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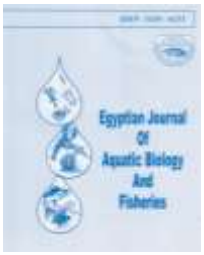

Biometrics, Gut Contents and Sexual Dimorphism of the West African Mud Creeper, *Tympanotonus fuscatus* var *radula* (Linnaeus, 1758) from the Mangrove Swamps of a Coastal Estuary in Nigeria

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ABSTRACT

The biometrics, gut contents and sex ratio of the West African Mud Creeper, *Tympanotonus fuscatus* var *radula* from Mangrove swamps of the University of Lagos Lagoon Front were studied for 12 months. *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. A total of 1135 samples were collected with highest species occurrence in August (11%). The total length ranged from 1.9 to 5.3 cm and total weight from 1.5 to 7.4g. The gastropod exhibited negative allometric growth with regression coefficient "b" of 1.19 values ($b < 3$). There was strong significant correlation between whorl number and shell length (Correlation coefficient, $r = 0.625$, $P < 0.01$). Monthly condition factor (K) for the combined sex ranged between 6.36 and 7.85 with a mean of 7.07. Out of a total number of 1135 samples collected, 544 (48%) had empty stomachs. The index of relative importance (IRI) showed diatom, plant materials and organic debris as primary food items while bacteria and seaweed were secondary items. Hence, the species can be said to be a deposit feeder. Sex ratio obtained during the study was 1:2.3 which was significantly different from the expected 1: 1 ratio. Availability of more femalespermits continuous laying of eggs, thus making the species available all year round.

INTRODUCTION

Tympanotonus fuscatus var *radula*is a species of snail living in brackish water, a gastropod mollusc in the family Potamididae. Jamabo *et al*. (2009) stated that the prosobranch gastropods are the commonest and most dominant molluscs in the brackish waters in West Africa. *Tympanotonus fuscatus*is a univalve gastropod of the Phylum Mollusca and the only extant species in the genus *Tympanotonus* (Reid *et al.*, 2008). The phylum is knownto radiate successfully into a variety of habitats, thegreat majority of which are aquatic while some are foundmostly in shallow waters and sometimes in inter-tidalzones where they burrow into the mud in the beds of theriver which serves as their habitat (Appleton *et al.*, 2009). *T. fuscatus* var *radula* crawlsunder water but usuallyremain passive when left uncovered by the tide. *Tympanotonus fuscatus* and *Pachymelinaaurita* are the two species of mangrove prosobranch commonly found in the estuarine habitat and benthos of the Lagos Lagoon.

Morphometric traits used to describe snails' growth usually include the live weight (LW) and the shell dimensions. In mangrove prosbranch, apex of the shell gets decollated. The loss of 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 and Lawal-Are, 2015).This mollusc is a relatively cheap source ofanimal protein and its shell can be used as a source ofcalcium in animal feeds and for construction (Jamabo*et al*., 2009). In riverine communities, it is either sold live in cane basket or de-shelled and sold in small metal wares containing water.

Reproductive cycle of the prosobranch, *Pachymelaniafusca* has been studied by Egonmwan (2007) while Uwadiae *et al.* (2009) worked onthe ecology and natural food components of *Pachymelaniaaurita*. The potential and abundance of *Tympanotonus fuscatus* in the mangrove swamps of the upper Bonny River have been reported by Jamaboand Alfred-Ockiya (2005).Udo (2013) and Ogunola *et al*. (2017) studied the length-weight/girthrelationship and condition factor of *Tympanotonus fuscatus*var*radula* from Cross River and Okrika Estuary respectively. Most literatures on *T. fuscatus* in Nigeria are on morphometric and ecology with dearth of information concerning the natural diets and sexual dimorphism of this species. Thus, there is a huge gap in the foundational knowledge required in the domestication of this gastropod. On this basis, the objective of the present study is to examine some aspect of the biology of this economically important species in respect to the biometrics, natural diets and sex ratio.

MATERIALS AND METHODS

The area of investigationlies between latitude 6^{o} 26' - 6^{o} 37' N and longitude 3^{o} 23' - 4^{o} 20' E, having low transparencyand alkaline innature (Fig. 1).The shores of the Lagos Lagoon and adjacent creeks are lined in undeveloped areas by mangrove swamps. An elaborate description of the study area is provided in Moruf and Ojetayo (2017).

