbidity levels fluctuations could be attributed to the heavy rains and increased flow velocity experienced during the sampling period. Water turbidity was inversely proportional to the water flow, as currents are often very strong at spring tides. Turbidity which is a function of the amount of dissolved or suspended matter in the water affects light penetration and hence photosynthetic activity for primary production. According to Lucinda and Martin (1999) turbidity may be caused by wind, current and erosion that sweep sediments from land into the continental shelf or any part of the water.

Dissolved oxygen showed a characteristic increase downstream with the lowest mean concentration recorded at Azuabie station. The observed differences could be related to the fact that Azuabie had higher organic matter content than the other three stations and as such is prone to oxygen deplection due to the activities of bacteria. Higher DO values recorded during the wet season are considered normal since there is an inverse relationship between temperature and dissolved oxygen in water. At high temperature, the solubility of oxygen decreases, this explains why the lowest mean DO value was recorded in Azuabie station which had higher temperature values.

The river system is brackish (salinities >1.0mg/l) through its main course. Seasonal variation is related to the rainfall regime. Salinity values increased downstream with Oba/Kalio station having the highest values while the lowest values were observed at Azuabie station. Fluctuations in salinity which were observed in the study stations is not an uncommon feature as estuaries are known for their fluctuating environmental variables (Venberg and Venberg, 1981). *T. fuscatus* is euryhaline, surviving in waters with wide range of salinities 0.1mg/l to 25mg/l (Egonmwan, 1980; Deekae, 1987).

The pH of sediments exhibited both spatial and seasonal variation. The acidity of mangrove soil is known to drop from near neutral when moist to less than four when oxidized (Dublin-Green and Ojanuga, 1988). This could be attributed to high rainfall leading to leaching of the soil. Similarly, Topouoglu *et al.* (2002) reported that mangrove sediment are often acidic, with acidity varying between 3.5 and 4.5. The low values are attributed to rapid mineralization and depletion due to intensive demand for nutrients by the macro fauna and flora and also the effect of leaching experienced during the heavy rainfall. The low values of organic carbon content is attributed to rapid mineralization and depletion due to intensive demand for nutrients by the macro fauna and flora and also the effect of leaching experienced during the heavy rainfall.

The total hydrocarbon values were moderately high ranging from 148 to 1732mg/kg. The higher mean level of THC at Azuabie station could be attributed to effluent discharges from the Trans Amadi abattoir, emissions from automobile activities on the major roads close to the station. Municipal waste discharges like metal scraps, disused cans and crates, sewage/septic waste are usually dumped daily at the sampling station. These metals unlike the organic waste are not biodegradable hence persist in the sediment.

The two prominent gastropods that co-habit the mudflat with *T. fuscatus var fuscatus* are: *Neritina adansoniana* and *Pachymelania fusca* var *quadriseriata*. The most dominant in all the stations was *P. fusca var quadriseriata*. Some other animals that associate with it in the mudflat are *Callinectes latimanus, Uca tangeri, Periophthalmus papilio, Pachymelania aurita,* and *Sesarma spp*. The most dominant was *Uca tangeri* in all the stations, the rare species that occurred was *Calinectes latimanus*. Flora associated with *T. fuscatus var fuscatus* are: some filamentous green algae which do grow on the shells of some individuals. The vegetation is dominated by the red mangrove *Rhizophora racemosa* and *R. mangle*. In all the stations, the white mangrove *Avicennia africana* is interspersed by *Nypa palm*. The rare species that occurred was *Drepanocarpus lunatus*. *T. fuscatus var fuscatus* was found in abundance at the mid – intertidal zone of the mudflat, an area always exposed at low tide; where the soil deposits consist of sandy peat with little organic matter and silt. The *T. fuscatus var fuscatus* variety is dominant in all the study areas. The species are found active at both low and high tides, they show greater activity at low tides when they crawl about rasping detritus and organic matter from the mud.

CONCLUSION

Tympanatonous fuscatus var fuscatus were found to be adequately adapted to the constantly fluctuating ecological condition of the brackish water environment thus they were found occurring in the habitat all the year round in all the stations. There was no much variation in water chemistry and sediment characteristics. The dominant plants in the mangrove swamp are the red mangrove *Rhisophora racemosa and R. mangle,* while the macro fauna include *Neritina adansoniana and* Pachymelania *fusca var quadriseriata. T. fuscatus var fuscatus* in habit the mid-intertidal areas of the mangrove swamps.

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