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Growth Pattern, Whorl and Girth Relationship of the Periwinkle, *Tympanotonus fuscatus var radula* (Linnaeus, 1758) from a Tropical Estuarine Lagoon, Lagos, Nigeria

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Abstract
The size composition and growth pattern of the periwinkle, *Tympanotonus fuscatus var radula* in a tropical estuarine lagoon were investigated. The Shell length ranged from 2.5cm to 5.9cm and weight from 0.02g to 9.42g.The periwinkle showed a unimodal size distribution. Also, there is strong significant correlation between whorl number and increase in shell length ($r = 0.625$, $P < 0.01$), suggesting that the higher the shell length the more whorls an individual possesses. The girth-length and weight-girth relationships were positively correlated with calculated "b" of 0.65 and 0.40 respectively. The pattern of growth (negative allometric) was verified from the value of $b < 3$. The condition factor ranged between 4.6 and 10.3 and decreased with size, indicating that the species are in good condition.

Keywords: Periwinkle, Girth, Whorl, Length-weight, Mangrove swamp.

1. Introduction
Tympanotonus fuscatus var radula has an elongated shell with regular increasing whorls, weakly curved ribs and much fine striation with blackish brown stripes on the shell. The loss of apex or last whorl is common among adult and a protective operculum in the aperture which is used to seal the snail in case of any disturbance (Moruf [16]). *T. fuscatus* is a prosobranch gastropod common in many brackish water creeks, estuaries and mangrove swamps within the Lagos Lagoon. Jamabo *et al*. [10] stated that the prosobranch gastropods are the commonest and most dominant molluscs in the brackish waters in West Africa. They are univalve gastropods of the Phylum Mollusca. The genera consist of *Tympanotonus*, *Pachymelania* and *Merceneria*. The two species of Periwinkle commonly found in the estuarine habitat and benthos of the Lagos Lagoon are *Tympanotonus fuscatus* and *Pachymelina aurita.* The genera *Tympanotonus* is commonly referred to as "periwinkle" in Nigeria. Periwinkles are shell fishes found in the littoral region of the sea, brackish or estuarine waters which are seasonally submerged regions like the mangrove swamps. They inhabit the quiet waters where the substratum is rich in decaying organic matter and muddy (Jamabo and Chinda, [11]).
Millions of *Tympanotonus* species are transported from the Niger Delta daily to other parts of Nigeria in jute bags. They can remain in these bags for weeks without water. During the transportation to the markets the periwinkles are subjected to high temperatures in addition to lack of food and water. Thermal tolerance has been used to examine the thermal capacities of marine invertebrates to tolerate their environment (Egonmwan [6]). Eulittoral gastropods which are subject to periodic but predictable rehydration have evolved adaptations that enable them to maintain their foraging activity during the short period of exposure whereas the Eulittoral fringe species that experience prolonged and unpredictable emergence have selected for adaptations that minimized water loss rates (McMahon [15]).
Tympanotonus fuscatus var radula inhabits the mudflat of the Lagos Lagoon system, which is a large expanse of shallow water extending from Republic of Benin in the west to the Niger Delta in the east (Fagade [9]). The shores of the Lagos Lagoon and adjacent creaks are lined in undeveloped areas by mangrove swamps. Although human activities such as the cutting of the mangrove tree, *Rhizophora racemosa* for firewood has altered the vegetation in many places, the fauna inhabiting the mudflats have remained typical of West Africa mangrove swamps. The habitat periodically dries up between November and April due to dry season and at low tides exposing the animals (Jamabo and Chinda, [11]). *T. fuscatus var radula* crawls about under water but usually remain passive when left uncovered by the tide.

