BODY WEIGHT PREDICTION OF BLACK AND WHITE SKINNED ARCHACHATINA MARGINATA SNAILS FROM QUANTITATIVE TRAITS MEASUREMENTS

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ABSTRACT

A study was conducted to investigate the relationship between body weight and quantitative traits measurements and to predict body weight from quantitative traits in black and white skinned *Archachatina marginata*. A total of five variables which included shell length (SHL), shell width (SHL), shell mouth length (SML), shell mouth width (SMW) and body weight (BDW) were measured from 100 *A. marginata* snails, 50 each of black skinned and white skinned *Archachatina marginata* with weight ranging from 4.24g to 7.93g and from 0.11g to 1.77g for black skinned and white skinned A.marginata respectively selected based on active appearance and no injury on the foot or shell. The data generated from this study were used to evaluate phenotypic correlations, simple and multiple regressions; and means of body weight and quantitative traits were compared using SPSS, 2007.The results obtained from the study showed significant differences ($p<0.001$) in values of quantitative traits measured (SHL, SHW, SML, SMW and BDW) between black skinned and white skinned *A.marginata*. The results of phenotypic correlation among quantitative traits of black skinned and white skinned A.marginata showed positive, strong and very high relationship between body weight and all quantitative traits measured. The highest significant ($p<0.001$) correlation was recorded between body weight and SHL ($r=0.867$) for white skinned *A.marginata*. The prediction equations obtained for body weights of black skinned and white skinned *A.marginata* indicated that each one of the quantitative trait (SHL, SHW, SML, SMW), or combination of two or more traits can predict body weight of black and white skinned A.marginata with very high accuracy. It was concluded that, body weight can be predicted with high accuracy from body measurements to support breeding, selection and other husbandry practices.

Keywords: *Archachatina marginata*, Quantitative traits, Correlations, Predictions.

INTRODUCTION

Nigeria is endowed with large numbers of micro-livestock which are yet to be fully investigated for meat production; snails are the largest in number. Snails are one of the commonest sources of animal protein in southern Nigeria where the ecology favours their continued existence. The meat is high in protein (12-16%) and irons (45-50mg/kg), low in fat (0.05-0.08%) and contains all the amino acids needed for human nutrition (NAERLS, 1995). Snails are normally picked in the wild by children and women for supplementary income and food for the family. But this culture has considerably declined because of human activities such as deforestation, pesticide use, agriculture, bush fires and collection before they reached maturity (Akinnusi, 2004). These have led to snail farming in recent years (NAERLS 1995). The advantages of snail farming over the conventional domesticated animal species are numerous as documented by Akinnusi 2004, Ejidike 2002, Cobbinah, 1993, Ajaji. 1998 and Awesu, 1980.

Archachatina marginata is one of the species of African land snails known as Giant African land snails (Okon and Ibom 2012; Okon *et al.*, 2008; Akinnusi, 2004). It could be black or white skinned (Okon and Ibom, 2012; Ibom, 2009; Okon *et al*., 2008; Ejidike, 2002). The black skinned *A. marginata* snail is popular and appreciated as a valuable source of animal protein in Nigeria and beyond. It constitutes an important component of the food for numerous rural dwellers, especially in the rainforest zones (Akinnusi, 2004). Although the white skinned *A.marginata* snail has the same nutritional attributes as the black skinned one, they are being discriminated against by some people because of taboos and superstitious beliefs in some communities, others associate them with certain gods or deities; hence its domestication has been discouraged by some snail farmers (Okon and Ibom, 2012).

