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Research Article

STUDY OF BIOMETRIC RELATIONSHIPS OF THE MOLLUSC, *TAGELUS ANGULATUS SOWERBY II,* 1847 (MOLLUSCA; SOLECURTIDAE*)* ON THE WEST AFRICAN COAST IN NIUMI NATIONAL PARK (GAMBIA)

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ABSTRACT
This study examines the biometric aspects of *Tagelus angulatus* ***Sowerby II, 1874*** in Gambia. The main objective of this study was to determine the parameters of the size-weight relationship of this species, establish relationship equations between length/height and length/bulge as well as to determine size distribution. The study of size-weight relationship revealed negative allometric growth (b=2.503). The differences between correlation coefficients of equations between length/height (R^2=0.792) and length/bulge (R^2=0.745) are not significant. The length, height, bulge and individual weight averages are equal to 58.49±5.43, 19.78±7.79, and 13.83±1.35 mm and 11.33±2.71 g respectively. Size distribution is multimodal and the largest mode is 55 mm.

Key Words: *Tagelus angulatus Sowerby,* Niumi National Park, Mbankam Mudflats and Allometric

INTRODUCTION
The family *Solecurtidae Orbigny*, 1846 is divided into two genera: the *Tagelus* genus and the *Solecurtus* genus. There are about 40 species found throughout the world, particularly in tropical regions (Hartmann, 2006).
Tagelus angulatus is the only species of the genus reported on the East Atlantic coast from Mauritania to Angola (Nicklès, 1950; Monteillet & Rosso, 1977; Elouard, 1974; Elouard & Rosso, 1977; Boucet, 1977; Monteillet & Plaziat, 1979; Monteillet & Plaziat, 1980). *Tagelus angulatus* is considered a euryhaline bivalve, withstanding wide variations in salinity and living in sandy bottoms near mouths of rivers. It feeds by filtering particles found in the water column through its incurrent siphon (Zabi & Le Loeuff, 1994).
It is an equivalve shell species; knife-shaped, white, almost rectangular, and 60-70mm wide (Nicklès, 1950). With a fragile shell, it builds tunnels which allow it to move through sediment and to protect itself.
Tagelus angulatus is a very sought-after species for human consumption (Okera, 1976) and for its cultural value. Unlike West Atlantic coast species (Fraser, 1967, Ceuta & Boehs, 2011; Ishiyama & Shiga, 1998; Christo, 2012) data on the life-cycle characteristics of this West African species is rare, if any. This is why we think that it is necessary to provide the scientific community with information on *Tagelus angulatus* size structure for the sustainable management of this important resource for some African communities.
This work studies biometric relationships and size structure of the *Tagelus angulatus* of the Saloum Delta estuarine ecosystem in its Gambian sector (Niumi National Park).

MATERIALS AND METHODS
Sampling site
The sampling was conducted in Mbankam Mudflats, a village in Niumi National Park located in the north-east of Gambia. The park is made up of marine, coastal and terrestrial ecosystems. Situated between 13°30’ and 13°35’ latitude north and 16°29’ and 16°33’ longitude west, Niumi Park is characterized by the presence of diverse ecological environments: a marine environment that extends beyond the 6 m isobaths towards open sea, a mangrove ecosystem with *bolongs,* and a continental environment made up of forests.
Collection of data
Samples were collected in August 2015 as part of the "*Management of West African Marine and Coastal Biodiversity by Strengthening Conservation and Monitoring Initiatives in Marine Protected Areas (MPAs) – BioCos project*". The study was based on 176 individuals of overall length of between 40 and 69 mm. For each individual examined, the length (L), height (H), and bulge (B) were measured to the nearest millimetre with the aid of an electronic caliper, and the overall weight was determined using a 0.1g precision electronic balance. When establishing the size-weight relationship and size distribution, only length was selected for the accuracy of its measure.

