The ecology and natural food components of *Pachymelania aurita* MÜLLER (Gastropoda: Melaniidae) in a Coastal lagoon

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Abstract: The **e**cology and natural food of *Pachymelania aurita* MÚLLER in a coastal Nigerian lagoon are reported. Ecological parameters were investigated by monthly sample collection from September, 2004 to August, 2006. Natural food components were identified by microscopic examination of the feacal matter. The abundance of the *P. aurita* was related to salinity, total organic content (TOC) and grain size of sediment at the study stations. Greater densities of *P. aurita* occurred at stations with relatively higher salinity (>1.77‰), low TOC (<10%), high sand (>60%) and low mud (<30%) contents. A range of 0.01 – 19.72‰ for water salinity was observed during this study, while sediment sand and mud recorded ranges of 65.8-92.8% and 7.8-29.4% respectively. The TOC of sediment ranged between 2.05 and 98.5%. Sediments at the study stations were predominantly sand intermixed with varied proportions of mud and varied rapidly within relatively short distances along the study stretch. A total of 6,869 individuals were recorded during the study, with wet and dry season contributions of 3,693 and 3,176 individuals respectively. Population of *P. aurita* was highest (490 individuals) in the month of January, 2005, while the lowest (230 individuals) was recorded in October, 2005. Total biomass was lowest (55.64g) in March, 2005, while the highest (166.90g) was observed in July, 2005. The natural food of *P. aurita* consists of blue-green algae (*Anabaena, Aphanocapsa*), diatoms (*Navicula, Synedra, Cyclotella, Nitzchia)* bacteria, higher plant materials, organic debris and sand grains. Report and Opinion. 2009; 1(5):41-48]. (ISSN: 1553-9873)

Key words: ecology, natural food, *Pachymelania aurita*, coastal lagoon.

1. Introduction

The genus *Pachymelania* is one of the commonest and most dominant gastropod molluscs in the south-western lagoon systems of Nigeria (Oyeneka, 1975; Uwadiae, 2009; Uwadiae et al., 2009). It is endemic to West Africa (Oyenekan, 1975), and is harvested by natives of coastal towns and villages in Nigeria as a staple source of protein.

Although *Pachymelania* spp adapts to freshwater they prefer brackish water of higher salinity and often extremely abundant in mangrove swamps and on mud-flats within the reach of the tide in the lagoons and river estuaries (Egonmwan, 2007). Of the four species, only *P. bryoensis* inhabits fresh water, others including *P. aurita* and *P. fusca* are characteristics of brackish tidal water and mangrove swamps along the West African Coast (Oyenekan, 1975; Egonmwan, 2007).

The shell characteristics, classification and geographical distribution of the genus have been reported (as cited in Egonmwam, 2007).The ecology of the genus in relation to changes in temperature, salinity and survival out of water under experimental conditions has been documented (Oyenekan, 1975).The genital ducts of three species (*P. aurita, P. fusca, and P. bryoensis*) have been described (Oyenekan, 1984). The production and population dynamics of *P. aurita* in the brackish water Lagos lagoon have been studied by Ajao and Fagade (1990).

Most of the literatures on *P. aurita* in Nigeria is on the high brackish water populations. There is apparently no information on the ecology of fresh water and low brackish water populations. Furthermore, information on the food of *P. aurita* like many benthic invertebrate species is limited, this has left huge gap in the foundational knowledge required if we are to think of domesticating the gastropod to save their populations from complete decimation in the face of the serious ecological threats to their natural habitats.

This paper aims at highlighting the factors affecting the abundance and distribution of *P. aurita* in a low brackish water environment. The paper also reports the natural food of *P. aurita* in the study area.

