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Population Estimation of Periwinkles Tympanotonus Fuscatus and Parchymelania Aurita at Esuk Mba Mangrove Swamp along Cross River Estuary

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Abstract
An investigation was carried out at Esuk Mba mangrove swamp to estimate the population of periwinkles, *Tympanotonus fuscatus* and *Parchymelania aurita*. Sampling was carried out weekly using the capture mark-release-recapture method for the estimation of the population. The Lincoln index was used for the calculation of the total population. The result showed that apart from week four, the total population of *T. fuscatus* was higher than that of *P. aurita*, while apart from week three and four the density of *T. fuscatus* was higher than *P. aurita*. Generally, the total population and density of *T. fuscatus* was higher than *P. aurita*. The dry season prevalent at the time of this study and migration of P. aurita in search of shelter to avoid adverse environmental conditions were factors in the low population of *P. aurita*. However, the quiet waters, muddy substratum with plenty detritus as food, and absence of anthropogenic sewage inputs characteristic of the study site, were enabling factors for the high population of *T. fuscatus*. It was inferred that the high population of *T. fuscatus* was due to its ability to withstand adverse environmental conditions than *P. aurita.*
Keywords: Population, Periwinkles, Esuk Mba, mangrove swamp, Cross River, Estuary.

Introduction

Periwinkles are shell fish that inhabits mangrove swamps of West Africa (Jamabo and Chinda, 2010) where the substratum is muddy and rich in detritus. Nickles (1950), held that the prosobranch gastropods are the commonest and most dominant molluscs in the brackish waters in West Africa. The two species of periwinkles commonly found in creeks, estuarine habitats and benthos of the Niger Delta are *Tympanotonus fuscatus* and *Parchymelania aurita* (Deekae, 1987; Jamabo and Chinda,2010; Bob-Manuel, 2012). These species are morphologically different. *P. aurita* develops sharp spines, broader aperture, although the sharpness of the spines depends on the age of the organism, the older it becomes, the spines gets blunt and thicker (Bob-Manuel, 2012). 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 turreted, glandular and spiny shells with tapering ends (Jamabo and Chinda, 2009), and inhabits the mudflats of the Lagos lagoon system which is a large expanse of shallow waters, extending from republic of Binin in the West to the Niger Delta in the East (Hill and Webb, 2008; Yologe, 2002; Fagade, 2005). Factors responsible for their distribution such as nature of bottom deposits, water depth and currents have been reported by Deekae (1987). The genus *Parchymelania* is endemic to West Africa (Bachanan, 1964; Oyenekan, 1975) as confirmed by Odum (1977) who reported that the mud surfaces in West Africa mangrove swamps are littered with periwinkles. Ajao and Fagade (1990) reported that the abundance of *P. aurita* at the Lagos lagoon was related to the slit-clay, total organic matter and the metal content. *T. fuscatus* occur in the littoral habitat such as mangrove swamps and *P. aurita* colonized the subtidal and mud beaches (Dambo, 1985 and 1993). In the habitat, *T. fuscatus* migrate to the coastal edge and congregates under tufts of grasses and breathing roots of the mangrove plant *Avicenia nitida* which shades them from the direct rays of the sun and during the dry season (Cariton and Cohen, 2002). The two genera are commonly referred to as periwinkles in Nigeria. Periwinkles can make regular feeding excursions and trace paths back to their former ecological niches, hence remain within a short distance for many weeks (Bob-Manuel, 2012). Oyenekan (1979) reported that *T. fuscatus* can survive for a long period in the absence of water, but only make use of their reserve food. According to Dambo (1985 and 1993), *P. aurita* could be easily affected by pollutants than *T. fuscatus* due to the ability of the latter to contract faster and deeply up to three-quarters into the shell.

