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Comparative Studies of Growth Performance and Body Parameters of Two Ectotypes of *Archachatina marginata var. saturalis*

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Abstract This study evaluated the growth performance and body parameters of two *ectotypes* of *Archachatina marginata var. saturalis*. The study was carried out at the Botanical garden, University of Calabar, Calabar. Thirty (30) adult black-skinned snails, thirty adult white skinned (30) each of the *A. marginata* with 2, 3 and 4 whorls were used respectively for the study. Identification and sorting of the snails sourced from a reputable snail vendor in Ibadan into breeds was done using the appropriate profile and template. The body weights of the snails ranged from 11.65 to 30.99 g. The indices used were body weight, body length, body width, 'mouth' length and 'mouth' width. Results obtained from the study showed that black skinned snails gain more weight than the white skinned snails (P<0.05). The results showed that body length and width increment were higher (P<0.05) for black skinned snails. All regression coefficients (R^2) were found to be significant (P<0.001) with high R^2 values (0.680 – 0.867) for black-skinned. The actual and predicted body weights were more or less similar which confirmed the fact that body weight can be predicted from quantitative traits measurements with accuracy. Thus, these quantitative or phenotypic traits of the two *ectotypes* of snail studied could be chosen to differentiate snails.

Keywords Black-skinned snails, *Archachatina marginata*, Morphometric traits

1. Introduction

Archachatina marginata snails is one of the species of African land snails called Giant African land snails [12, 23]. It could be black and white skinned [12]. The black skinned 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 [2]. Although the white skinned snails has the same nutritional attributes as the black-skinned, they are being discriminated against by some people because of tabbos and superstitious beliefs in some communities, others associate them with certain gods or deities; hence its domestication has been discouraged by some snail farmers [12].

Snail meat has been consumed by humans worldwide since prehistoric times [10, 11]. Majority of the developing and underdeveloped countries of the world especially Africa is currently in trouble of massive reduction in per capital income and food production, especially within the last few decades [7]. The food deficient situation is intensified with protein deficiency when compared to the availability of calories [4].

The rapid growth of human population has not only led to higher demand for animal protein but has called for increase efficiency in feedstuff utilization by livestock. The implication of the alarming increase in population, however, is that many people require snail meat in their diet because of its importance in improving the activities of the hormones and enzymes and its improvement of the defense mechanism of the body [1]. Nigerians are presently interested in the production of highly nutritive, medicinally by-product utilizers like snail [8].

The average citizen cannot afford most of the conventional animal protein sources like: goat, beef, pork and mutton. These major protein sources are currently threatened by high cost of feed, persistent drought, diseases, primitive animal husbandry techniques and low productivity of local animal breeds [22]. Snail meat is a high quality food that is rich in protein, low in fat and a source of iron calcium, magnesium and zinc [1]. Snail meat is high in protein (88.37%) and irons (45-50mg/kg), low in fat and contains almost all the amino acids needed by humans [4]. A recent study has also shown the glandular substance in edible snail meat cause agglutination of certain bacteria which could be of value in fighting a variety of ailments including whooping cough [4]. Mackerras and Sandars [25] stated that rat

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lungworm (*Angiostrongylus cantonensis*), was found to be carried normally by unidentified species of garden slugs. Fromming [26] also emphasized that the coprophagous habits of slugs strongly implicates them in spreading the diseases of humans and plants. But these items are only suggestive in the case of *A. fulica*. Mead [27] stated that under no circumstances can there be found any grounds for the fears of [28] who believe that these snails could spread the several dread fluke diseases of humans.

This study was designed to compare the growth performance and body parameters of black-skinned and white-skinned *A. marginata* and to develop regression equation for predicting their body weight using quantitative traits based on number of whorls.