2.0. Materials and Methods

2.1. Description of Study Area

Epe lagoon (fig. 1) is located in Lagos state. It lies between latitudes $3^0 50'$ – $4^0 10'$N and longitudes $5^0 30'$–$5^0 40'$E. It has a surface area of about 243km^2. The lagoon which has an average depth of about 2.45m is fed by the waters of adjoining rivers and creeks. It is connected to the ocean through the Lagos harbour and tidal influence is relatively weak. An elaborate description of the study area is provided in Uwadiae (2009) and Uwadiae et al. (2009).

2.2. Field Investigation

In order to address the issues regarding the ecology of *P. aurita*, it was important to know the substratum conditions which determine the occurrence and habitat selection of the organism. Sediment samples were collected using a Van Veen grab ($0.1m^2$) from an anchored boat with an out-board engine. The sediment samples collected at each station were placed in labeled polyethylene bags for grain size and total organic content analysis in the laboratory. The samples were stored in the refrigerator prior to analysis. Three grab hauls for *P. aurita* specimens were also taken from each station, the collected material from two of the hauls were washed through a 0.5mm mesh sieve. The residue in the sieve was fixed in 10% formalin solution and kept in labeled plastic containers for onward transportation to the laboratory. The third haul was emptied into a wide open plastic bowl and specimens of *P. aurita* picked into plastic containers with water from the habitat and transferred to the laboratory. Water samples for the salinity analysis were collected with prewashed plastic bottles.

2.3. Laboratory Investigation

Sediment grain size analysis was performed using the direct method for separating sediment into grain size fractions. Air dried samples were passed through a graded series of standard sieves. Griffin SIH – 310-V sieving outfit was used. The fractions of sand and mud obtained were recorded in percentages. The TOC of the sediment was estimated by loss of weight on ignition in muffle furnace at 555^0C as employed by Uwadiae et al. (2009).

Fixed samples were washed with tap water to remove the fixative and any remaining sediment to facilitate easy removal of specimens of *P. aurita*. The number of individuals for each station were counted and recorded. The changes in population densities of the gastropod within the 24 months period were examined. Salinity was determined according to the methos described by APHA (1985).

2.3.1. Determination of Biomass

The biomass was determined by wet method. This involved direct weighing of all the specimens of *P. aurita* in each sample. They were allowed to dry for one minute after puncturing the shells with a fine needle and the mantle cavity water sucked up with filter paper. The organisms were then weighed using a weighing balance and values approximated to the nearest weight in gramme (g).

