Journal of Agricultural Science; Vol. 4, No. 10; 2012
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

# Comparative Differentiation of Morphometric Traits and Body Weight Prediction of Giant African Land Snails with Four Whorls in Niger Delta Region of Nigeria

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Received: May 21, 2012 Accepted: June 13, 2012 Online Published: August 31, 2012

doi:10.5539/jas.v4n10p205 URL: http://dx.doi.org/10.5539/jas.v4n10p205

**Abstract**

Four hundred (400) adult black-skinned snails, two hundred (200) each of *Archachatina marginata* and *Achatina fulica* with weight ranging from 50.42 g to 198.84 g and from 100.10 g to 184.00 g for *A. marginata* and *A. fulica* respectively selected based on active appearance, number of whorls and no injury on the foot and/or shell of a base population from a population gathered in the wild within the Niger Delta region were used for the study. Data collected on the selected snails were used to evaluate phenotypic correlations and multiple regression functions which were used for predicting body weights from quantitative traits. Results obtained from the study showed that *A. fulica* snails with 4 whorls are genetically heavier than *A. marginata* snails with 4 whorls. This is because there was large and significantly different ($P<0.001$) disparity in values of measured quantitative traits (mean body weights) among the two breeds. The results of phenotypic correlations among quantitative traits of the two breeds indicated positive, strong and very high significant ($P<0.001$) correlation coefficients ($r_p$) between body weight and all body components studied. Whereas for *A. fulica* snails, there were positive but lower significant ($P<0.05$) phenotypic correlation coefficients ($r_p$) between body weight and some body components studied. In fact, there were no significant ($P>0.05$) phenotypic correlation coefficients ($r_p$) between shell length and shell 'mouth' width ($r = 0.250$) and between shell 'mouth' length and shell 'mouth' width ($r = 0.187$) for *A. fulica* snails. The prediction equations evolved for body weights of growing snails with 4 whorls using quantitative traits from *A. marginata* and *A. fulica* indicated that these quantitative traits, namely; shell length, shell width, shell 'mouth' length and shell 'mouth' width best predicted body weight for *A. marginata* and *A. fulica* snails with 4 whorls. The quantitative or phenotypic traits of the two breeds of snail studied could be chosen to differentiate as well as characterize growing snails in the Niger Delta region of Nigeria.

**Keyword:** morphometric traits, prediction, whorls, Niger Delta, Nigeria

## 1. Introduction

Within the family *Achatinidae*, four species are classified as giant African land snails: *Achatina achatina*, *Achatina fulica*, *Archachatina marginata*, *Limicolaria aurora* (Smith & Fowler, 2003). Of these species, Smith and Fowler (2003) pointed out that only *Achatina fulica* (plate 1) and *Archachatina marginata* (plate 2) are "truly giant African land snails, as the largest specimens recorded by [PPQ] have been in the range of 750 g and 8″ (20.32 cm) shell length".

The giant African land snail has emerged as a notable experimental model for several fundamental and applied biological descriptions in the last few decades. Besides, snail production holds lots of potentials in the Nigerian livestock industry and can serve as a means to alleviate the acute protein shortage. This owes to the fact that snails have high rate of productivity and fecundity (Ibom et al., 2008; Okon & Ibom, 2010; Okon & Ibom, 2012).

*Achatina achatina* is the largest gastropod among the giant African land snails recorded in the Guinness Book of records, with a maximum of recorded shell length of 27 cm (Nisbert, 1974; Jennifer, 1975). *Archachatina* *marginata* is the second largest, while *Achatina fulica* is the smallest (CAB, 2003; Venette & Larson, 2004). But in Nigeria, *Achatina achatina* is the second most popular breed of snail after *Archachatina marginata* kept and reared (Okon et al., 2012). The shell of *Archachatina marginata* is slightly smaller, usually about 110 mm long and 66 mm wide.