To ensure the sustainability of these two strains (the black and white skinned *A. marginata* snail), there is need to improve on their productive capabilities. Genetic improvements of animal species can be achieved by quantitative measurement, correlation among performance traits and development of selection programmes for effective planning (Okon and Ibom 2011; Fajemilehim *et al.*, 2003). Body weight is an important measure of size which is use both by sellers and buyers (Fitzhurgh, 1976). It has been reported that snail body weight can be predicted using quantitative traits; these traits include shell length, shell width, shell mouth length, and shell mouth width (Okon *et al*., 2012). Correlation and regression are the two most common techniques used to determine the relationship between two or more variables. Okon and Ibom (2011) using multiple regression equations observed that shell length and shell width are better predictors of hatchling body weights of *A. achatina* than *A. marginata* juvenile snails. These same authors obtained high, positive significant correlation values between body weights and these quantitative traits in both *A. marginata* and *A. achatina* snails.

A lot of works have been reported on black skinned *A.marginata* snail, but not much is documented on white skinned *A. marginata*. Therefore this study was design to evaluate and compare quantitative traits of black and white skinned *A.marginata*, obtain correlation coefficients among quantitative traits and to develop regression equation models for estimating the body weight of black and white skinned *A.marginata* snail using quantitative traits.

Materials and Methods

Study area

The research was carried out in Animal Science Laboratory of University of Calabar, Cross River State, Nigeria. Calabar is situated within the geographical area between latitude $4^{o}58^{o}$N and longitudes $8^{o}17^{o}$E of the equator with annual temperature and rainfall ranges of 25^{o}C to 30^{o}C and 1260mm – 1280mm respective (Okon *et al*., 2009). The relative humidity of Calabar is 51% - 98% (Ojanuga, 2006).

COLLECTION OF SAMPLE

A total of one hundred (100) adult snails, fifty (50) each of black skinned *A. marginata* and white skinned *A. marginata* were used for the study. The snails were purchased from local markets in Delta and Cross River States of Nigeria. The snails were randomly selected on the basis of their skin pigmentation, active appearance and no injury on the foot or shell of the base population. All snails selected had weight ranging from 4.24g – 7.93g and from 0.41g to 1.77 g for black skinned *A. marginata* and white skinned *A.marginata* respectively.

Data collected on quantitative traits from both black and white skinned *A.marginata* were shell length (SHL), shell width (SHW), shell mouth length (SML), Shell mouth width (SMW) body weight (BDW),

An electronic balance, ScoutTM pro-scale with 0.01 g to 1000 g sensitivity was used to measure weight, while Vernier Caliper was used to measure lengths and widths. The data were analyzed using SPSS (2007) for simple statistics, phenotypic correlation, simple and multiple regression functions for predicting body weights from quantitative traits.

RESULTS AND DISCUSSION

The summary statistics are shown in table1. The results were expressed as means, standard deviation, standard error and coefficient of variation for each quantitative trait measurement. The result indicated that black skinned *A.marginata* had significant higher values for measured quantitative traits than white skinned *A.marginata*. There were statistical differences ($p<0.001$) as shown in table 2 in body weight and all other quantitative traits measured (SHL, SHW, SML, SMW) between black and white skinned *A.marginata*, the black skinned *A.marginata* recorded 5.915g while the white skinned recorded 0.806g in body weight, these differences could be attributed to the sizes of the two types of *A. marginata* that were available for the study.

Table 1: Summary statistics of quantitative traits of black and white skinned *A.marginata*

Variables	no	means±SD	S.E	C V	means±SD	S.E	CV
SHL (mm)	50	9.748±1.457	0.206	14.94	4.304 ±0.755	0.106	17.54
SHW (mm)	50	4.538±0.434	0.614	9.563	1.632±0.374	0.529	22.91
SML (mm)	50	4.740±0.504	0.713	10.63	1.762±0.325	0.460	18.44
SMW(mm)	50	1.794±0.347	0.491	19.32	0.319±0.329	0.465	10.31
BDW (g)	50	5.915±0.921	0.130	15.57	0.806±0.300	0.425	37.22

SHL=shell length, SHW=shell width, SML= shell mouth length, SMW=shell mouth width, BDW= body
Weight, S.E= standard error, SD= standard deviation, CV= coefficient of variation

Table 2: Paired sample test of quantitative traits between black and white skinned *A.marginata*