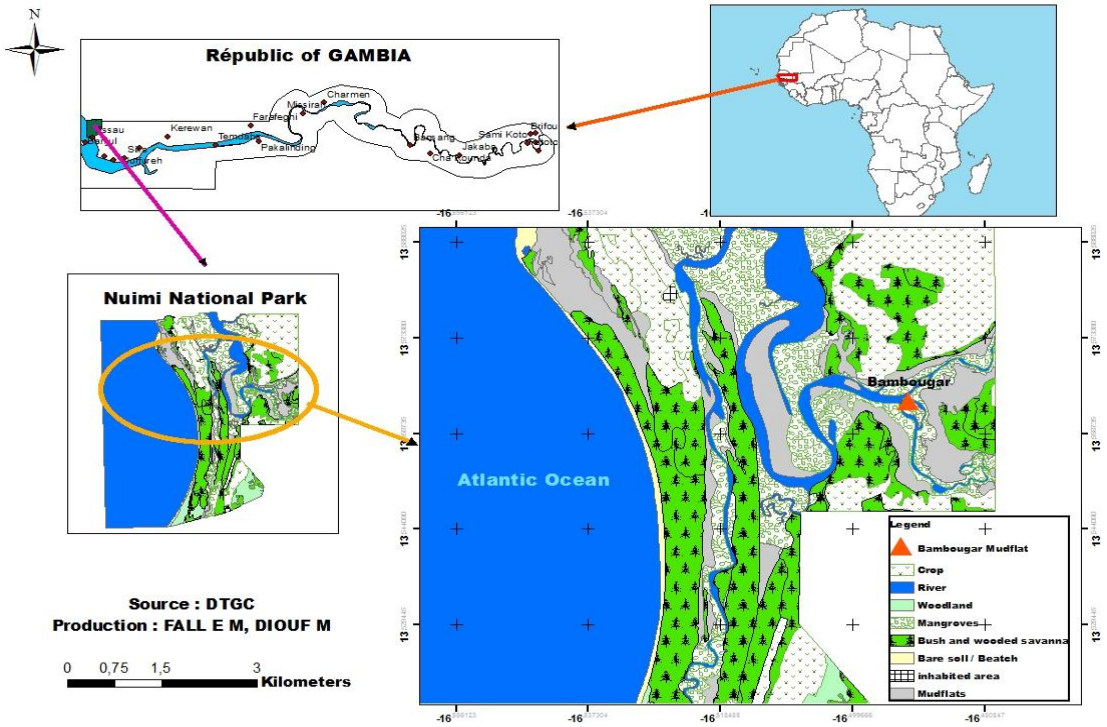

Figure 1: Position of the sampling site

Biometric relationships

The study of biometric relationships calculated concerning the *Tagelus angulatus* species refer to equations between:

Length (L) and height (H);
Length (L) and bulge (B);
Length (L) and weight (W).

Size-weight relationship

Among many fish species, weight (W) is related to size (L) by a non-linear relationship of the type, $\mathbf{W=a*L^b}$. Knowledge of this relationship has applications in fisheries biology and the evaluation of fish stocks (Kochzius, 1997; Ruiz-Ramirez et al., 1997; Le Tourneur et al., 1998). Such a mathematical equation allows the conversion of one parameter to another as it is often required during field measurements. They also help to assess performance. In addition, parameters **a** and **b** of the size-weight relationship generally give information on variations in weight of an individual relative to its size and as such, can be compared between two or several populations living in similar or different ecological conditions.

This size-weight relationship enables the size of a species to be converted into theoretical weight or the reverse. This equation facilitates the estimation of weight during sampling based on length, which is an easier parameter to measure. The size-weight relationship is generally expressed by the equation: $\mathbf{W=a*L^b}$ (**W** is the fresh weight in grams (g), **L** is the length in millimetres, a regression or ordered constant originally and **b** the allometric coefficient). The coefficient **b** is often close to 3. It expresses the relative body shape of the species. When it equals 3, growth is said to be isometric. When it is different to 3, growth is allometric. A coefficient **b** greater than 3 indicates greater growth in weight than in length, and inversely (Ricker, 1980).

This relationship can be linearized by log transformation in order to reduce variability and to make the two variables uniform (**W** and **L**): ln **W** = ln **a** + **b*** ln **L** (Doume Doume et al., 2013).

Relationship between length–height and length-bulge

The relationships that link the length of *Tagelus angulatus* to its height and its bulge are described by the formulae: $H = a_{1*}L + b_1$ and $B = a_{2*}L + b_2$

Size structure

Length frequency distributions, which allow a representation of the demographic structure of the population, have been simplified; for this the individuals were regrouped by size classes of 5 mm intervals. Knowledge of the size

structure of a species is a basic condition for effective and successful management of its fisheries as well as the implementation of collapsed fisheries reconstruction programmes (Begg et al., 1999).

Statistical analysis

Statistics and graphics were done with Excel and R software.

In order to test if values from **b** vary significantly from 3, Student's t-test was applied using the 0.05 threshold.

RESULTS

Size-weight relationship

Knowledge of the size-weight relationship is of paramount importance for estimating biomass and fish species production. The results linking *Tagelus angulatus* weight to length are shown in figure 2 and expressed by the equation: $\mathbf{W} = 0.0005_{*}\mathbf{L}^{2.503}$. The estimated value of allometry (b=2.503) for *Tagelus angulatus* is significantly different from 3 ($p<0.05$), illustrating negative allometric growth for this species.