Plate 1. *Achatina fulica*

Plate 2. *Archachatina marginata*

Breed type has a marked effect on performance and productivity of snails than all other factors considered. This is attributed to physiological adaptability to the environment and genetic variations among and within breeds (Okon et al., 2012). According to Raut and Barker (2002), *A. fulica* and *A. marginata* both share a determinate shell growth. *A. marginata* produces a peristome with a reflected lip and reaches sexual maturity 2 – 4 months later than *A. fulica*. Venette and Larson (2004) opined that when *A. fulica* is full-grown, the shell consists of from 7 to 9 (exceptionally 10) whorls, with a moderately swollen body-whorl and a sharply conical spire, which is distinctly narrowed but scarcely drawn out at the apex. In *A. fulica*, both columella and parietal callus are white or blue white, without any trace of pink, whereas with *A. marginata* both columella and parietal callus are either white or red. These numbers of whorls on the body of the snails could be exploited for differentiation and determination of body weight of snails.

Body weight is the commonly reported measure of size. Body weight according to Fitzhurgh (1976) has been used by both local sellers/buyers and researchers as a parameter for selection. Snail weight can be predicted using quantitative or morphometric traits. These traits include body weight, shell length, shell width, shell “mouth” length and shell “mouth” width. Okon and Ibom (2011) using multiple regression equations noted 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.

There are scares information on differentiation and prediction of body weights of giant African land snails kept and reared in the Niger Delta region of Nigeria.

## 2. Materials and Methods

The research was carried out in Calabar, Nigeria. Calabar is the capital of Cross River State, one of the States that constitute the Niger Delta region of Nigeria. The location and climate of Calabar is as prescribed in Okon and Ibom (2011). The Niger Delta region is characterized with average annual temperature and rainfall ranges from 28 to 30 $^{o}$C and 2500 mm to 4000 mm respectively, making it one of the wettest area in Africa, thus suitable for snail rearing. Relative humidity really rarely drops below 60 % and fluctuates between 90 and 100 % for most months of the year.

Four hundred (400) adult black-skinned snails, two hundred (200) each of *A. marginata* and *A. fulica* were selected from a population gathered from the wild within the Niger Delta region for this study. The snails were selected based on active appearance, number of whorls and no injury on the foot and/or shell of the base population. All the snails selected had four (4) numbers of whorls on the shell and had weight ranging from 50.42 g to 198.84 g and from 100.10 g to 184.00 g for *A. marginata* and *A. fulica* respectively.

Data collected on quantitative traits from both breeds were body weight, (BSW), shell length (BSL), shell width (BSH), shell “mouth” length (MSL), shell “mouth” width (MSW). An electronic balance, Scout$^{TM}$ 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 GENSTAT (2009) software package for the simple statistics and SPSS (2007) for phenotypic correlation and multiple regression functions for predicting body weights from quantitative traits.

**3. Results and Discussion**

The results of the description of sampled population are presented in Table 1. The results were expressed as mean, standard deviation and coefficient of variation for each quantitative measurement. *A. fulica* with 4 whorls had higher values for measured quantitative traits than *A. marginata*. There was a large disparity which was significantly different (P<0.001) between the mean body weights of these two breeds, 138.60 g for *A. fulica* snails and 115.80 g for *A. marginata* snails (Tables 1 and 2). It indicated that *A. fulica* snails with 4 whorls is genetically heavier than *A. marginata* snails with 4 whorls, as this was confirmed by the test of significance of the difference (t – test) between the two breeds (Table 2). However, these results do not agree with the views of CAB (2003) and Venette and Larson (2004) that *A. marginata* is the second largest snail among the giant African land snails and *A. fulica* the smallest.

Table 1. Mean, standard deviation and coefficient of variation of quantitative traits in mature *A. marginata* and *A. fulica* snails

| | ***A. marginata* (n = 200)** | | | ***A. fulica* (n = 200)** | | |
|---|---|---|---|---|---|---|
| Quantitative Traits | $\bar{X}$ | SD | CV | $\bar{X}$ | SD | CV |
| Body weight (g) | 115.80 | 40.71 | 35.15 | 138.60 | 19.68 | 14.21 |
| Body length (mm) | 9.76 | 1.53 | 15.72 | 10.44 | 0.43 | 4.16 |
| Body width (mm) | 4.97 | 0.66 | 13.23 | 5.09 | 0.23 | 4.41 |
| Shell “mouth” length (mm) | 5.04 | 0.54 | 10.70 | 5.30 | 0.22 | 4.17 |
| Shell “mouth” width (mm) | 2.85 | 0.52 | 18.08 | 2.99 | 0.23 | 7.69 |