Paired Quantitative trait	t- value	LOS
BS-SHL/WS-SHL	21.855	***
BS-SHW/WS-SHW	33.654	***
BS-SML/WS-SML	37.006	***
BS-SMW/WS-SMW	21.698	***
BS-BDW/WS-BDW	36.230	***

BS-SHL= Black skinned shell length, WS SHL= white skinned shell length, BS-SHW= black skinned shell width, WS-SHW= white skinned shell width, BS-SML= black skinned shell mouth length, WS-SML= white skinned shell, mouth width, BS-SMW = black skinned shell mouth width, WS-SMW= white skinned shell mouth width, BS-BDW= black skinned body weight, WS-BDW= white skinned body weight, ***= Highly significant ($p<0.001$)

Correlation between body weight and quantitative traits measurements

The correlation coefficient between body weight and other quantitative traits measurements for white and black skinned *A.marginata* are presented in table 3. The results indicated that body weight correlated significantly ($p<0.001$) with all the quantitative traits measurements in both black skinned and white skinned *A.marginata*. Shell width (SHW) showed the highest correlation with body weight (r=0.711 and 0.827 for black skinned and white skinned *A.Marginata* respectively). This indicates that increase in SHW will lead to increase in body weight. The present study is in agreement with the work of Okon and Ibom (2012), Okon *et al.,* 2011, Okon *et al*., (2010) and Ibom (2009). Ibom, 2009, indicated that this pair of quantitative traits have direct relationship, and are controlled by the same gene in the same direction, thus selection for one trait will lead to improvement of the other. Okon *et al*., (2011) indicated that traits which have high correlation with body weight can be used in predicting body weight in snail. However, the higher significant correlation coefficient between body weight and quantitative traits measurement in both black and white skinned *A.marginata* suggest that a combination of quantitative traits or SHW alone would serve as good predictor of body weight in both white skinned and black skinned *A.marginata*. The higher correlation between body weight and quantitative traits measurements for white skinned *A.marginata* suggest that body weight could be predicted more accurately in white skinned *A.marginata* as compared to black skinned *A.Marginata*.

Table 3: Phenotypic correlation amongst quantitative traits in white and black *A.marginata*

		White skinned *A.marginata*			
	BDW	SHL	SHW	SML	SMW
BDW	1	0.867	0.827	0.777	0.511
SHL	0.382	1	0.903	0.920	0.605
SHW	0.711	0.373	1	0.894	0.600
SML	0.573	0.312	0.373	1	0.624
SMW	0.618	0.483	0.647	0.611	1
		Black skinned *A.marginata*			

BDW= body weight, SHL= shell length, SHW= shell width, SML= shell mouth length, SMW = shell mouth width,

This report is in line with the work of Okon *et al*., 2012, Okon *et al*., 2011 and Ibom, 2009. The results indicates that the pairs of quantitative traits used have direct relationship or are controlled by the same gene in the same direction, thus selection for one trait will lead to improvement of the others as earlier noted by Ibom, 2009. It has been reported by Okon *et al.,* (2011) that high correlated responses of quantitative traits can be used for selection, cross breeding and prediction of body weight in growing snails.

Prediction of Body Weight from Body Measurements

The prediction equations to estimate body weight from quantitative traits measurement for black and white skinned *A.marginata* are presented in table 4. The variation in body weight was explained to a large extent by SHW (which had the highest R^2 in both the black skinned and white skinned *A.marginata*) although all regression coefficient (R^2) for other quantitative trait measured were found to be significant ($p<0.001$) with moderate to high R^2 values (R^2= 0.382-0.711 for black skinned *A.marginata* and R^2 =0.511-0.867 for white skinned *A.marginata*). The results of this study confirmed that body weight of *A.marginata* snail can

be predicted with confidence from most of the quantitative traits measurements. The value of R^2 increased as more independent variables were added to the regression equation showing that estimating bodyweight using a single body measurement is not the only suitable criterion for predicting body weight. Topal *et al*., (2003) noted that anyone of R^2 or MSE may be confidently applied to investigate the fitting state of simple and multiple regression models to actual data for estimation of body weight in livestock. The higher and significant ($p<0.001$) R^2 value and smaller MSE obtained in the study using single or multiple predictor variable indicated that all quantitative traits used (SHL,SHW, SML, and SMW) as independent variables were good estimators of body weights in black and white skinned *A.marginata*. However, it is necessary to consider the economic feasibility and technical ability to use the model in adopting the multiple regression models developed.