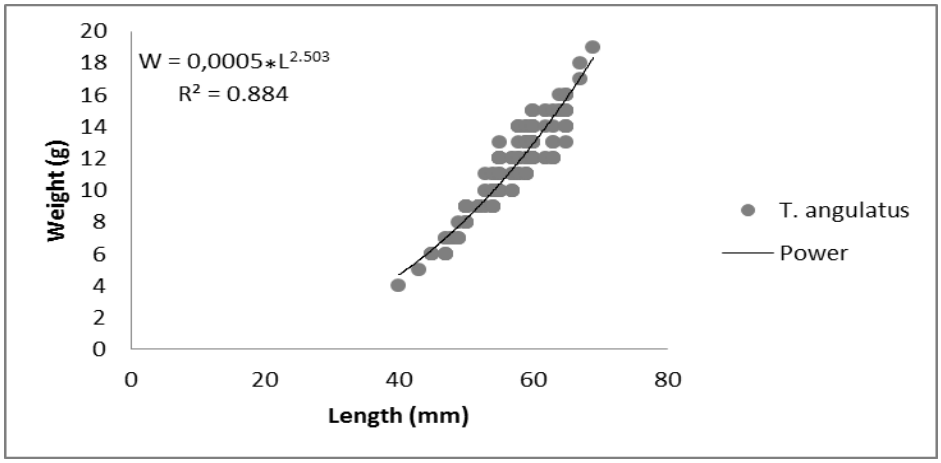

Figure 2: Length-weight relationships for *Tagelus angulatus*

Relationship between length-height and length-bulge

The biometric study on 176 individuals essentially concerned establishing length-height and length-bulge relationships. The graphic adaption of these relationships is respectively plotted in figures 3 and 4. The correlation between height and length is greater than that between bulge and length but does not vary significantly ($p>0.05$).

Table 1: Parameters of length-weight relationship for *Tagelus angulatus*

Variables	Parameters			Equations
Height and Length	a_1=1.293	b_1=3.208	R^2_1=0.792	H = 1.293*L + 3.208
Bulge and Length	a_2=0.215	b_2=1.669	R^2_2=0.745	B = 0.215*L + 1.669

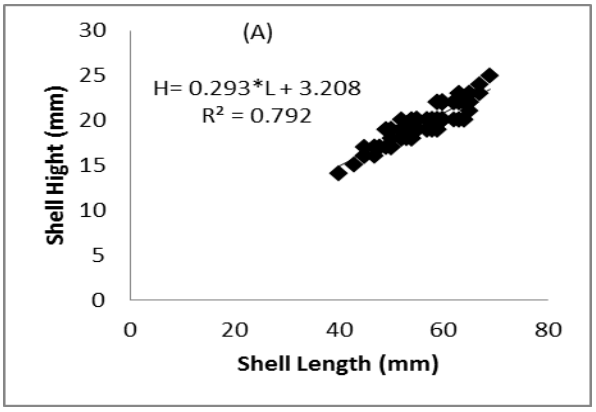

Figure 3: Relationship between length-height (A)

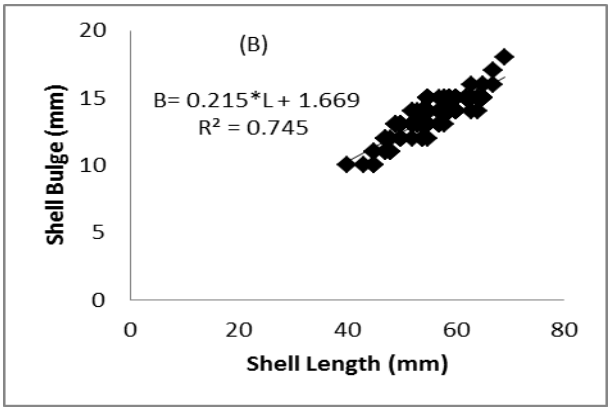

Figure 4: Relationship between length-bulge (B)

Size structure

The average variables measured are equal to 58.49±5.43, 19.78±7.79, 13.83±1.35 mm and 11.33±2.71 g for length, height, bulge and individual weight respectively. The values measured for length are between 40 and 69 mm, 14 and 25 mm, 10 and 18 mm respectively for length, height and bulge. Length was used to establish size structure. Size distribution is multimodal and the largest mode is 55 mm; the mean size of individuals captured is 58.49±5.43 mm (Fig. 5).