Table 2. Paired samples test of quantitative traits between *A. marginata* and *A. fulica* snails

| **Paired Quantitative Traits** | **t – values** | **Significant level** |
|---|---|---|
| Am – BDW/Af - BDW | – 3.478 | $0.001^{***}$ |
| Am – BDL/Af – BDL | – 2.857 | $0.006^{NS}$ |
| Am – BDH/Af - BDH | – 1.171 | $0.247^{NS}$ |
| Am – MSL/Af – MSL | – 2.939 | $0.05^{*}$ |
| Am – MSW/Af - MSW | – 1.791 | $0.079^{NS}$ |

Am = *Archachatina marginata*, Af = *Achatina fulica*, BDW = Body Weight, BDL = Body Length, BDH = Body Width, MSL = Shell ‘Mouth’ Length, MSW = Shell Mouth Width, NS = Non-significant (P>0.05), *** = Highly significant (P<0.001), * = Significant (P<0.05).

On the other hand, the results of this study agreed with results obtained by Okon et al. (2008) with *A. marginata* for mean body weight of 120.30±2.10 g for large sized snails with 4 whorls, 197.37±3.25 g for extra large sized snails with 4 whorls in Odukpani Local Government Area (L.G.A.) and also 122.97±2.53 g for large sized snails with 4 whorls and 167.35±3.15 g for extra large sized snails with 4 whorls in Yakurr L.G.A. For *A. marginata* snails from Ogoja L.G.A., Okon et al. (2008) obtained lower mean body weight values of 107.26±2.22 g for medium sized snails with 4 whorls, whereas for small sized and large sized *A. marginata* snails with 4 whorls from Ikom L.G.A., Okon et al. (2008) obtained mean body weights of 77.33±1.00 g and 166.25±3.16 g respectively. These Local Government Areas are from Cross River State, one of the States of the Niger Delta region of Nigeria.

This might be attributed to the fact that *A. marginata* is mainly a terrestrial snail, whereas *A. fulica* is mostly associated with tropical and sub-tropical moist broadleaf forest (Venette & Larson, 2004), typical of the Niger Delta region. Besides, it might be due to size and wider spread of the body weight range of *A. marginata* than those of *A. fulica*. Snails used for the study had higher and wider body weight range, from 50.43 g to 198.84 g (mean 158.42 g) for *A. marginata* and lower and closer body weight range, from 100.10 g to 184.00 g (mean 183.90 g) for *A. fulica*. On size of snails, Venette and Larson (2004) opined that full-grown snails have between 7 and 9 whorls, but in this study the snails used had only 4 whorls, meaning they were not fully mature (that is growing snails). Though there were relative differences within and between the snails' body components (i.e. shell length, shell width, shell 'mouth' length and shell 'mouth' width) for *A. marginata* and *A. fulica* snails, these differences did not differ significantly (P<0.05) between the two breeds (Table 2).

The results of phenotypic correlations among quantitative traits of the two breeds evaluated (Table 3) indicated positive, strong and very high significant (P<0.001) correlation coefficients ($r_p$) between body weight and all body components studied for *A. marginata*. Whereas for *A. fulica* snails, there were positive but lower significant (P<0.05) phenotypic correlation coefficients ($r_p$) between body weight and some body components studied. In fact, there were no significant (P>0.05) phenotypic correlation coefficients ($r_p$) between shell length and shell 'mouth' width (r = 0.250) and between shell 'mouth' length and shell 'mouth' width (r = 0.187) for *A. fulica* snails. The non-significant (P>0.05) phenotypic correlations denoted that these pairs of traits have no direct relationships and are likely not controlled by the same genes in the same direction. The lowest but positive and strong correlation coefficient of r = 0.774 obtained between body weight and shell 'mouth' width for *A. marginata* snails is higher than the highest, significant (P<0.05) correlation coefficient of r = 678 recorded between body weight and shell width for *A. fulica* snails.