The shell characteristics, classification and geographical distribution of the genus have been reported (as cited in Egonmwam [6]). Shell characteristics and anatomy of *T. fuscatus* was studied by Johanson [12], while Binder [3] investigated its limits of penetration into the freshwater. Obazee [17] investigated its biology, reproduction and nutrient values in Lagos lagoon. He observed that the shell apex gets decollated. *Tympanotonus fuscatus var radula* is found in the intertidal zone at low water mark in several parts of the world.
The ecology of the genus as related to changes in temperature, salinity and survival out of water under experimental condition has been documented (Engonmwan, [7], Jamabo and Chinda, [11]). Plaziat [20] studied its polymorphism and distribution in Camaroun estuaries. Morphometric traits used to describe snails' growth usually include the live weight (LW) and the shell dimensions (Roberson [22]). This study will provide a basis for the establishment of a practical conversion protocol to simplify laboratorial experiments which is a pre-requisite for effective management, culture and conservation of this specie.

2. Materials and Methods

2.1 Study site

The Lagos Lagoon is one of the nine lagoons in Southwestern Nigeria which the Mangrove swamp of University of Lagos lagoon front (Fig.1) is found. The study site lies between latitudes 6º 26' – 37' N and longitude 3º 23 – 4º 20'E. The study was carried out between September 2014 and February 2015.

Fig. 1: Map of University of Lagos showing sampling location **Source**: Bolaji *et al*. [4]

2.2. Collection of Specimen:

The periwinkles (plate 1) were collected with hand and hand net on monthly basis at the station between 1000 and 1200 hrs. A total of 500 periwinkles were studied. Samples collected were washed and placed in a synthetic polythene bag and transported to the laboratory.

Plate 1: *Tympanotonous fuscatus var radula*

2.3 Laboratory analysis

The shell length (SL) of the periwinkle measured to the nearest centimeter from the edge of the frontal region to the tip of the shell apex using a ruler to the nearest 0.1cm, while the shell width (WDT) was measured from the tip of the left to right side. The Shell weight of the periwinkles was taken to the nearest tenth of a gram on a Sensitive weighing scale. The length measurements were converted into length frequencies with constant class interval.

The data collected was used to evaluate the relationship of the shell length (SL) and weight (SW) of *T. fuscatus* using the formula:

$W = a L^{b}$ ……..…….Equation 1 (Parson [18])

Where W = Weight (g)
L = Shell length (cm)
a = Regression constant
b = Regression co-efficient.

The equation was linearised by a logarithmic transformation to give:

Log W = Log a + b Log L ……...……Equation II (Parson [18])

The condition factor `K´ was calculated with the following formula

$K=100W/L^{b}$ ……Equation III (Ricker [21])

Where K=condition factor
W=weight of the periwinkle (g)
L=length of the periwinkle (cm)
b = regression coefficient

It is defined as a condition representing how lean or fat the periwinkle is

3.0 Results

The Total length of *T. fuscatus var radula* of Lagoon Lagoon ranged from 2.5 to 5.9cm while the weights ranged from 0.02 to 9.42g. There is a positive relationship as the longer the specimens the heavier it became giving a regression coefficient of 0.91 (Fig.2). In a similar manner, the Girth size changed positively as the weights and total lengths of specimen also changed (Fig.3 and 4). There is strong significant correlation between whorl number and increase in Shell length ($r = 0.625$, $P < 0.01$) (Fig.5), suggesting that the higher the shell length the more whorls an individual possess. The condition factor ranged between 4.6 and 10.3 and decreased with size (Table 1).

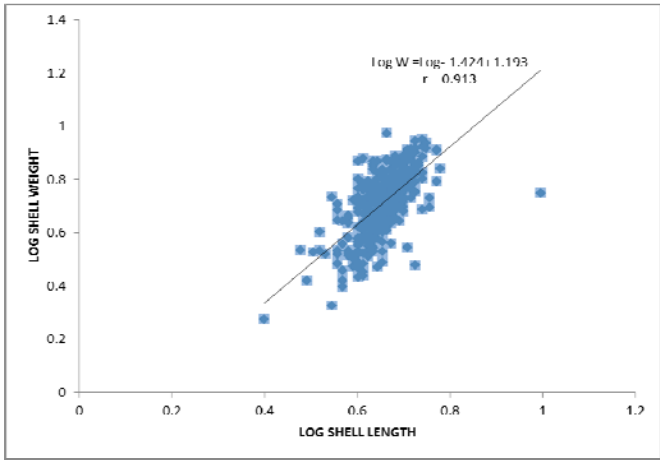

Fig 2: Summary of the Log Total weight/ Log Shell Length of *Tympanotonus fuscatus var radula* from Lagos Lagoon front (September, 2014-February, 2015)

