



Morphological Characterization of *Archachatina marginata* and *Achatina fulica*: Implications for Snail Farming in Nigeria

Etukudo, Owoidihe Monday

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Abstract

For this study, 400 mature black-skinned snails with five whorls were purchased from Offiong Market in Essien Udim Local Government Area, Akwa Ibom State, Nigeria. Of these, 200 were each of the species *A. marginata* and *A. fulica*. The presence of five (5) whorls for each species was used to identify and select these snails into the *A. marginata* and *A. fulica* species, respectively. The study's findings for the morphological characteristics (body weight, body shell length, body shell width, mouth shell length and mouth shell width) of these two snail species showed that, for a given number of whorls, *A. marginata*'s attributes were all larger and significantly higher ($P < 0.001$) than those of *A. fulica*. With the exception of *A. fulica* species, which had positive, weak, and low morphometric correlation coefficients between mouth shell width and body weight, mouth shell width and body shell length, and mouth shell width and body shell width, respectively, all other components were positively, strongly and significantly ($P < 0.001$) correlated for the both snails. However, for the same *A. fulica* species of snails, the only positive, weak, and non-significant ($P > 0.05$) morphometric correlation coefficient between mouth shell length and mouth shell width was found to be $r = 0.140$. Morphometric trait disparities are highly influenced by species type, snail age and size variations, number of whorls, and body weight ranges have high effects on morphometric trait disparities and morphometric correlation coefficient of estimation. Thus, the morphometric traits of *A. marginata* and *A. fulica* species of snails studied could be selected for quantitative differentiation and characterization snails for farming, domestication and breeding purposes. For farming purpose, *A. marginata* snails are highly recommended due to their heavy and larger morphological characteristics recorded from them in this study.

✉ Etukudo, Owoidihe Monday: owoism1981@gmail.com

Department of Biological Sciences, Faculty of Computing and Applied Sciences, Topfaith University, Mkpatak, Akwa Ibom State, Nigeria.

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1.0 Introduction

Snail farming, management and production are profitable endeavors, if breeding stocks of snails with reproductive efficacies are employed and managed effectively either intensively or extensively. Large populations of several snail breeds, including *Archachatina marginata*, *Achatina achatina*, and *Achatina fulica*, have been discovered throughout Nigeria. In order to properly capture the information and results for future use, consumers, farmers, producers, merchants, and researchers have recently focused on the management and production of these massive species of snails (Okon and Ibom, 2012; Etukudo *et al.*, 2024 a, b). The huge African snail, or *A. marginata*, is indigenous to West Africa, extending from Cameroon to the Democratic Republic of the Congo (Cowie, *et al.*, 2009). Conversely, *A. fulica* is indigenous to East Africa, particularly Kenya and Tanzania, but has been steadily brought to other regions as a food source and through the pet traders (Rowson *et al.*, 2010).

The *A. marginata* (Fig. 1), has the potential to grow up to 120mm in length and 130mm in diameter with 6-7 whorls, with brownish yellow shell coloration and uniformly arranged bands and zig-zag lines or spots that are dark-brown or reddish brown in color. The columella, outer lip and inside the aperture (mouth) are white or pale blue. The apex of the shell is likely flattened, bulbous and pale or pinkish. The body color of the animal is variable (albino or tan to ash to grey) (Abbot, 1989; Barkar, 2002; Cowie *et al.*, 2009; Okon and Ibom, 2012; Etukudo *et al.*, 2024b). *A. marginata* snails can lay up to 32 eggs as clutch size when fully mature unlike *A. fulica*. The *A. fulica* species (Fig. 2), is the smallest among the African land snails, with lengthy, enlarged body whorls (Jummai and Okoli, 2013; Okon *et al.*, 2017; Etukudo *et al.*, 2024b). When completely grown, *A. fulica* has seven to nine whorls in its narrow, conical shell,

which is roughly twice as wide as it is, according to Okon *et al.* (2017). The shell's color varies according to the environmental conditions and dietary intake, and it is reddish brown with yellow and vertical markings. When *A. fulica* reaches the adult stage of development, its shell can be at least 20 cm long and 7 cm wide. For *A. fulica* to hatch, the ideal temperature is 15 °C, and the huge egg production varies from 4.5 cm to 5.5 cm in diameter (Okon *et al.*, 2017; Etukudo *et al.*, 2017, 2024b).