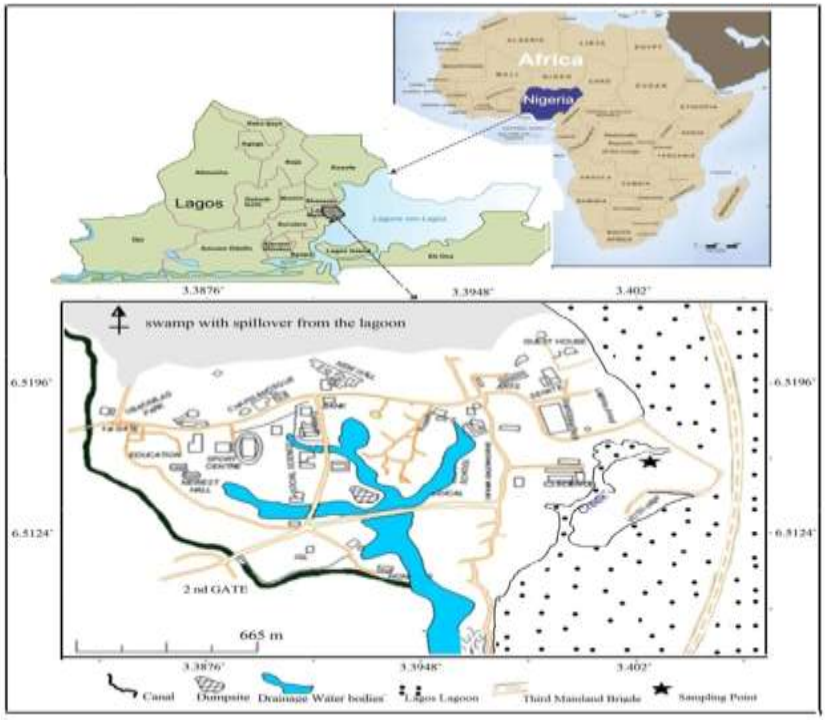

Fig. 1: Map of UNILAG Lagoon Front showing the sampling site

A total of 1135 samples of theWest African Mud Creeper, *Tympanotonus fuscatus* were collected randomly between 1000 and 1200 hrs over a period of twelve months (Sept. 2014 to Aug. 2015) from the mangrove swamps. The samples were handpicked from the bottom of the swamp by divers at vegetation site and were put into a small plastic bucket. The specimens were immediately preserved in an ice-chest with ice-blocks and later transferred into a deep freezer (-20ºC) in the laboratory prior to analysis. At the laboratory, the specimens (Fig. 2) were brought out from the freezer and allow thawing. Excess water was removed from the specimen using filter paper. Biometric parameters were measured with vernier calipers and recorded. The shell length was obtained with the use of a divider and a meter ruler measuring from the apex to the topmost edge of the aperture and the number of whorls on each was counted. Further observation was done under microscope and a magnifying lens. The shell length (SL) 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 (SW) was measured from the tip of the left to right side. The total weight was taken to the nearest tenth of a gram on a sensitive weighing scale.

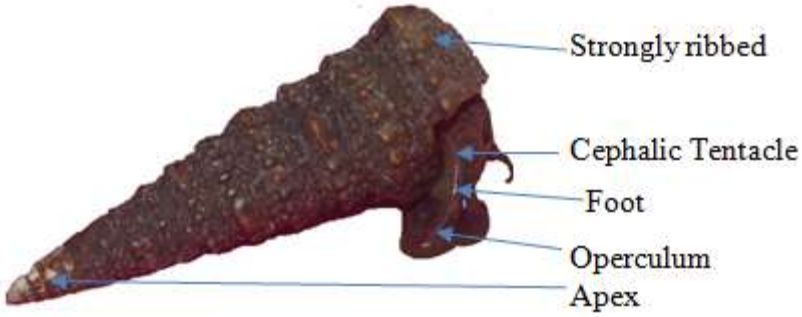

Fig. 2: Protruding Flesh of *Tympanotonus fuscatus* var *radula* from the shell

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

$Log\ W = Log\ a + b\ Log\ L$…….....Equation I (Parson, 1988)