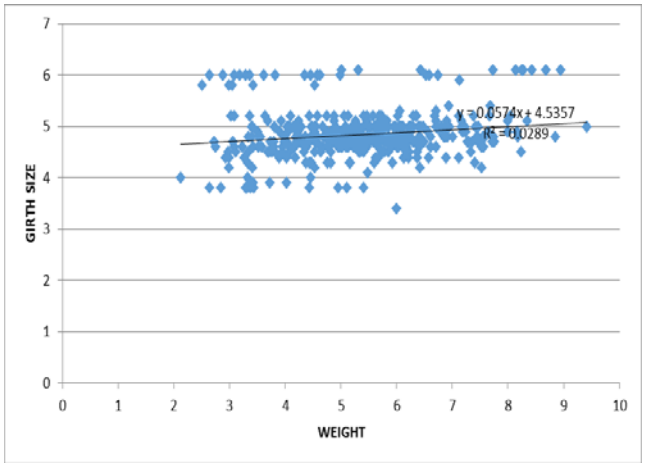

Fig 3: Summary of Weight-Girth relationship of *Tympanotonus fuscatus var radula* from Lagos Lagoon front (September, 2014-February, 2015)

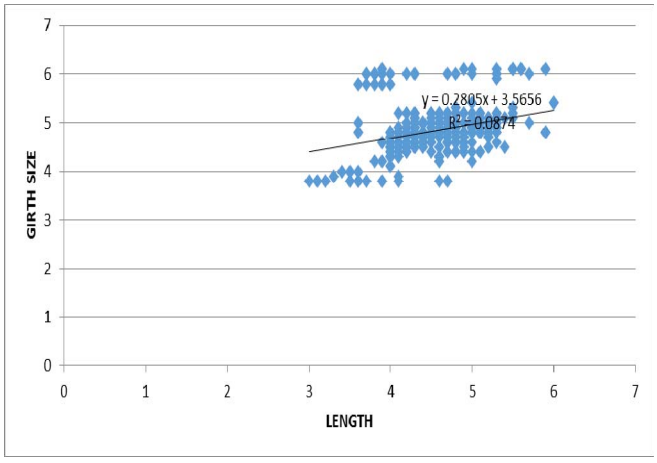

Fig 4: Summary of the Length-Girth Size relationship of *Tympanotonus fuscatus var radula* from Lagos Lagoon front (September, 2014-February, 2015)

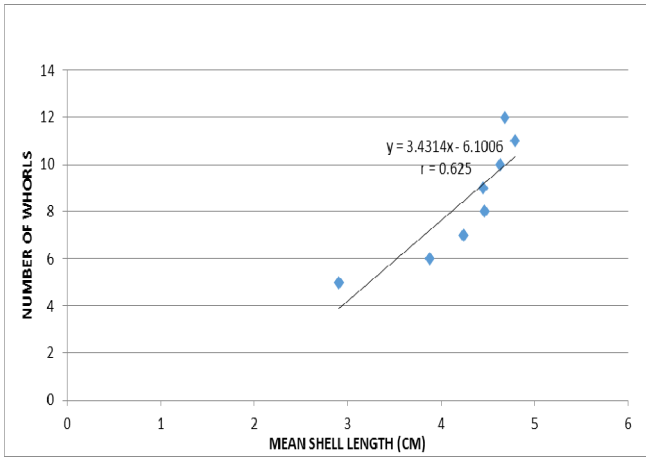

Fig 5: Summary of shell length /whorl frequency of *Tympanotonus fuscatus var radula* from Lagos Lagoon front (September, 2014-February, 2015)

Table 1: Condition Factor (K) by size of *Tympanotonus fuscatus var radula* from the Mangrove Swamp of University of Lagos Lagoon front.