2. Materials and Methods

2.1. Study Area, Snail Species and Management of Experimental Animals

The study was conducted at the Botanical garden of the University of Calabar, Calabar, Nigeria. The description of the area and climate were as prescribed in Okon *et al* [14, 17]. Sixty grower snails (*Archachatina marginata var. saturalis*) were used. These consisted of 30 snails each of the black- and white- skinned ectotypes of *A. marginata*. The weight of the snails ranged from 11.65 to 30.99 g for the two *ectotype*. The snails were selected based on active appearance and no injury on the foot and/or shell from a base population.

2.2. Study Procedure

Experiment I: The snails were grouped into two treatments for growth performance.

Experiment II: The selected snails were grouped into six treatments (number of whorls – 2, 3 and 4) with three replicates; black-skinned and white-skinned *ectotypes* in a completely randomized design. The snails were fed with pawpaw leaves for the period of 16 weeks. The snails were managed in wooden cage compartments kept outside under trees shade. Each cell of the cage compartments measured 40 cm (length) x 40 cm (width) x 30 cm (height) and housed two snails per cell.

2.3. Data Collection and Analysis

Data collected on growth performance included body weight (BWT), shell length (SHL), shell width (SHW), shell mouth length (SML) and shell mouth width (SMW). Weight was measured using a ScoutTM Pro electronic scale with 0.01 g sensitivity, while measurements of the length and width were done using Vernier caliper. These data were subjected to analysis of variance using SPSS package. T-test statistical tool was used to compare means of measured parameters between the breeds (experiment 1). Multiple regression function was used in predicting snails body weights from morphometric traits of the two *ectotypes* of snails studied.

3. Results and Discussion

Table 1 shows the results of the description of sampled population expressed as Mean ± standard error of mean and T-test for each morphometric measurement. The black-skinned snails had the best mean weight gain (13.98 g) while white-skinned snails the least mean weight gain (8.77 g). The T test analysis shows that there was significant difference ($P<0.05$) in the length increase of the snails between black and white-skinned snails. Black-skinned snails had the best mean width increase of (3.35cm) while white-skinned snails recorded (2.48cm). Shell mouth length increase and mouth width increase were higher for black-skinned snails. However, the T-test analysis shows that there was no significant difference ($P>0.05$) in the SMLI and SMWI. There were large disparities which were significantly different ($p<0.01$) between the mean body weights between these *ectotypes* of snails; 25.63 ± 0.19 g for black skinned snails while 39.76 ± 1.46 g for white skinned snails. Although, all other measured morphometric traits of black skinned snails were bigger and longer than those of white skinned snails. The results indicated that black skinned snails gain more weight and other morphometric traits than the white skinned snails, as this was confirmed by the test of significance of the difference (t-test) between the two *ectotypes*.

The results of this study is not in agreement with the results obtained by Okon *et al*. [16] 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*. [16] obtained 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*. [16] obtained mean body weights of 77.33±1.00 g and 166.25±3.16 g respectively.

Similarly, the results of mean body weights (Table 1) in this study did not agree with the higher mean body weight (BDW) value of 138.60 g for *A. fulica* snails with 4 whorls by Okon *et al*. [15]. The BDW results were also lower than the 127.20 g and 48.85 g for mean body weights for *A. achatina* and *A. fulica* snails with 4 whorls respectively reported recently by Etim [5]. The mean BDW of 182.00 g and 65.05 g for *A. achatina* and *A. fulica* snails with 5 whorls also reported by Etim (5) were higher and heavier than the 25.63 g and 39.76 g for black skinned and white skinned snails obtained in this study. Etta *et al.* [6] also reported a higher mean BDW of 137.50 g for A. fulica snails with 4 whorls. In another study, Ibom *et al*. [9] had earlier reported higher mean body weights of 93.70 g, 109.70 g and 73.00 g for A. fulica snails from central agro-ecological zone, northern agro-ecological zone and southern agro-ecological zone of Delta state respectively. The difference in BDW here could be attributed to the age and size differences of snails used; body weight ranges as well as number of whorls on the shell of the snails.