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

The condition factor `K´ was calculated usingthe belowequation

$K = \frac{100W}{L^b}$…….Equation II (Bannister, 1976)

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

The specimen was placed in a G-clamp and pressure was applied gradually until the shell cracked. Immediately the shell gave first sound of a crack, the pressure on the G-clamp was stopped and gradually the snail was released from the clamp. A pair of forceps was used to gradually remove the broken shells. The process was repeated until all the shell was removed and the soft body viewed. The flesh of the

organism was then turned out from its shell until the columella was broken and the animal was completely free from the shell.

The removed soft body was then placed in Petri dish for further observation.Stomach of the gastropod was dissected for food analysis. Each stomach was studied as a unit in order to provide information on individual variation. The stomach, which is blackish in color, is located underneath the body. The abdomen of each specimen was opened lengthwise and the stomach content were emptied into a petri dish containing little amount of water which loosen up the materials for easier identification and estimation oforganisms number done under a monocular microscope. The stomach fullness was estimated as described by Olatunde (1978). The composition of the stomach content was determined by content analysis using the frequency of occurrence and numerical abundance methods as described by Hyslop (1980). The weight of the food items are measured using Gravimetric method and expressed as:

$$\%Weight\ of\ food\ item = \frac{Weight\ of\ the\ particular\ food\ item}{Total\ weight\ of\ all\ food\ items} \times 100$$

……. Equation III(as cited by Agbugui *et al.,* 2014)

The importance of various food items were determined with the index of food importance following a method used by Ugwumba and Ugwumba (2007)

$$IRI = (Cn + Cw)\,X\,F$$……Equation IV

Where IRI = index of relative importance. Cn = percentage of numerical composition Cw = percentage of gravimetric composition. F = percentage of frequency of occurrence

Food item with %IRI ≥ 3 are regarded as primary,
≥ 0.1 to <3 are secondary
≤ 0.1 are considered as incidental food items.

In term of sex ratio, the specimens were sorted out and sexed using gonad colour. In adult, the colour of the gonads varies with sex-creamy colour in female and yellow in male (Screenivasan, 1997). The sex ratio was calculated to test if there is any significant difference in the ratio of male: female *Tympanotonus fuscatus*using Chi-square test with expected ratio of 1:1 at 1df and 5% level of significance.
The formula is stated below:

$$X2 = \frac{(O-E)^2}{E}$$

Where O= Observed and E= Expected…….Equation V (Parson, 1988)

Statistical analysis was carried out using Windows 2010 Microsoft Excelstatistical tools and Chi square ($\chi 2$) test at 1 *df* and 5% level of significance.

RESULTS

Occurrence

1135 specimens of the West African Mud Creeper, *Tympanotonus fuscatus* var *radula* were examined in this study. The speciesoccurred throughout the year in the mangrove swamps while the highest number of samples wasobtained in August (11%) (Fig. 3).

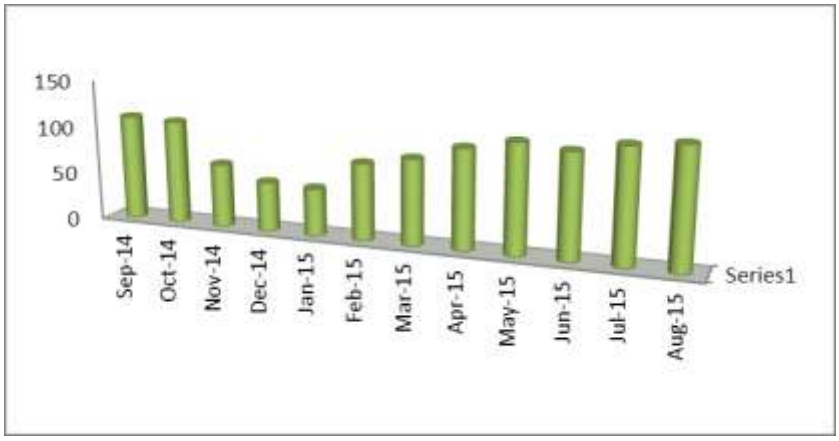

Fig. 3: Monthly occurrence of *T. fuscatus* Var *radula* from Mangrove Swamp of UNILAG Lagoon Front (Sept. 2014 - Aug. 2015)

Biometrics

Shell length of *T. fuscatus* ranged from 1.9 to 5.3 cm and total weight from 1.5 to 7.4g. The graph of Log Total weight/ Log Shell Length **(Fig. 4).**

Showed that the longer the specimen the heavier it became, giving a regression coefficient of 1.19. In a similar manner, the girth size changed positively as the weights, and total lengths of specimen also changed **(Figs. 5 and 6)**.