Shell length	Number	Total length (cm)	Total weight(g)	Condition factor(K)
2.5-2.9	1	2.5	0.8	5.7
3.0-3.4	6	3.2	3.3	10.3
3.5-3.9	25	3.6	3.7	8.0
4.0-4.4	129	4.1	11.1	16.1
4.5-4.9	149	4.7	8.4	8.1
5.0-5.4	69	5.2	6.4	4.6
5.5-5.9	15	5.6	11.2	6.4

4. Discussion and Conclusion

4.1 Size composition/Abundance

The size frequency distribution of a population is a dynamic characteristic that can change throughout the year as a result of reproduction and rapid recruitment from larvae (Johannson [12]). Maximum size of samples (*T. fuscatus)* in this study of 5.9cm total length was bigger than those reported for the same species in Cross River by Paul [19]. The maximum size attainable by any fish species (Fin or Shellfish) is location specific (King [13]) and may be due to factors such as pollution, high fishing pressure and environmental degradation (Abowei and Hart, [1]). However, the Maximum size in this study is in conformity with the finding of Edmonds [5] where his records indicate that the smallest *T. fuscatus* measured 1.80 cm total length or 0.52 gm (body weight) and the largest measured 5.2 cm total length or 7.81gm body weight. The final total lengths of species are one of the criteria in assessing the exploitation level of that organism in its environment. This is implying that the species is still underexploited in the Mangrove swamp of Lagos Lagoon, Nigeria.

4.2 Length-weight relationship

Length-weight relationship which is a measure of the weight growth of most fin fishes, shellfishes and other invertebrates tend to show "isometry" when the 'b' value has been determined to be equal to 3.0 while "allometric" situations reports b<or> 3 When the 'b' value is less than 3.0 or greater than 3.0 they are said to be either "negative allometry" or "positive allometry" (Bagenal and Tesch, [2]). In this study the 'b' value of 2.05 is less than the isometric value and probably show a negative allometry indicating that in *T. fuscatus var radula* the larger the species the smaller their organs. Torres [23] reported a value of b<3 in a multi- species study of LWR's. In this study the relationship between total length and body weight of *T. fuscatus* showed a positive correlation. This finding was not in contrary to that of Paul [19] on *T. fuscatus* in Cross River. This means that there was a general corresponding and proportionate increase in weight with increases in total length of the species. Hence it may be an ideal parameter for weight estimation. In this study too, it was observe that specimens with similar total lengths tend to exhibit the same body weights**.** Also, there is strong significant correlation between whorl number and increase in shell length ($r = 0.625$, $P < 0.01$), suggesting that the higher the shell length the more whorls an individual possess.

4.3 Condition factor

In studies of population dynamics, high condition factor values shows favorable environmental conditions such as habitat and prey availability (Kusemiju [14]). This assertion shows relevance to this research work, the mean condition factor for the *T. fuscatus was* 8.46, a high value. This is quite different from the low condition factor of 0. 28 reported by Paul [19] for *T. fuscatus* in Cross River.

The high condition factor aptly describes the good state of wellbeing of the Periwinkle which may be attributed to certain factors in their habitat (habitat difference). This has a lot to do with the condition factor of the species. Condition factor of species describe the well-being, corpulence and fatness of the organism. This definition was used by Etim and Taege [8] to describe the condition of *Egeria radiata* of the Cross River at Itu. The condition factor of 8.46 calculated for this animal is different from the expected Fulton's condition of 1.13 already published and reported by Etim and Taege [8]. The plausible reason for this high condition factor in *T. fuscatus* can be accounted for by reasons of differences in terms of species of study, their origin and other factors known to influence parameter of organisms originating from different places. It can as well be related to food scarcity/ starvation or even reproduction. These factors are known to influence growth data and could lead to low physiological conditions in species. The value obtained in this study for condition factor shows that the *T. fuscatus* are in better condition in Lagos Lagoon than in other water bodies where the species had lower values and this may be due to better foraging ability and conservation of stored food energy in the adults, or possibly due to increasing weight of maturing gonads in the larger samples.

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