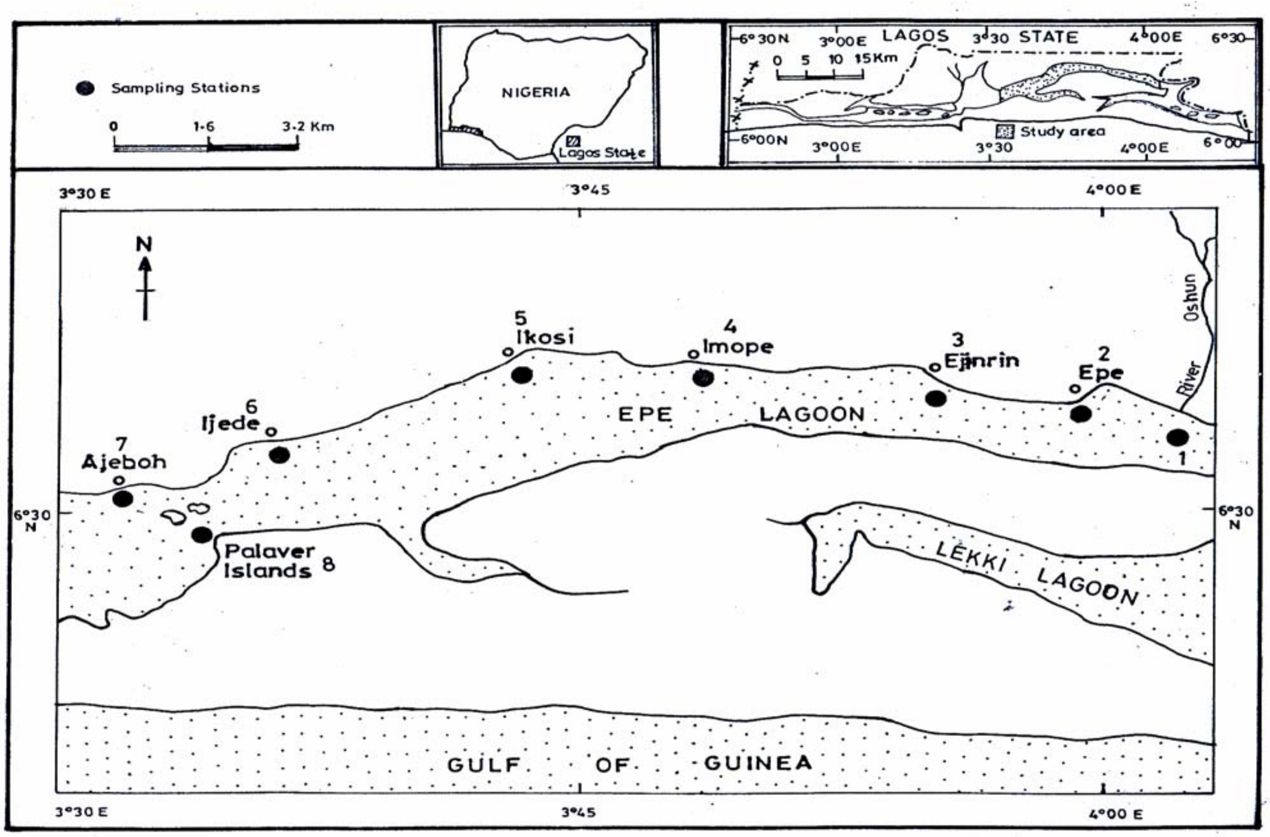

Figure 1. Map showing the study stations

2.3.2. Food Components

The composition of the natural food of *P. aurita* was determined by faecal content analysis as described by Thomas et al. (1985) using the frequency of occurrence and numerical abundance methods (Thomas et al., 1985; Ugwumba, 1990; Ugwumba and Adebisi, 1992). Specimens of *P. aurita* were separated into juveniles (1-10mm) and adults (>17mm). Sixty juveniles and adults were selected on the bases of good health and placed in two different tanks containing sediment and water from the habitat for 72 hours. These specimens were then transferred into Petri dishes (5 specimens of in each Petri dish) with water from the habitat and allowed to stay for 72 hours. The faecal matter of the adults and juveniles were fixed with 30% formalin solution. All the formalin fixed feacal materials were examined under the microscope and the food items identified.

3.0. Results

3.1. Physico-Chemical Characteristics of Sediment.

The summary of values of physicochemical parameters investigated during the study period is presented in table 1. The study area was predominantly sand intermixed with varying proportions of mud. The percentage of sand ranged from 65.8 to 92.8%, and mud fraction ranged between 7.8 and 29.4%. All the stations studied showed fluctuating levels of total organic content. The highest value (98.5%) was observed at station 3 in September, 2004, while the lowest value (2.05%) was recorded at station 5 in December, 2004. Salinity values for the study area ranged between 0.00 – 19.72ppt.

3.2. Distribution, Population and Biomass.

During this study it was observed that *P. aurita* occurred in larger numbers in stations closer to the brackishwater Lagos lagoon. Five of the stations (4 to 8) contained the gastropod in all the samples collected during the sampling months. The gastropod was recorded ten times in station 2, six times in station 3, and three times in station 1. Low numbers (3, 53 and 7) of individuals were recorded in stations 1, 2, and 3 respectively, while stations 4 to 8 recorded higher numbers (723, 1,709, 2,135, 1,422 and 1,491 respectively) of individuals.