Morphometric traits measured showed that body length (BHL) was not significantly (P > 0.05) different. White skinned snails had the longest body (4.51 mm) while the shortest shell length was obtained for black skinned snails (3.23 mm). The value obtained were higher than the range of 2.79 - 3.15mm reported by Ibom and Okon [12] for *A. marginata* and lower than 10.44 mm reported by Etta *et al*. [6] but comparable with the 3.34 - 3.80mm in Okon *et al*. [15] for *A. achatina*. Shell width (SHW) was not significantly (P > 0.05) different among the snails, although the highest value was obtained for black skinned snails while white skinned snails recorded the least. The results for average shell width obtained were lower than the 14.1 mm mean shell width reported in Amubode [3] and the range of 11.09-11.15cm recorded in Omole [24]. The difference here might be due to the size used by the authors. The results obtained shell mouth length was lower than the 5.291 mm while the width was higher than the 2.990 mm for APL and APW respectively, reported by Etta *et al*. [6].

Table 1. T-Test between black-skinned and white-skinned snails *A. marginata*

	Black-skinned	**White-skinned**	
Traits	**Mean ± SEM**	**Mean ± SEM**	**P value**
Initial body weight	11.65 ± 0.20	30.99 ± 0.73	0.058
Final body weight	25.63 ± 0.19	39.76 ± 1.46	0.022
Body weight increase	13.98 ± 0.04	8.77 ± 0.73	0.014
Initial body length	3.23 ± 0.07	4.51 ± 0.18	0.109
Final body length	7.27 ± 0.07	7.17 ± 0.04	0.188
Body length increase	4.04 ± 0.00	2.66 ± 0.15	0.010
Initial body width	0.90 ± 0.07	1.69 ± 0.15	0.188
Final body width	4.25 ± 0.07	4.17 ± 0.04	0.188
Body width increase	3.35 ± 0.00	2.48 ± 0.11	0.010
Initial shell mouth length	1.07 ± 0.03	1.87 ± 0.07	0.081
Final shell mouth length	4.35 ± 0.11	4.33 ± 0.11	1.000
Shell mouth length increase	3.28 ± 0.08	2.46 ± 0.04	0.321
Initial mouth width	0.53 ± 0.01	0.93 ± 0.01	1.000
Final mouth width	3.78 ± 0.07	3.69 ± 0.73	1.000
Mouth width increase	3.25 ± 0.07	2.76 ± 0.07	1.000

Table 2. Body weight prediction equations for black and white-skinned *A. marginata*

Ectotype	**No of whorls**	**Equations**	**R**	**R^2**	**SEE**
Black-skinned	2	Y=1.277+0.354BDL+0.490BDW-0.233SML+2.305SMW	0.931	0.867	0.9221
	3	Y=29.527+2.40BDL-14.754BDW+11.412SML-1.451SMW	0.824	0.680	5.0810
	4	Y=-6.269+6.268BDL+1.386BDW-0.247SML-2.954SMW	0.926	0.857	2.5389
White-skinned	2	Y=4.876-0.376BDL+1.719BDW+0.333SML+0.864SMW	0.948	0.899	0.768
	3	Y=9.152+3.286BDL+13.171BDW-7.121SML-4.601SMW	0.863	0.744	3.021
	4	Y=-39.495+14.128BDL-7.437BDW+0.996SML+3.816SMW	0.857	0.736	6.440

R= Coefficient of determinant; R^2= regression coefficient; SEE = Standard error of estimate

Table 3. Comparison between actual and predicted body weights for black and white-skinned *A. marginata*

Ectotype	**No of whorls**	**Actual weight (g)**	**Predicted weight (g)**
Black-skinned	2	6.9812	6.9824
	3	24.6125	24.6108
	4	24.8375	24.8361
White-skinned	2	10.2962	10.2963
	3	44.8337	44.8326
	4	55.3838	55.3894

The prediction equations to estimate body weight from quantitative traits measurement for black-skinned and white-skinned *A. marginata* snails based on number of whorls are presented in Table 2. In both *ectotypes*, *A. marginata* with 2 numbers of whorls had the highest R^2. All regression coefficients (R^2) were found to be significant ($P<0.001$) with high R^2 values (0.680 – 0.867 for black-skinned *A. marginata* and 0.736 – 0.899 for white-skinned *A. marginata*). This confirmed that body weight of *A. marginata* can be predicted with confidence from the quantitative traits measurements irrespective of the number of whorls.