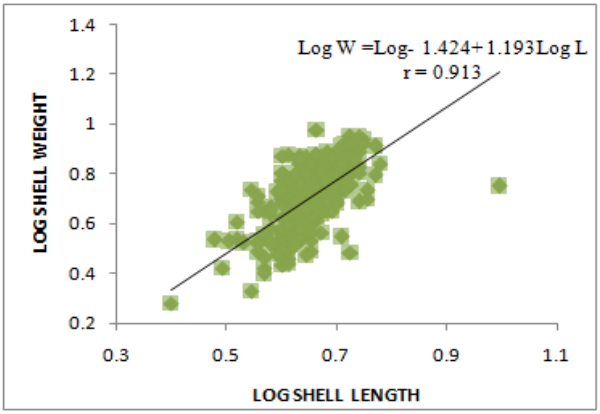

Fig. 4: Log Total weight/ Log Shell Length of *T. fuscatusvar radula* from Mangrove Swamp of UNILAG Lagoon Front (Sept. 2014 - Aug. 2015)

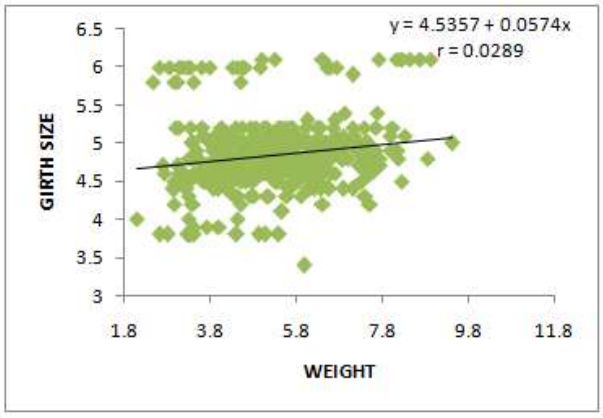

Fig. 5: Weight-Girth relationship of *T. fuscatusvar radula* from Mangrove Swamp of UNILAG Lagoon Front (Sept. 2014 - Aug. 2015)

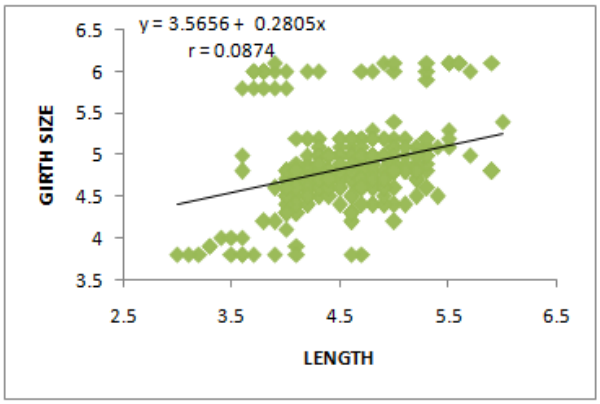

Fig. 6: Length-Girth size relationship of *T. var radula* from Mangrove swamp of UNILAG Lagoon Front (Sept. 2014 - Aug. 2015).

Strong significant correlation (Fig. 7) between whorl number and shell length ($r = 0.625$; $P < 0.01$), suggested that the higher the shell length the more whorl an individual possessed.