Variation in the abundance of *P. aurita in* some of the study stations is presented in Figure 2. The seasonal variation in the population and biomass of *P. aurita* are shown in Figures 3 and 4. The highest population (490) of *P. aurita* in the study area occurred in the month of January, 2005, while the lowest (230) was recorded in October, 2005. In May, 2005, 443 individuals of *P. aurita* were encountered. A reduction in the number of individuals was observed in May, 2006 when 437 individuals were enumerated. Four hundred and twenty five (425) individuals occurred in the samples collected for the month of July, 2006. The results recorded in this study indicate increase in population during the transitional months from rainy to dry season.

Monthly densities of individuals ranged between 144 observed in the month March, 2006 and 544 which occurred in the month of August, 2006. The monthly variation in the number of individuals showed a comparatively higher number of individuals in the transition months from rainy to dry season. The highest density ($190/0.1m^{-2}$) per sampling effort was recorded in November, 2005 at station 6.

Pachymelania aurita was most abundant in sediments with percentage TOC content between 3.63 and 4.14%, and sand between 78.5 and 81 %. The density was low in sediments with high percentage TOC, such as that in station 3 (Figure 5). Although no particular trend was shown in the biomass values recorded, higher biomass (like the population) values occurred during the transitional months from rainy to dry season. Total biomass was lowest (55.64g) in March, 2005, while the highest (166.90g) was observed in July, 2005.

Table 1. Summary of values of physico-chemical parameters of the study stations.

Parameter	Study station															
	1		2		3		4		5		6		7		8	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Salinity(ppt)	0.35	0.00	0.24	0.00	0.28	0.00	1.77	0.01	3.62	0.01	8.37	0.01	19.30	0.06	19.72	0.04
Sand (%)	92.2	79	87.4	61.4	89.4	54.4	85.4	65.4	93.6	71.4	92.2	73.6	89	65.8	92.4	73.5
Mud (%)	21	7.8	28.6	11.4	44.6	9.4	27.6	14.6	28.6	6.5	26	7.8	29	11	26.5	7.6
TOC (%)	8.61	2.11	8.22	2.10	10.45	3.51	7.50	1.01	7.30	1.02	7.50	1.01	6.00	1.01	6.30	1.01

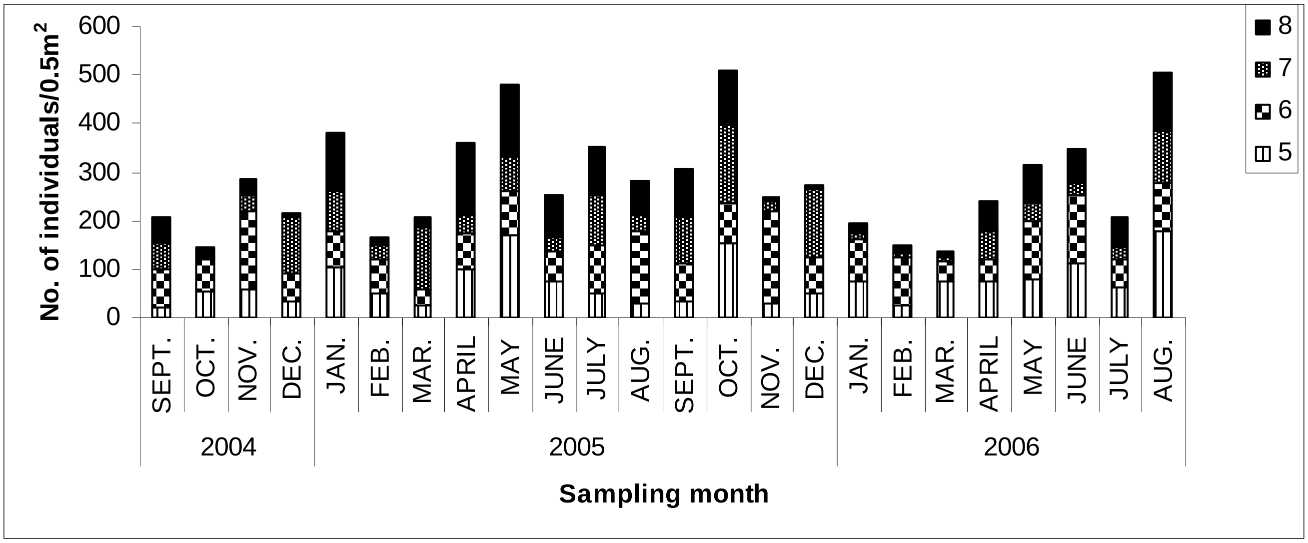

Figure 2: Variation in abundance of *P. aurita* at some of the study stations during the sampling months.