The equations indicated that these quantitative traits, namely; body length, body width, shell 'mouth' length and shell 'mouth' width best predicted body weight for *A. marginata*, as there were little or no differences between the actual and predicted live weights of these snails using multiple regression equations. However, these results of prediction do not agree with that of Okon *et al*. [13] and Olawoyin and Ogogo [21] for *A. marginata* snails because of age differences and number of quantitative traits used in the equation. Okon *et al*. [13] could not closely predict body weights of A. marginata snails using shell length and shell width. Also Olawoyin and Ogogo [21] 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*. [13] used juvenile snails with 2 to 3 whorls and two traits (shell length and shell width) in their study, while Olawoyin and Ogogo [21] used growing snails with 3 to 5 whorls but only one trait (shell length) in their prediction.

High percent coefficients of determination (R^2 %) of 86.7% and 89.9% obtained in this study for black and white skinned *A. marginata* with 2 whorls indicated that variations in body weights of the two ectotypes of snails with 2 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*. [13] noted that methods of statistical analysis could also affect the results obtained. Okon *et al*. [18, 20] using simple correlation analysis for a single trait obtained very high coefficient of determination (R^2), whereas Okon *et al*. [13] 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 [2] whorls, the coefficients of determination obtained were very high.

The comparison of the actual body weight and predicted body weight from linear regression equations are presented in Table 3. The actual and predicted body weights were more or less similar which confirmed the fact that body weight can be predicted from quantitative traits measurements with accuracy. This is in line with earlier works [19, 13, 23] who indicated that there were no significant differences between actual and predicted body weights.

4. Conclusions

From the results of this study, the black-skinned *A. marginata* gain more weight than the white-skinned *A. marginata*. Prediction of body weight using multiple regression analysis accurately predicted the body weight using quantitative traits. These quantitative traits (shell length, shell width, shell "mouth" length and shell "mouth" width) predicted the body weight of both black and white skinned *A. marginata* snail with 2, 3 and 4 whorls very accurately. Thus, these quantitative or phenotypic traits of the two *ectotypes* of snail studied could be chosen to differentiate snails.

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REFERENCES

[1] Ademolu, K. O., Idowu, A. B., Mafiana, C. F., and Osinowo, O. A., 2004, Performance, proximate and mineral analyses of African giant land snail (*Archachatina marginata*) fed different nitrogen sources. *African Journal of Biotechnology*, 3 (8): 412-417.

[2] Akinnusi, O., 2004, Introduction to snails and snail farming. Triolas Exquisite Venture. Abeokuta, Nigeria.

[3] Amubode, F. O., and Ogogo, A. U., 1994, Performance of snail (*A. Marginata*) fed with varying levels of calories-protein supplementary diets. *Nigerian Journal of Forestry,* 24 (1&2), 34-43.

[4] Cobbinah, J. R., Vink, A., and Onwuka, B., 2008, Snail Farming: Production, Processing and Marketing, (Agromisia Foun dation, Agrodok 47 and CTA, Wageningen).

[5] Etim, A. B., 2017, Phenotypic traits differentiation, identification of Chromosome Numbers and Body Weights Prediction among Three breeds of Snails and Two varieties of *Archachatina marginata* Snails. M. Sc. Thesis, Department of Animal Science, University of Calabar, Calabar, Nigeria, p. 211.