Table 3. Phenotypic coefficient of correlations ($r_p$) of quantitative traits of *A. marginata* and *A. fulica* snails

| | *A. marginata* | | | | |
|---|---|---|---|---|---|
| | BDW | BDL | BDH | MSL | MSW |
| BDW | 1 | 0.902** | 0.927** | 0.890** | 0.774** |
| BDL | 0.641** | 1 | 0.911** | 0.900** | 0.833** |
| BDH | 0.678** | 0.624** | 1 | 0.933** | 0.797** |
| MSL | 0.505* | 0.503 | 0.611** | 1 | 0.775** |
| MSE | 0.378* | 0.250 | 0.377 | 0.187 | 1 |
| | BDW | BDL | BDH | MSL | MSW |
| | *A. fulica* | | | | |

BDW = Body Weight, BDL = Body Length, BDH = Body Width, MSL = Shell 'Mouth' Length, MSW = Shell Mouth Width, ** = P<0.01 (Highly significant level), * = P>0.05 (No Significant level).

The highest, positive, strong and closely correlated responses between shell width and shell 'mouth' length (r = 0.933) and between body weight and shell width (r = 0.927) was recorded by *A. marginata* snails in this study. These positive significant correlation coefficient obtained were noted by Ibom (2009), Okon et al. (2010a,b), Okon et al. (2011) and Okon and Ibom (2012). According to Ibom (2009) and Okon et al. (2011), this signifies that the pairs of quantitative traits used have 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. Further more, these results confirmed Okon et al. (2010a,b) and Okon et al. (2011) earlier views of high correlated responses of these quantitative traits for selection and cross breeding for genetic improvement as well as being better predictors of body weights in growing snails.

However, the results obtained in this study are quite lower than the strong, positive and highly significant correlation coefficient of r = 0.96 obtained Okon et al. (2010a,b) between hatchling body weight and shell length for the purebred white-skinned (Albino) and $F_1$ crossbred snails of *A. marginata*. Also, Ibom (2009) reported strong, positive and very high correlation coefficients of r = 0.99 between body weight and shell length, body weight and shell width for purebred black-skinned snails (BS X BS), purebred white-skinned snails (WS X WS) raised in Obubra, Nigeria. The differences in correlation coefficients here could be attributed to breed effect, age and size differences of snails used, body weight ranges as well as number of whorls on the shell of the snails.

The size and body weight ranges of *A. marginata* snails used in this study ranged between 50.42 g and 198.89 g, while that of *A. fulica* snails ranged between 100.10 g and 184.00 g. Nevertheless, the snails used here had 4 whorls against other studies with varied numbers of whorls, ages and sizes. But Venette and Larson (2004) opined that when *A. fulica* is full-grown, it has 7 to 9 whorls. Besides, *A. marginata* is known to be the second largest breed of snails in Nigeria, thus higher correlation coefficients, whereas *A. fulica* is known to be the smallest, hence lower correlation coefficients (CAB, 2003; Venette & Larson, 2004).

The prediction equations evolved for body weights of growing snails with 4 whorls using quantitative traits from *A. marginata* and *A. fulica* are shown in Table 4. The equations indicated that these quantitative traits, namely; shell length, shell width, shell 'mouth' length and shell 'mouth' width best predicted body weight for *A. marginata* and *A. fulica* snails with 4 whorls, as there were little or no differences between the actual and predicted liveweights (Table 5) of these growing snails using multiple regression equations. This may be due to the positive, strong and closely correlated response of body weight with the quantitative traits used in the predictions. However, these results of prediction do not agree with that of Okon et al. (2011) and Olawoyin and Ogogo (2006) for *A. marginata* snails because of age differences and number of quantitative traits used in the equation. Okon et al. (2011) could not closely predict hatchling (juvenile) body weights of *A. marginata* snails using shell length and shell width. Also Olawoyin and Ogogo (2006) reported shell length as a better predictor of body weight for growing snails. Thus, using more than two quantitative traits in the prediction equation may likely give a better and more reliable result. This might be attributed to the effects of age and size of snails, number of whorls on the snail shells and number of traits involved in the prediction as Okon et al. (2011) used juvenile snails with 2 to 3 whorls and two traits (shell length and shell width) in their study, while Olawoyin and Ogogo (2006) used growing snails with 3 to 5 whorls but only one trait (shell length) in their prediction.