It is well recognized that snails might provide people with a sustainable food source. Payne and Wilson, (1999) and Etta *et al.* (2016), claimed that the foot, or roughly 38% of the snail's total weight, is edible. With a protein concentration of 37.51%, iron content of 45–59 mg/kg, and fat content of 0.05–0.08%, the foot's meat is extremely nutrient-dense and therefore the perfect choice for hypertension individuals (Owolabi, 2013). Additionally, it has been documented that snails can help treat conditions including rheumatism, whooping cough, anemia, ulcers, asthma, and aging issues (Abera and Lameed, 2008). In order to establish accurate genetic parameters for a certain feature and subsequently incorporate it into breeding programs, it is preferable to have a qualitative assessment of the animals' conformation (Okon and Ibom, 2011). According to Ibom, (2009); Banjoko *et al.* (2012) and Etukudo *et al.* (2024b), the quantitative characteristics that are primarily utilized to gauge snail growth and growth rates are body weight and body parameters such shell length, width, thickness, and mouth length and width. In the marketing and breeding of the highest-grade snail stocks, the quantity of whorls is also frequently counted as a crucial component. Given Nigeria's high demand for animal protein, Ibom, (2009); Okon and Ibom, (2011); Etukudo *et al.* (2017) and Etukudo *et al.* (2024a), also believed that estimating the genetic correlations between

performance traits in the breeding goal and selection strategies, programs, and development for efficient planning could lead to the genetic improvement of any species of snail.

Interestingly, snail species have been identified and characterized based on shell morphology, anatomy of genitalia, and mantle color, criteria are applied continuously to describe new species (Okon *et al.*, 2012; Etukudo *et al.*, 2018a). However, species of land snails with similar morphology have ambiguous identities, especially juvenile snails, due to the great level of morphological variation observed in some snail species (Etukudo *et al.*, 2024f).

Morphometric or phenotypic characters or traits that has been used for characterization of snails includes; body weight, body shell length, body shell length, mouth shell length, mouth shell width and number of whorls, all these characters are controlled by gene(s) (Ibom, 2009; Okon and Ibom, 2012; Etukudo, 2017; Etukudo *et al.*, 2024h). Morphometric characterization of giant African land snails plays an essential role in understanding their ecological, evolution, systematics, and potential for conservation. This study, therefore aims to provide information on morphological characteristics of *Archachatina marginata* and *Achatina fulica* snails in Nigeria.



Figure 1: *A. marginata* species



Figure 2: *A. fulica* species

2.0 Materials and Methods

2.1 Study area

The study was conducted at the Biological Laboratory, Topfaith University, Mkpatak, Akwa Ibom State, Nigeria.

2.2 Experimental animals

Four hundred (400) adult black-skinned snails, consisting of two hundred (200) each of *A. marginata* and *A. fulica* were procured from Offiong Market in Essien Udim Local Government Area, Akwa Ibom State, Nigeria. For identification and selection of these snails into *A. marginata* species and *A. fulica* species, profile and template of Nisbert, (1974); and Okon and Ibom, (2012), were adopted. The selection was also based on the presence of five (5) whorls for both species respectively.

2.3 Data collection

The Morphological characteristics measured from the two species of snails were body weight (BDW), body shell length (BSL), body shell width (BSW), mouth shell length (MSL), and mouth shell width (MSW). The body weights were measured in grams (g) using a digital electronic scale (Model – M411L M-metlar. England), while the other phenotypic traits parameters were measured in centimeters (cm) using a Venier caliper.

2.4 Statistical analysis

Data obtained were subjected to analysis using Genstat, (2011) software package for mean and standard error, t-test and phenotypic correlations between body weights and other phenotypic traits were also analyzed.

3.0 Results and Discussion

The results of the morphological traits measured between *A. marginata* and *A. fulica* snails were presented as Mean \pm standard error of mean and t-values for each morphological measurement (Table 1). *Archachatina marginata* snails recorded the highest values for all the morphological traits measured unlike *Achatina fulica* snails. The two species of snails shown great disparities that led to significant differences ($P < 0.001$) between the mean body weights of 124.14 g for *A. marginata* and 61.20 g for *A. fulica* respectively (Table 1). Similarly, all other morphological traits measured for *A. marginata* snails were higher than *A. fulica* snails. The results shown that *A. marginata* snails are bigger, and heavier than *A. fulica* species of snails, this was further confirmed by the test of significance of the difference (t-test) that was recorded between the two species of the snails (Table 1). The results obtained in this study are in line with the results obtained by Etta *et al.* (2016) and Etukudo *et al.* (2024b, h), that the *A. marginata* snails are always larger and heavier than the smallest *A. fulica* snails.