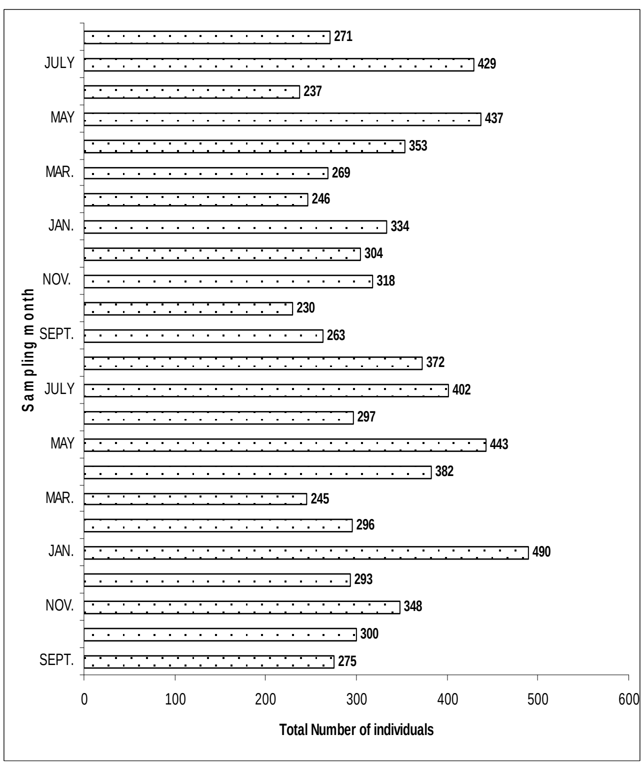

Figure 3. Seasonal variation in the population of *P. aurita* in Epe lagoon (Sept. 2004 - Aug. 2006).

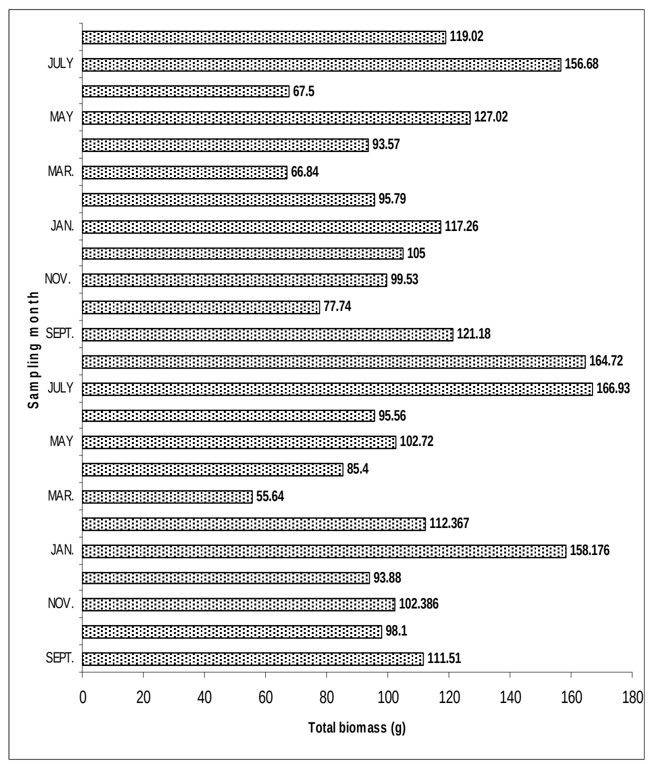

Figure 4: Seasonal variation in the biomass of *P. aurita* in Epe lagoon (Sept. 2004 - Aug. 2006)