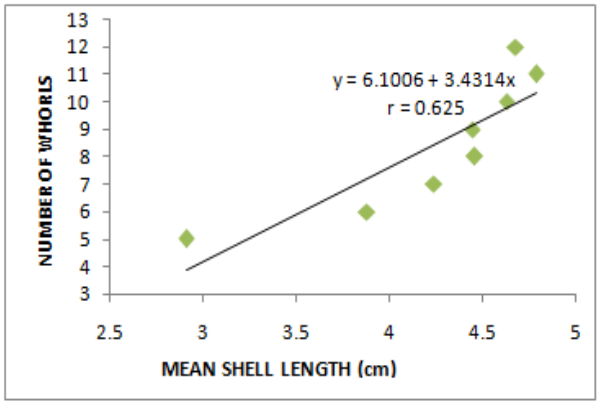

Fig. 7: Shell length /whorl frequency of *T. fuscatusvar radula* from Mangrove swamp of UNILAG Lagoon Front (Sept. 2014 – Aug. 2015).

Condition Factor

The summary of monthly condition factor (K) for *T. fuscatus*, as presented in Fig. 8, shows that the male of *T. fuscatus* is in a better condition having the highest K-value with a range between 6.19 and 8.69 (mean = 7.02).

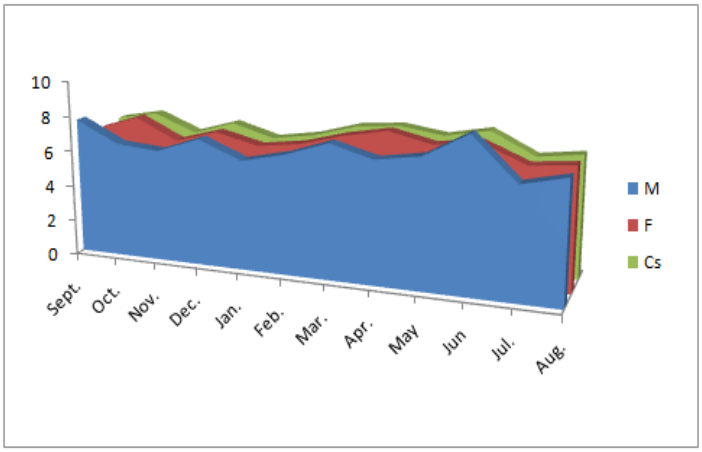

Fig. 8: Monthly Condition Factors by sex of *T. fuscatusvar radula* from Mangrove Swamp of UNILAG Lagoon Front (Sept. 2014-Aug. 2015)

The K-value for the female *T. fuscatus* ranged from 6.38 to 7.93 (mean = 7.09) whilea range between 6.36 and 7.85 (7.07) for the combined sexes.

Stomach Fullness and Content

544 (48%) of the 1135 specimens of *T. fuscatus* var *radula* examined for gut content had empty stomachs (Table 1). The probranch fed mainly on diatoms (29.4% by number and 34.4% by occurrence), plant materials (26.0%), organic debris (22.3% by number and 9.4% by occurrence), bacteria, seaweed and sand grain (Table 2). The percentage of index of relative importance shows that diatom, plant materials and organic debris are regarded as primary food items while bacteria and seaweed are secondary items. Sand grain is considered as incidental gut content.

Table 1: Stomach fullness of *T. fuscatus* var *radula* found in Mangrove Swamp of UNILAG Lagoon Frontbetween September 2014 and August 2015

Stomach Fullness	No. of samples	(%)
0 (empty)	544	48.0
25	290	25.6
50	190	16.7
75	50	4.4
100	61	5.3
Total	1135	100

Table 2: Stomach contents of *T. fuscatus* var *radula* found in Mangrove Swamp of UNILAG Lagoon Frontbetween September 2014 and August 2015

FOOD ITEMS	NUMERICAL ABUNDANCE		FREQUENCY OF OCCURRENCE		GRAVIMETRIC METHOD		INDEX OF RELATIVE IMPORTANCE	
	NO	%	NO	%	G	%	IRI	%
Plant materials	384	26.0	9	28.1	2.0	29.9	1571	33.3
Diatom	433	29.4	11	34.4	3.4	50.8	2759	58.5
Organic debris	329	22.3	3	9.4	0.6	9.0	294	6.2
Seaweed	121	8.2	1	3.1	0.4	6.0	44	0.9
Bacteria	208	14.1	2	6.25	0.2	3.0	51	1.1
Sand grain	-	-	1	3.1	0.1	1.5	-	
Total	**1475**	**100**			**6.7**	**100**	**4719**	**100**