Table 4. Prediction equations for body weights of *A. marginata* and *A. fulica* snails

| Breed | No. of whorls | Equation | R | $R^2$ | SEE |
|---|---|---|---|---|---|
| *A. marginata* | 4 | $Y = 169.741 + 8.542X_1 + 35.121\ X_2 + 5.712\ X_3 - 0.451\ X_4$ | 0.938 | 0.880 | 14.74 |
| *A. fulica* | 4 | $Y = -\ 260.3 + 15.20X_1 + 31.7\ X_2 + 7.9\ X_{3\ +}\ 12.26\ X_4$ | 0.921 | 0.847 | 14.68 |

$X_1$ = Body Length, $X_2$ = Body Width, $X_3$ = Shell "Mouth" Length, $X_4$ = Shell "Mouth" Width.

Table 5. Comparison between actual and predicted body weights of adult snails using regression equations

| Breed | No. of whorls | Actual Weight (g) | Predicted Weight (g) |
|---|---|---|---|
| *A. marginata* | 4 | 115.80 | 115.69 |
| *A. fulica* | 4 | 138.60 | 138.30 |

High percent coefficients of determination ($R^2$%) of 88 % and 84.7 % obtained in this study for *A. marginata* and *A. fulica* respectively indicated that variations in body weights of the two breeds of snails with 4 whorls of the shell used can be explained by changes in the number of quantitative traits and methods of statistical analyses used in the prediction. Hence, Okon et al. (2011) further noted that methods of statistical analysis could also affect the results obtained. Okon et al. (2010a,b) using simple correlation analysis for a single trait obtained very high coefficient of determination ($R^2$), whereas Okon et al. (2011) results that involved multiple correlation analysis used two traits (shell length and shell width) in the equations obtained low $R^2$ values. But for this study, using multiple regression analysis, multiple quantitative traits (shell length, shell width, shell "mouth" length, and shell "mouth" width) from snails with multiple (4) whorls, the coefficients of determination obtained were very high.

## 4. Conclusion

The results of this comparative study revealed that there are significant differences ($P<0.001$) in body weight and shell 'mouth' length between *A. marginata* and *A. fulica* snails found in the Niger Delta region of Nigeria. *A. fulica* snails with 4 whorls are bigger, heavier and have longer shell 'mouth' length than *A. marginata* snails with 4 whorls from the study area. But on phenotypic correlations ($r_p$) among the quantitative traits, *A. marginata* recorded higher significant ($P<0.001$) positive, strong correlations between body weight and all other quantitative traits studied, whereas *A. fulica* recorded lower significant values. In fact there were no significant ($P>0.05$) phenotypic correlations between shell length and shell "mouth" width ($r = 0.250$) and between shell "mouth" length and shell "mouth" width (r = 0.187) for *A. fulica* snails. However, on prediction of body weight using multiple regression analysis, these quantitative traits (shell length, shell width, shell "mouth" length and shell "mouth" width) predicted the body weight of both *A. marginata* and *A. fulica* snails with 4 whorls very accurately. Thus, these quantitative or phenotypic traits of the two breeds of snail studied could be chosen to differentiate as well as characterize growing snails in the Niger Delta region of Nigeria.

**References**

CAB. (2003). *Crop protection compendium: Global module*. Commonwealth Agricultural Bureau International, Wallingford, UK.

Fitzhurgh, H. A. (1976). Analysis of growth curves and strategies for altering their shapes. *Journal of Animal Science, 42*, 1036-1040.

GENSTAT. (2009). Genstat release 12.1 (PC/Windows XP) Lawes Agricultural trust. (Rothmted experimental station, VSN International Ltd).

Ibom, L. A., Okon, B., & Essien, A. (2008). Morphometric analysis of eggs laid by two ectotypes of Snails *Archachatina marginata* (Swainson) raised in captivity. *Global Journal of Agricultural Sciences, 7*(2), 119-121.