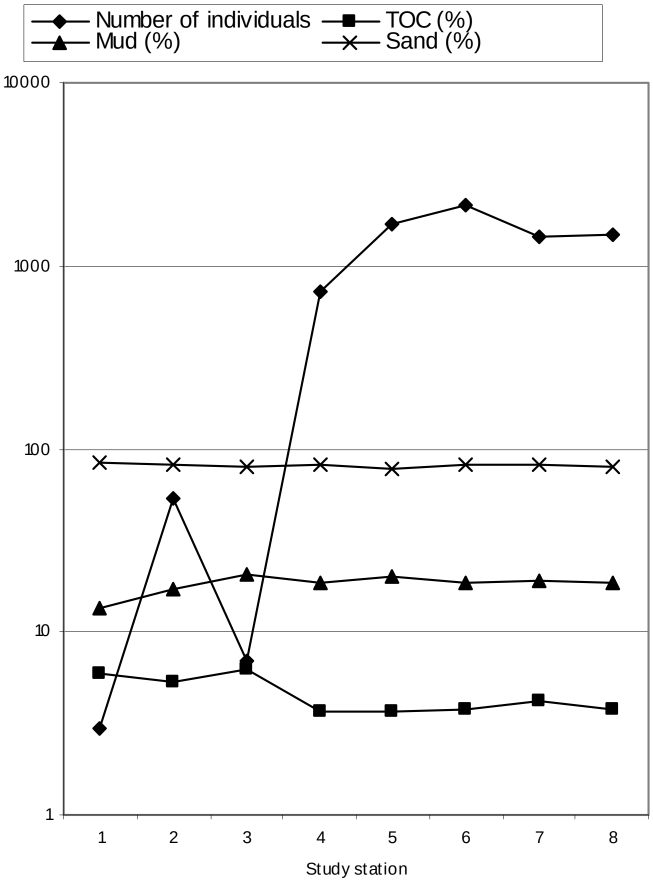

Figure 5: Variations in percentage TOC, sand, mud and number of individuals at the study stations.

3.4. Food Components

Figure.6 shows the percentage composition of the food items in the faecal matter of *P. aurita*. Items encountered in the faecal matter of the specimens examined included microalgae, bacteria, vascular plant materials, organic debris and sand grain. Items found in the faecal matter of adults but not in the faecal matter of the juveniles included a diatom *Cocconeis*. In terms of the frequency of occurrence, higher plant materials, organic debris and sand grains ranked highest (100%), they occurred in all the specimens examined. In the adults of *P. aurita*, the diatoms, *Navicula* and *Synedra* ranked second in percentage occurrence with their presence in 75% of the total adults. In the juveniles *Synedra* and *Cyclotella* ranked second in percentage occurrence, they were represented in 75% of the total juveniles.

In terms of numerical abundance or percentage number, higher plant materials and sand grains constituted the highest number (21.43%) in the faecal content of the adult of *P. aurita* from the habitat. Organic debris constituted 18.57%, *Navicula* 11.42%, *Synedra* 10%, *Cyclotella* 8.57%, *Niztchia* and *Cocconeis* recorded 5.71% and 4.2% respectively. In the juveniles of *P. aurita* from the habitat, sand grains constituted the highest percentage number (25%). Organic debris and higher plant material constituted 22.22% and 19.44% respectively. *Navicula* recoreded 13.88%, *Synedra* 11%, *Cyclotella* 8.33% and *Niztchia* 5.55%.