Tympanotonus fuscatus is a delicacy in most riverine communities as it provides a relatively cheap source of animal protein, vitamins and minerals (Egonmwan, 1980; Jamabo and Chinda, 2010). According to Akwari and Archibong (2011), periwinkles have a very high protein content of 10.2 mg/ml. The periwinkle flesh is edible and also used as baits by fishermen (Bob-Manuel, 2012). The snails are used to prepare delicious meals like Ekpang Nkukwo, Efere Abak, Edikang Ikong, and others in Cross River State, Nigeria. Bob-Manuel, (2012), revealed that the organism is very medicinal for cases like endemic goitre and pregnant women due to its iodine, calcium, phosphate and iron content. Grolier (1980), reported that grounded periwinkle shell is used as powder for pimples, vim for cleansing, fertilizers and calcium source in animal feed. The shell competes favourably in construction industry, ornamentals and cosmetics (Jamabo and Chinda, 2010; Bob-Manuel, 2012). Jamabo and Alfred-Ockiya (2009), revealed that periwinkle sizes of 25mm-50mm shell length are harvested daily at low tides from the wild without any effort at biodiversity conservation or culture them in Nigeria (Jamabo and Chinda, 2010). The wild population of these two genera are disappearing alarmingly, and larger sizes are no more available in the market (Powell et al., 1985; FAO/FIDI, 1994; Bob-Manuel, 2012).

Apart from the work of Udo (2013) and Ewa-Oboho and Otogo (2009), there is dearth of information on the work done on periwinkles in Cross River State, Nigeria. This study is therefore aimed at estimating the population of periwinkle species along Esuk Mba mangrove swamp in Cross River State Estuary.

MATERIALS AND METHODS

Study Area

The study area is Esuk Mba mangrove swamp along Calabar River which empties into the Cross River Estuary. This area is located between latitude 4^0 47'' 0' and 44^0 52'' 30'N and longitude 8^o 22'' 30'E. The major vegetation consist of mangrove forest dominated by red mangrove *Rhizophora mangle* and *Rhizophora racemosa*. In some areas, the white mangrove *Avicennia africana* is interspersed with Nypa Palm. The low intertidal zone exposes the mud flats which are bare of vegetation but impregnated by peat, detritus and sand deposits. The predominant human activities in the area include fishing, and mangrove timber exploitation.

Sample Collection

The method of sampling used in this study is that described by Bob-Manuel (2012). The capture mark-release-recapture method was used for estimating the population size of *T. fuscatus* and *P. aurita* at Esuk Mba Mangrove Swamp Creek. This method involves capturing the organism, marking it in some way without causing it any harm or damage and returning it back so that it can resume a normal role in the population.

One meter square ($1m^2$) quadrat was used. This was thrown randomly within the designated area to obtain the density per unit area. Periwinkles caught in each throw were identified and marked with a white water resistant paint and released back to the same experimental site to re-integrate with the population. This was carried out weekly for a period of seven weeks. Once every week the population was trapped again, counted and the population size estimated using Lincoln index as shown below:

$$\text{Estimated total population} = \frac{\text{No of organisms initial sample} \times \text{No of organisms in second sample}}{\text{Number of marked organisms recaptured}}$$

i.e $N = \frac{an}{r}$

Where: N = total population
A = original number marked
N = Total of 2^{nd} sample
R = Total recapture