Table 1: Mean \pm SE of Morphological traits between *A. marginata* and *A. fulica* snails based on 5 whorls.

Morphological Traits	A. m \pm SE	A. f \pm SE	t-values	Significant level
BDW (g)	124.14 \pm 2.091	61.20 \pm 3.24	9.83	P < 0.001
BSL (cm)	10.31 \pm 0.013	7.00 \pm 0.37	4.89	P < 0.001
BSW (cm)	6.42 \pm 0.041	4.56 \pm 0.78	4.06	P < 0.001
MSL (cm)	6.04 \pm 0.039	3.16 \pm 0.81	2.98	P < 0.001
MSW (cm)	4.10 \pm 0.043	2.12 \pm 0.63	1.87	P < 0.001

A. m = *Achatina marginata*, A. f = *Achatina fulica*, BDW = Body weight, BSL = Body shell length, BSW = body shell width, MSL = Mouth shell length, MSW = Mouth shell width, P < 0.001 = Highly significant.

On the other hand, the mean body weights of 124.14 g and 61.20 g obtained in this study for *A. marginata* and *A. fulica* respectively, were lower than the values of 135.250 g and 137.50 g

for *A. achatina* and *A. fulica* with the same number of whorls (5) by Etta *et al.* (2016) but the results were in tandem with values of 124.41 g and 61.20 g obtained for *A. marginata* and *A.*

fulica respectively, with the same number of whorls by Etukudo *et al.* (2024 b, h). The variations in body weights here may be attributed to the type of feed, age, and size of the snail species.

There was a large variation among other morphological traits measured in this study which were highly significantly ($P < 0.001$) different between the mean shell parameters of the two species of snails (Table 1). The results obtained in this study for body shell widths, mouth shell lengths, and mouth shell width were higher than the values 5.29 cm, 5.368 cm, and 3.184 cm obtained for *A. marginata* species, but lower than the values 5.087 cm, 5.291 cm and 2.99 cm respectively, for *A. fulica* species of snails by Etta *et al.* (2016). Only the body shell length obtained in this study for *A. marginata* species of snails recorded lower value than 10.55 cm obtained by the same author. The variations in body shell parameters recorded in this study with of Etta *et al.* (2016), may be due to the nature of the feed they fed the snails with before

the commencement of the study, and also the age and size of the snails used. On the other hand, the results obtained in this study for shell parameters were in tandem with the values of 10.310 cm, 6.419 cm, 6.041 cm, 4.104 cm for bod shell length, body shell width, mouth shell length, and mouth shell width respectively for *A. marginata* species of snails with 5 whorls as reported by Etukudo *et al.* (2024h).

The results obtained for morphological correlations among morphometric traits in this study for the two species of snails with 5 whorls (Table 2) indicated positive, strong, high and highly significant ($P > 0.001$) correlation coefficient (r_p) between body weights and most of the body shell parameters studied for *A. marginata* and *A. fulica* species of snails with 5 whorls. On the other hand, only mouth shell width and other body shell parameters were indicated positive, weak, low significant ($P < 0.05$) and non-significant ($P > 0.05$) correlation coefficients for *A. fulica* snails (Table 2).

Table 2: Morphological Correlation (r_p) of body traits of *A. marginata* and *A. fulica* snails based on 5 whorls.

	BDW	BSL	BSW	MSL	MSW
BDW	1.000	0.897**	0.768**	0.720**	0.467**
BSL	0.728**	1.000	0.654**	0.786**	0.673**
BSW	0.651**	0.642**	1.000	0.728**	0.740**
MSL	0.573**	0.620**	0.571**	1.000	0.724**
MSW	0.392*	0.281*	0.361*	0.140 ^{NS}	1.000

NS = $P > 0.05$ (Non-Significant Level), * = $P < 0.05$ (Low Significant Level), ** = $P < 0.001$ (Highly Significant Level).