Table 4: Body weight prediction equations for black and white skinned *A.marginata*

Am - Skin type	Prediction equations	R^2	SEE	MSE
Black skinned Am	Y=3.565+0.241 (SHL)	0.382	0.86	0.740
	Y=0.924+1.507 (SHW)	0.711	0.654	0.429
	Y=0.963+1.045(SML)	0.573	0.762	0.582
	Y=2.980+1.636(SMW)	0.618	0.731	0.535
	Y=-1.272+0.086(SHL)+1.40(SHW)	0.722	0.651	0.424
	Y=-1.691+0.076(SHL)+1.162(SHW)+0.337(SML)	0.735	0.644	0.415
	Y=-1.110+0.043(SHL)+1.008(SHW)+0.226(SML)+0.533(SMW)	0.748	0.638	0.407
White skinned Am	Y=-0.681+0.345(SHL)	0.827	0.151	0.023
	Y=-0.278+0.664(SHW)	0.867	0.170	0.29
	Y=-0.459+0.718(SML)	0.777	0.191	0.37
	Y=0.657+0.466(SMW)	0.511	0.201	0.068
	Y=--0.625+0.261(SHL)+0.189(SHW)	0.873	0.149	0.022
	Y=-0.589+0.326(SHL)+0.263(SHW0-0.248(SML)	0.879	0.148	0.022
	Y=-0.606+0.327(SHL)+0.266(SHW)-0.240(SML)-.021(SMW)	0.879	0.149	0.022

R = coefficient of determination, SEE= standard error of estimation, MSE= residual mean square, SHL= shell length, SHW= shell width, SML= shell mouth length, SMW = shell mouth width, Y = body weight

Table 5: Comparison between measured and calculated body weight values for black skinned A.marginata And White skinned A.marginata

		Corresponding results based on regression equations for body weights (g)							
	Actual body weight(g)	SHL	SHW	SML	SMW	SHL+SHW	SHL+SHW+SML	SHL+SHW+SML+SMW
Black skinned A.marginata	5.915	5.914	5.914	5.916	5.914	5.919	5.920	5.910
White skinned A.marginata	0.806	0.805	0.806	0.806	0.806	0.806	0.807	0.806

The comparison of the actual body weight and predicted body weight from linear regression equations are demonstrated in table 5. The actual and computed body weights were more or less similar which confirms the fact that body weight can be predicted from quantitative traits measurements with accuracy. The present study is in agreement with Okon *et al*., 2010 and Okon *et al*, 2011. The same authors indicated that there were no significant differences between actual body weight and body weight predicted with equations.

CONCLUSION

The results of this study revealed that there are significant differences in body weight of black skinned *A.marginata* and white skinned *A.marginata*. The black skinned *A.marginata* were heavier than the white skinned *A.marginata* from the study area. Phenotypic correlation among the quantitative traits in white skinned *A.marginata* showed significantly positive and stronger relationship between body weight and all other quantitative traits studied compared to the correlation among body weight and quantitative traits in black skinned *A.marginata*.
Prediction of body weight using simple and multiple regression analysis was accurately predicted using each quantitative trait, or combination of two or more traits. This suggest that bodyweight can be predicted from quantitative traits measurements with high accuracy to support improvement and husbandry practices of black and white skinned *A. marginata*.
The production, processing and consumption of both black and white skinned *A. marginata* should be encouraged in Nigeria.

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