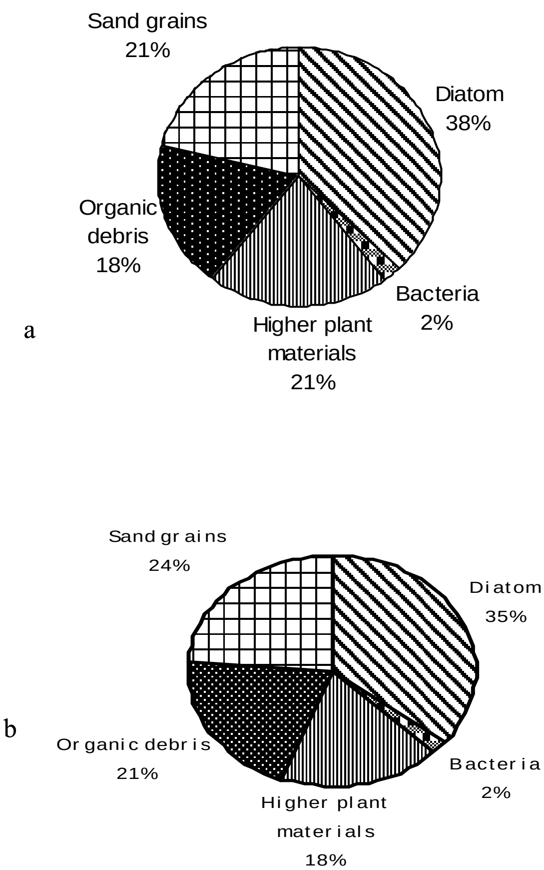

Figure 6: Percentage composition of the faecal matter of specimens of (a) adult, and (b) juveniles of *P. aurita*.

4.0 Discussion

The narrow variability of sand and mud observed in the study area corroborates the results recorded by Oyenekan (1988) on the sediment characteristics in the Lagos lagoon. Sediment in the study stretch was sandy, except for station 3 where the proportion of mud was more than sand particles in the months of September and December, 2004 and January, 2005. The TOC recorded in all the stations ranged between 2.05 and 8.5%. This is in close semblance with the result (0.50 – 11.95%) reported for the Lagos lagoon by Brown (2000), but differs from that (53.21 - 90.18%) reported by Ajao and Fagade (1991) for the same lagoon. The lowest value of TOC observed occurred at station 5 during the dry season and may be attributed to low sediment transport and reduced allochthonous input. The highest value recorded occurred in station 3 in October, 2004 and could be due to deposition of organic debris from the farm land by this station (Uwadiae et al., 2009).

The distribution of *P. aurita* in the study area is a reflection of its euryhaline nature. It occurred in all study stations. This observation is similar to that of Ajao and Fagade (1990) which opined that the organism was recorded in most part of the Lagos lagoon all the year round and was relatively tolerant of physical and chemical variations in the environment. Like most aquatic molluscs (Eckman, 1983) it however prefers sediments with little silt. The low density and complete absence of the species in some grab samples in some study stations (1, 2 and 3) is associated in part with the possible effects of anthropogenic activities and majorly to salinity of the stations (Uwadiae, 2009). According to Egonmwan (2007), although *Pachymelania* spp adapts to freshwater they prefer brackish water of higher salinity. Of the four species, only *P. bryoensis* inhabits fresh water, others are characteristics of brackish tidal water and mangrove swamps along the West African coast (Oyenekan, 1975; Egonmwan, 2007). This explains the preponderance of the species in stations (4 to 8) where higher salinity values were observed. The euryhaline nature of the organism is a possible premise while there were higher numbers of individuals observed during transiting months from rainy to dry season.

Station 3 where the highest mud content was observed in the substratum, recorded the least number (7) of *P. aurita*. Although muddy particles hold the largest amounts of total TOC which represent a food source for deposit feeding organisms (Brown, 2000), it limited the abundance of the filter feeder. Induced sedimentation resulting from high organic matter can smother benthic molluscs both at their adult and planktonic stages. Increased turbidities may increase the formation of pseudofeces and decrease the amount of water that is pumped (Hart and Fuller, 1979).