The strong, positive and highly significant ($P < 0.001$) correlation coefficients (r_p) were recorded between body shell length (BSL) and body weight (BDW), with $r = 0.897$; body shell width (BSW) and body weight (BDW), with $r = 0.768$; body shell width (BSW) and body shell length (BSL), with $r = 0.654$; mouth shell length (MSL) and body weight (BDW), with $r = 0.720$; mouth shell length (MSL) and body shell length (BSL), with $r = 0.786$; mouth shell length (MSL)

and body shell width (BSW), with $r = 0.728$; mouth shell width (MSW) and body weight (BDW), with $r = 0.467$; mouth shell width (MSW) and body shell length (BSL), with $r = 0.673$; mouth shell width (MSW) and body shell width (BSW), with $r = 0.740$; mouth shell width (MSW) and mouth shell length (MSL), with $r = 0.724$ respectively for *A. marginata* snails (Table 2). Similarly, strong, positive and highly significant ($P < 0.001$) correlation coefficients

(r_p) were also recorded between body weight (BDW) and body shell length (BSL), with $r = 0.728$; body weight (BDW) and body shell width (BSW), with $r = 0.651$; body weight (BDW) and mouth shell length (MSL), with $r = 0.573$; body shell length (BSL) and body shell width (BSW), with $r = 0.642$; body shell length (BSL) and mouth shell length (MSL), with $r = 0.620$; body shell width (BSW) and mouth shell length (MSL), with $r = 0.571$ for *A. fulica* snail (Table 2). More so, there was a weak and lower significant ($P < 0.05$) correlation coefficient (r_p) recorded between body weight (BDW) and mouth shell width (MSW), with $r = 0.392$; body shell length (BSL) and mouth shell width (MSW), with $r = 0.281$; and body shell width (BSW) and mouth shell width (MSW), with $r = 0.361$ for *A. fulica* snails (Table 2). Non-significant ($P > 0.05$) correlation coefficient (r_p) was recorded only between mouth shell length (MSL) and mouth shell width (MSW), with $r = 0.140$ for the same *A. fulica* snails (Table 2).

The positive correlations between pairs of morphometric traits obtained in this study were in agreement with the report of Ibom, (2009); Okon and Ibom, (2011); Okon, *et al.* (2011) and Etukudo *et al.* (2024h). This signifies that the pairs of morphometric traits used have a direct relationship or at least they are controlled by the same gene in the same direction, thus selection for one trait will lead to improvement of the others. The results obtained in this study also agreed with that of Ehiobu and Kyado, (2000); Ibom, (2009); Okon, *et al.* (2011) and Etukudo *et al.* (2024b, h), with the view that correlations between morphometric traits could be high or low, positive or negative. On the other hand, this results of low, non-significant phenotypic correlations between mouth shell length and mouth shell width obtained in this study for *A. fulica* snails were not in agreement with Okon and Ibom, (2011), Okon, *et al.* (2010a, b), earlier observation of high correlated responses of morphometric traits for selection and cross breeding for genetic improvement. The

disparities in correlation coefficients obtained in this study could be due to species effect, age and size variations of the snails used, body weight ranges. The species type and the number of whorls used have high effects on the morphometric correlation coefficient (r_p) estimates as reported by Okon *et al.* (2011) and Etukudo *et al.* (2024b, h).

4.0 Conclusion

All morphometric features examined in this study showed higher values for the *A. marginata* species than for the *A. fulica* species. Significant differences ($P < 0.001$) were found between body weight and all other morphometric features, indicating high variability for the morphometric traits examined in this study. The test of significance of the difference (t-test) further supported the genetic findings that the *A. marginata* species was larger and heavier than its *A. fulica* counterpart with the same number of whorls. The study found that there were positive, strong morphometric correlations between the phenotypic traits of the two snail species. The correlation coefficient (r_p) between body weight and some of the body shell parameters under investigation was high significant ($P < 0.001$), low significant ($P < 0.05$), and non-significant ($P > 0.05$). These demonstrated that the differentiation of morphometric features and the correlation coefficient of estimation are strongly and significantly impacted by the species type, age, and size variations of the snails utilized, as well as the number of whorls and body weight ranges. As a result, the two snail species under study's morphometric characteristics might be chosen for quantitative distinction and characterization of snails for farming, domestication, and breeding. For farming purpose, *A. marginata* snails are highly recommended due to their heavy and larger morphological characteristics recorded from them in this study.

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