Results

Table 1 illustrates the weekly periwinkle samples collected during the study period. In week one, the initial samples of *T. fuscatus* and *P. aurita* collected in the study area were one thousand five hundred (1,500) and six hundred (600) respectively. In week two, one thousand two hundred (1200) organisms of *T. fuscatus* and one hundred and twenty (120) of *P. aurita* were marked. The second sampling within this week revealed that three hundred and twenty (320) organisms of *T. fuscatus* and twelve (12) of *P. aurita* were recaptured. In week three, the samples of *T. fuscatus* and *P. aurita* marked were one thousand four hundred (1,400) and one hundred and twenty-five (125) respectively. The third sampling carried out in week three showed that three hundred and five (305) *T. fuscatus* and only two (2) of *P. aurita* were recaptured. One thousand five hundred (1,500) *T. fuscatus* and fifty (50) *P. aurita* were marked in week four, recapturing seventy- seven (77) *T. fuscatus* and three(3) *P. aurita* in the fourth sampling. The number of samples marked in the fifth week were one thousand three hundred and fifty (1,350) *T. fuscatus* and ten (10) of *P. aurita*, recapturing one hundred and sixty-eight (168) and five (5) respectively. In week six, it was seen that of the one thousand six hundred (1,600) organisms of *T. fuscatus* and ninety (90) of *P. aurita* marked, two hundred and twenty-eight (228) of *T. fuscatus* and sixteen (16) of *P. aurita* were recaptured. Ninety percent (90%) of T. fuscatus recaptured were observed to have sunken their tissues almost half the shell. In the final week, two thousand four hundred (2,400) *T. fuscatus* and seventy (70) *P. aurita* were marked, recapturing seventy (70) of *T. fuscatus* and seven (7) of *P. aurita* (Table 1). The total population of *T. fuscatus* and *P. aurita* was estimated using the Lincoln's index earlier explained. The population densities per square metre of a quadrat for *T. fuscatus* and *P. aurita* were derived by dividing the population of each organism per week by thirty (30), the number of times the quadrat was thrown (table 2). The results showed that apart from week 3 and week 4 the population of *T. fuscatus* was higher than that of *P. aurita*, in terms of estimated total weekly population and the weekly population densities (Table 2).

Table 1. Samples of *T. fuscatus* and *P. aurita* collected and marked during the study period.

Weeks	Total *T. fuscatus* marked.	Total *T. fuscaus* unmarked	Total no. recaptured	Total *P. aurita* marked	Total *P. aurita* unmarked	Total recaptured	Total quadrat thrown
Wk 1		1500 sample (initial)			600 sample (initial)		
Wk 2	1200	600	320	120	100	12	30
Wk 3	1400	400	305	125	40	2	30
Wk 4	1500	80	77	50	110	3	30
Wk 5	1350	200	168	10	60	5	30
Wk 6	1600	300	228	90	120	16	30
Wk 7	2400	60	70	130	70	7	30

Table 2. Estimated total weekly population and population density of *T. fuscatus* and *P. aurita*

Weeks	*T. fuscatus*	*P. aurita*	Population density (m^{-2}) *T. fuscatus*	Population density (m^{-2}) *P. aurita*
Wk 2	2250	1000	75	33
Wk 3	1836	2500	61	87
Wk 4	1558	1833	52	61
Wk 5	1607	840	54	28
Wk 6	2105	675	70	26
Wk 7	2057	1300	69	43

Discussion

This study revealed that the population estimation of Periwinkles at Esuk Mba mangrove mudflat showed that T. fuscatus was more abundant in terms of number than *P. aurita*. This finding is in line with the work of Bob-Manuel (2012) who reported that *T. fuscatus* was more abundant than *P aurita* in number at Rumuolumeni Mangrove creek, Port Harcourt. One of the contributions for the abundance of *T. fuscatus* popularly known as ''Periwinkles'' in the study area was that gastropod inhabits quiet waters, where the substratum is muddy and rich in detritus as earlier reported by Jamabo and Chinda (2010). The high population of *T. fuscatus* in this study supports the work of Bishop (1993), who reported that the abundance, composition, distributed and diversity of sediment dwelling molluscs can be affected by a wide range of factors, including physicochemical characteristics of water sediments, availability of food and nature of substrate. Another factor responsible for the abundance of *T. fuscatus* in this study was the high ability to tolerate a wide range of salinity of 0.1 mg/l to 25 mg/l (Egonmwan, 1980). This means that fluctuations in salinity, which is not an uncommon feature as estuaries are known for their fluctuating environmental variables, could be responsible for the population decline of *P. aurita* in the study area.