The highest biomass value (666.285g) occurred in station 5. This may be attributed to the seemingly favourable environmental conditions prevalent in this site. These include a relatively high sand content with proportionate admixture of mud and organic matter. The results of biomass recorded in this study compares favourably with those of Ajao and Fagade (1990), who reported lowest and highest values of annual biomass of *P. aurita* as 47.513mg and 7082.7646mg respectively.

The detrimental consequences of anthropogenic activities particularly with respect to the introduction of organic matter, waste dump and sand mining also limited the abundance of the species. This observation was supported by the occurrence of species associated with organic pollution at some of the study stations. These included *Nereis* spp and *Chironomous* sp which have been reported in similar disturbed environments (Chukwu and Nwankwo, 2004) and referred to as opportunistic species.

z Information on the food of *P. aurita* is limited. According to Calow (1970), little detailed information concerning the natural diets of aquatic gastropods is available. This work therefore is among the first major report on the food of benthic gastropod in a tropical lagoon. Analysis of the faecal content of *P. aurita* shows that its food items include miroalgae, bacteria, vascular plant materials, organic debris and sand grains. This array of food items is similar to those recorded as stomach contents of some aquatic gastropods (Cummins, 1979; Thomas et al., 1985; Akintunde, 1988; Ugwumba, 1990; Egonmwan, 1991). The preponderance of sand grains in the faecal matter of all the specimens examined corroborates the reports of Thomas et al. (1985) and Dillon (2000). Organic debris ranked second in terms of percentage abundance and occurred in all the animals examined. Benthic microalgae are embedded in a complex sediment structure, so grazers move through the interstitial system or upon the surface and capture mobile flagellates and diatoms, or also browse the epigrowth on sand grains (Dillon, 2000). Also, sand grains are commonly found in the stomach of most freshwater gastropods, constituting an especially large fraction of the gut contents in many lymnaeids (Dillon, 2000). It has also been reported that sand grain is actively ingested and used in the tituration of food (Dillon, 2000; Graham, 1955).

The occurrence of diatoms and cyanobacteria as the only microalgae encountered in this study may be linked to their preponderance in aquatic sediment (Nwankwo and Akinsoji, 1989). Their survival in may linked to their habit and general biological characteristics. A number of species of cyanobacteria and diatoms are adapted to life in the aquatic sediment (Dakshini and Soni, 1982). Nwankwo and Akinsoji (1989) reported the greatest count of diatoms notably *Navicula* and *Nitzichia* in their study of the benthic algal community of a saw dust deposition site. They also stated that diatoms are the dominant plants in mud and sand. The overwhelming presence of the diatoms among other microalgae in the faecal matter of *P. aurita* may be attributed to their relatively indigestibility caused by the impregnation of their cell wall with silica and the overlapping of the two halves of the cell wall making it difficult for the simple digestive system of the animal to cope with. However, it has been reported that some benthic species are able to puncture and suck out the content of diatom cells (Dillon, 2000).

No living macrophyte or other living plant material was identified as a component of the feacal content of *P. aurita*, aquatic snails tend not to attack living macrophytes under natural conditions. Thomas et al (1985) reported that snails under natural conditions consume much higher quantities of dying or decomposing aquatic plants than living materials. This claim is corroborated by the findings of Scheerboom and Van Elk (1978; Thomas et al., 1983) which showed that detritus (mainly of macrophyte origin) was the major dietary item for *L. stagnalis* as it formed 48.3% of the mean percentage composition of crop contents. Dead plant materials are also the major item in the diet of most species of terrestrial molluscs as well as freshwater prosobranchs such as *Viviparus contectus, Bithynia tentaculata* and *Melanopsis* spp (Dillon, 2000). In view of the predilection of most prosobranchs for dead or senescing plant material the percentage occurrence of organic debris recorded in this study for all the categories of specimens is true. Much of the organic debris recorded were in their early stages of decay which the animals might be able to take into their system during feeding activities.

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