Sex Ratio

A total of 315 male and 729 female *T. fuscatus* were encountered giving a sex ratio of 1male:2.3females. The Chi square ($\chi 2$) test for the sex ratio gave 164.2 where the tabulated value was 34.6 at 1 *df* and 5% level of significance **(Table 3).**

Table 3: Chi square test on sex ratio of *T. Fuscatus* var *radula* from the Mangrove Swamp of UNILAG Lagoon Front between September 2014 and February 2015

	Observed number	Expected number	Calculated x^2	Tabulated x^2
Male	315	522	164.2	34.6
Female	729	522		

Tab x^2< Cal.x^2. Females are significantly ($p<0.05$) more abundant than males.

Therefore, there is significant difference between the male and female of *Tympanotonus fuscatus* var *radula* from the Mangrove Swamp of Unilag Lagoon front throughout the year.

DISCUSSION

Maximum size of samples (*T. fuscatus)* of 5.3cm total length and 7.4g weight was bigger than those reported for the same species in Cross River by Udo (2013).As opined by Moruf and Lawal-Are (2017a), the maximum size attainable by any shellfish species could be genetic or location specific. Final total length of species is one of the criteria in assessing the exploitation level of that organism in its environment. This implies that the species is still underexploited in the mangrove swamp of Unilag Lagoon front and abundant throughout the year.

In this study, the observed value of the regression coefficient (b=1.19) under the Log Length/Log Weight relationship of *T. fuscatus* less than 3 is an indication of negative allometric growth. This is in agreement with the results from the Bonny Estuary, Niger Delta for the same species by Jamabo *et al.* (2009) who obtained "b" value of 1.41 and concluded that its weight increases faster than the length. According to Frosta *et al*. (2004), the slope value "b" indicates the rate of weight gain relative to growth in length and varies among different populations of the same species or within the same species. Wooton (1992) however opined that b<3 indicates that the fish gets relatively thinner as it grows larger while b>3,it gets plumpier as it grows larger.The correlation coefficient (r=0.91),indicates that there is a high degree of correlation between shell length and shell weight in the sample,its positive value reflects the fact that the slope is positive. Moreover, there is a 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 mean condition factor of 7.7 calculated for this species is similar to that of 10.3 value reported by Moruf and Lawal-Are (2015) but different from the result of Udo (2003) and that of Etim and Taege (1993) who reported lower condition factors. The conceivable reason for this discrepancy in condition factors could be differences in the ecological parameters of the study sites, foraging ability and conservation of stored food energy in the adults.

Analysis of the gut content indicates 48%empty stomachs with remaining paunch containing diatom, seaweed (Sea lettuce), bacteria, vascular plant materials, organic debris and sand grains. This array of food items which indicates deposit feedingis similar to those recorded for *Pachymelaniaaurita* by Uwadiae *et al.* (2009). Diatom ranked high in terms of percentage abundance and occurred in almost all the animals examined. The preponderance of sand grains in the stomach matter of all the specimens examined corroborates the reports of Dillon (2000). Acorrding to Chen *et al*. (2001)and Moruf and Lawal-Are (2017b), animals that consume a variety of prey types, when abundance of preferred prey is decreased increasingly take alternative prey. This might further explains the reason for the presence of sand grain and bacteria in the stomach of the West African Mud Creeper despite its preference for diatom and plant materials.

The sex of the species in this study could not be determined externally and that was done only after dissection. This is in conformity with the findings of Egonmwan (2007) on *Pachymelaniafusca* who reported that the species does not exhibit external sexual dimorphism. Although *Tympanotnus fuscutus*is dioecious, size range does not indicate that there is external sexual dimorphism, therefore, sex is only determined by the appearance and colour of the gonad. Gonads of females were observed to be creamy in colour and yellow in male (Screenivasan, 1997). The population sex ratio was 1:2.3 during the period of observation. This was significantly different under Chi square ($\chi 2$) test at 1 *df* and 5% level of significance revealing females as dominant

sex. It can therefore be concluded that the abundance of *Tympanotonus fuscatus* var *radula* in the mangrove swamps of Unilag Lagoon front lies on its reproductive strategy and its diverse food and feeding habit.

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