The result of this study does not conform with the findings of Ajao and Fagade (1990) who reported that large number of the gastropod *P. aurita* occurred in shallow shoal sand in Lagos Lagoon and referred to them as the commonest gastropod mullusc in the Lagoon. Dambo (1985, 1993) observe that *P. aurita* could be affected by pollutant than *T. fuscatus* because of *T. fuscatus* behaviour. This researcher disclosed that *T. fuscatus* has the ability to contract faster and deeply up to three-quarters into its shell, and maintain a healthy condition in adverse conditions more than *P. aurita* which does not survive such situation. Ajao and Fagade (1990) reported that the greatest densities occurred in areas further away from anthropogenic inputs of sewage and industrial effluents. Little wonder that the population of *T. fuscatus* was so high in Esuk Mba mangrove mudflats devoid of such conditions earlier described by Ajao and Fagade (1990) and Dambo (1985 and 1993).

Jamabo and chinda (2010), reported that temperature has no effect on the ecology of *T. fuscatus var fuscatus*. However, Oyenekan (1979) reported that temperature among other factors affect the ecology of *P. aurita*. Dambo (1985) also observed that the population distribution is affected by temperature exerted on soil surface during low tide and could therefore cause *P. aurita* to look for shelter. Bob-Manuel (2012), held that because of the global warming in recent times, it is possible that some of the *P. aurita* could avoid being exposed during low tide and therefore move down the sub-tidal zone. Esuk Mba mangrove swamp is within the sub-tropical belt of the Niger Delta, and characterized by heavy rainfall and high temperature of 28-32^{o}C as earlier described by Jamabo et al (2009) and Jamabo and Chinda (2010). I t could be inferred that the dry season accompanied with high temperatures between November and March (the study period), could be a factor in the low population of P.

aurita encountered in this study.

Although there have been no investigation into factors influencing the abundance of *T. fuscatus* at Esuk Mba mangrove mudflat, organic and mineral content could be responsible. This observation is in agreement with the work of Edokpayi and Ikhara (2010) who recorded *P. aurita* and *T. fuscatus* at all the study sites sampled. In their survey of Malacofauna sediments from Epe Lagoon, these researchers revealed that the presence of organic, sulphate, nitrate and phosphate minerals influenced the abundance of *T. fuscatus* and *P. aurita* in the area.

In the study of the life cycle of *P. aurita* in Lagos Lagoon, Ajao and Fagade (1990) revealed that the gastropod breeding season has a definite period which coincides with high salinity. Bob-Manuel (2012) observed that because of climate change, the high salinity which coincides with the dry season is greatly reduced due to rainfall in most parts of the year in Rumolumeni mangrove swamp creek. This climate change has a negative effect in reproduction of young ones into the population. Climate change is a global phenomenon and Esuk Mba mangrove swamp cannot be an exception, thus the decline in population of *P. aurita* in the study area.

In view of this investigation, dry season and migration were considered factors in the low population of *P. aurita* because of their scarcity in the study area. However, the abundance of *T. fuscatus* was due to its ability to withstand adverse environmental conditions, because ninety percent (90%) of the tissues of the harvested snails sunk very deep into the shell. Moreover, the quiet waters, muddy mangrove substratum with plenty of detritus as food, and absence of anthropogenic sewage input characteristic of the study site, were enabling factors for the high population of *T. fuscatus*.

It was concluded that *T. fuscatus* had better survival mechanism in adverse situations than than P. aurita and thus its abundance in Esuk Mba, the study area.

Information from this study revealed that there was need for investigation of more factors which could provide better breeding environment for these molluscs. This would eliminate the forces of extinction as already exemplified by the supply of smaller sizes in our markets as compared to the original larger sizes (Bob-Manuel, 2012; Powell et al, 1985; FAO/FIDI, 1994; Jamabo et al, 2009).

Authors' contribution. Iboh CI was the leader in this paper and writer of the manuscript. Iboh CI and Ajang RO were responsible for specimen collection. The Bench work was carried out by Iboh CI and Ekoro SC. The manuscript was finally reviewed by the authors.

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