Table 2: Minimum, maximum values, mean values and total number of variables measured

Variable	Min	Max	Mean	No.
Length	40	69	58.49±5.43	176
Height	14	25	19.78±7.79	176
Bulge	10	18	13.83±1.35	176
Weight	4	19	11.33±2.75	176

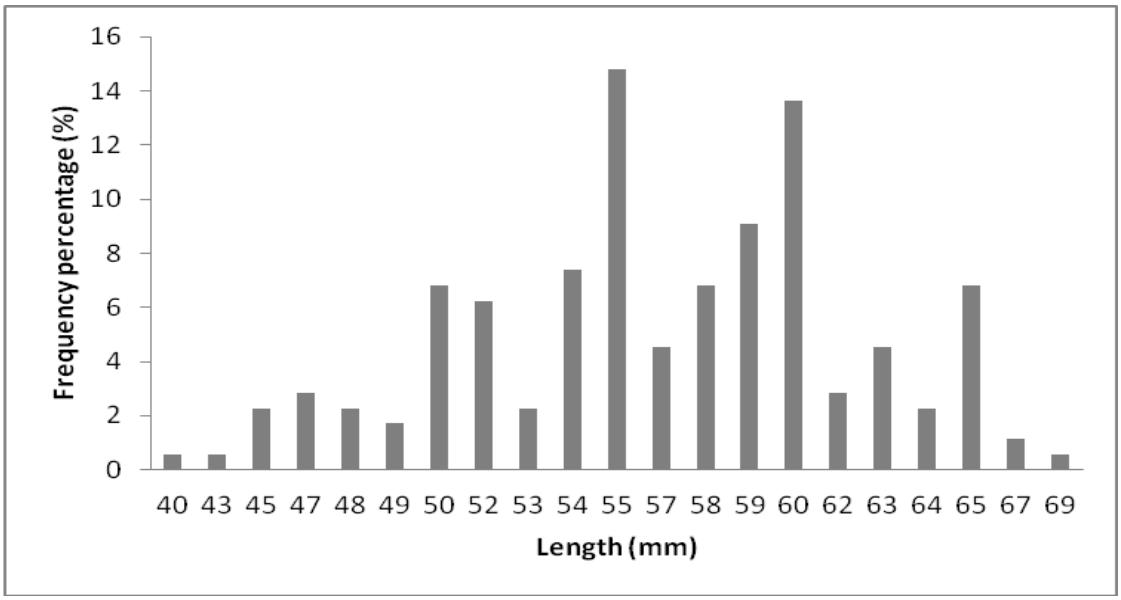

Figure 5: Distribution of size classes for *Tagelus angulatus*

DISCUSSION

Size-weight relationship

The data collected on *Tagelus angulatus* enabled us to produce the size-weight relationship of this species. The results obtained (allometric scaling **b**=2.503) show that allometric growth is negative. This means that *Tagelus angulatus* grows quicker in size (length) than in weight. Abrahão et al., (2010) also found negative allometric growth for *T. plebeius.* The results of Lomovaski et al., (2006) on the size-weight relationship of *T. plebeius* also shows negative allometry. According to Abrahão et al., (2010) the negative allometry detected for *Tagelus* could suggest morphological adaptation found among these burrowing animals in deep waters, which have elongated shells.

Size structure

Size distribution is multimodal and the most marked mode is 55 mm; the average size of individuals captured is 58.49±5.43 mm. The value of the mean size found for *Tagelus angulatus* is of the same order of magnitude as that of *Tagelus plebeius* studied by Lomovasky et al., (2005); Ceuta & Boehs (2012). However, Farias (2008) and Ishiyama and Shiga (1998) found smaller and larger mean lengths respectively for the species *Tagelus plebeius* and *Tagelus dombeii*. These mean size differences (Table 3) might be attributed to different environmental conditions. The differences in size observed might be linked to ecological characteristics particular of the species in each environment or to different hydrological and sedimentological models between the areas (Gaspar et al., 2002). It will be important to make the connection between the nature of substrates, hydrological models and growth to see the best conditions for optimal growth of this species.

Table 3: Minimum, maximum and mean size of *Tagelus angulatus* in different countries

Species	Area	Sex	Variable	Size range	Mean	Authors
T. angulatus	Gambia	Both male and female	Length	40-69	58.49±5.43	Present study
T. plebeius	Brazil	Male	Length	23-53.2	40.3±6.21	Farias (2008)
		Female		22-62.5	40.9±5.72	
T. plebeius	Brazil	Both male and female	Length	36.5-68.3	53.2±6.66	Ceuta & Boehs (2012)
T. dombeii	Peru	Both male and female	Length	41.7-90.4	73.8	Ishiyama and Shiga (1998)
T. plebeius	Argentina	Both male and female	Length	6.57-73.78	60.24	Lomovasky et al (2005)

CONCLUSION

This paper deals for the first time with the study of *Tagelus angulatus* growth aspects in Gambia, through the study of the length-weight relationship, size structure and the relationship between length-height and length-bulge. Thus, for this species whose biology has until now not been studied, knowledge of length-weight relationship parameters is essential in setting up measures for sustainable management of the resource.

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