Ibom, L. A. (2009). Variations in Reproductive and Growth performance traits of White-skinned x Black-skinned African giant snail hatchlings [*Archachatina marginata* (*Swainson*)] in Obubra, Nigeria. *Doctor of Philosophy Thesis*. Department of Animal Science, University of Calabar, Calabar, Nigeria.

Jennifer, M. P. (1975). Observation on the reproductive, growth and longevity of laboratory colony of *Achatina achatina* and *Archachatina marginata* snails. *Proceedings, Malacological Society on Land Snails*, 41, 395-415.

Nisbert, R. N. (1974). The life of *Archachatinidae* in London. *Procedings, Malacological Society on Land Snails*, 41, 1171.

Okon, B., Ibom, L. A., Etuk, N. E., & Akpan, E. W. (2008). Variations in Growth Patterns and Conformation of Snails: Influence of Strain and Location on Isometry of Growth in Cross River State of Nigeria. *Journal of Agriculture, Forestry and the Social Sciences, (JOAFSS), 6*(2), 218-227.

Okon, B., & Ibom, L. A. (2010). Commercialization of Snail production in Nigeria: Potentials, Viabilities and Challenges. *Journal of Applied Sciences (JAS), 13*(2), 9139 -9158.

Okon, B., Ibom, L. A., Williams, M. E., & Akwa, N. T. (2010a). Parity Effects on Breeding and Morphometric Traits of Eggs and Hatchlings of Purebred Albino Snails [*Archachatina marginata* (*Swainson*)]. *Journal of Agriculture, Biotechnology and Ecology*, *3*(1), 44-54.

Okon, B., Ibom, L. A., Williams, M. E., & Etukudo, O. M. (2010b). Effects of Parity on Breeding and Morphometric Traits of Eggs and Hatchlings of $F_1$ Crossbred of Snails (*Archachatina marginata var. saturalis*). *Journal of Agriculture, Biotechnology and Ecology*, *3*(1), 36-43.

Okon, B., & Ibom, L. A. (2011). Phenotypic Correlation and Body weights Prediction using Morphometric Traits of Snails in Calabar, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, *4*(3), 7-11. http://dx.doi.org/10.4314/ejesm.v4i3.2

Okon, B., Ibom, L. A., & Odido, E. E. (2011). Reproductive Performance and Egg Quality Traits of Crossbreeding between Two Strains of Snails. *Archivos De Zootecnia*, 60(229), 153-156. http://dx.doi.org/10.4321/S0004-05922011000100020

Okon, B., & Ibom, L. A. (2012). *Snail Breeding and Snailery Management*. Freshdew Productions, Calabar, Nigeria.

Okon, B., Ibom, L. A., Ettah, H. E., & Ukpuho, I. E. (2012). Effects of Genotype, Dietary Protein and Energy on the Reproductive and Growth Traits of Parents and $F_1$ Hatchlings of *Achatina achatina* (L) Snails in Nigeria. *International Journal of Applied Science and Technology*, *2*(1), 179-185.

Olawoyin, O. O., & Ogogo, A. U. (2006). Prediction of Optimum Stocking density in growing African giant land snails. *Tropical Journal of Animal Science*, *9*(2), 72-84.

Raut, S. K., & Barker, G. M. (2002). *Achatina fulica Bowdich* and other Achatinidae as Pests in Tropical Agriculture. In G. M. Barker [ed.], *Molluscs as Crop Pests*. Hamilton, New Zealand. CABI Publishing. pp. 55-114.

Smith, J. W., & Fowler, G. (2003). Pathway risk assessment for Achatinidae with emphasis on the giant African land snail, *Achatina fulica* (Bowdich) and *Limicolaria aurora* (Jay) from the Carribbean and Brazil, with comments on related taxa *Achatina achatina* (Linne) and *Archachatina marginata* (Swainson) intercepted by PPQ, USDA – APHIS, Center for Plant Health Science and Technology (Internal report), Raleigh, NC.

SPSS. (2007). Scientific Package for Social Sciences.

Venette, R. C., & Larson, M. (2004). Mini risk assessment giant African snail, *Achatina fulica* (Bowdich) [Gastropoda: Achatinidae], Department of Entomology, University of Minnesita, St. Paul, MN 55108, pp. 1-30.