[6] Etta, H. E., Okon, E. A., and Ekpe, P. A., 2015, Comparative Phenotypic Assessment of two Snail Breeds *Archachatina marginata* (S) and *Achatina fulica* (L) in Calabar, Cross River State. Proceedings of 4th International Conference/Workshop on Giant African Land Snails (NetGALS) 1st – 4th June, 2015, Nnamdi Azikiwe University, Awka. Pp. 40-48.

[7] FAO, 1991, African Research Bulletin Food and Agricultural

Organization of the United Nations Rome. Nigerian Lifestock subsector 53pp.

[8] Hamzat O. A, Omole A .J, Oredehin A., and Longe O. G., 2002, Effect of feeding dried Kolanut testa and palm kernel cake mixture on growth performance immature Giant Land Snails under kola plantation. *African Journal of Livestock Extension*, Vol. 1 Pg 9-12.

[9] Ibom, L. A., Okon, B., Okon, F. I., and Nwambam, I. U., 2014, Morphological charac terization of Giant African Land Snails from three Agro-ecological zones of Delta States. Proceedings of 3rd International Conference/Workshop on Giant African Land Snail (NetGALS), 1st – 4th June, 2014, Abeokuta, Nigeria, Pp. 38-44.

[10] Mogbo, T. C., Nwankwo, O. D., and Nwuzor, I. L., 2014, Growth performance of snails (*Achatina fulica*) fed with three different leaf materials. *American Journal of Biology and Life Sciences*, 2 (4): 96-99.

[11] Murphy, B., 2001, Breeding and growing snails commercially in Australia. A Report of the Rural Industries Research and Development Corporation Publication. No 00/188 Project No ARH-IA.

[12] Okon, B., and Ibom, L. A., 2012, Snail Breeding and Snailery Management, Freshdew Production, Calabar, Nigeria. p. 90.

[13] Okon, B., Ibom, L. A., and Odido, E. E., 2011, Reproductive Performance and Egg Quality Traits of Crossbreeding between Two Strains of Snails. *Archivos De Zootecnia*, 60 (229), 153-156.

[14] Okon, B., Ibom, L. A., Ekpo, I. A., and Ewa, E. C., 2009a, Evaluation of Reproductive performance and some egg quality parameters of Albino snails (*Archachatina mar ginatasaturalis* (Swaison). *Journal of Applied Sciences*, 12 (1): 8234-8240.

[15] Okon, B., Ibom, L. A., Ettah, H. E., and Ukpuho, I. E., 2012, Effects of Genotype, Dietary Protein and Energy on the Reproductive and Growth Traits of Parents and F1, Hatchlings of *Achatina achatina* (L) Snails in Nigeria. *International Journal of Applied Science and Technology*, 2(1), 179-185.

[16] Okon, B., Ibom, L. A., Etuk, N. E., and 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.

[17] Okon, B., Ibom, L. A., Williams, M. E., and Akpakpan, I. E., 2009b, Comparative Evaluation of Reproductive performance and some egg quality parameters of Black and White Skinned Snails. *Global Journal of Agricultural Sciences*, 8 (1): 77-80.

[18] Okon, B., Ibom, L. A., Williams, M. E., and 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.

[19] Okon, B., Ibom, L. A., Williams, M. E., and Etukudo, O. M., 2010, Effects of Parity on Breeding and Morphometric Traits of Eggs and Hatchlings of F1 Crossbred of Snails (*Archachatina marginata var. saturalis*). *Journal of Agriculture, Biotechnology and Ecology*, 3(1):36-43.

[20] Okon, B., Ibom, L. A., Williams, M. E., and Etukudo, O. M., 2010b, Effects of Parity on Breeding and Morphometric Traits of Eggs and Hatchlings of F1, Crossbred of Snails (Archachatina marginata var. saturaliś). *Journal of Agriculture, Biotechnology and Ecology*, 3(1), 36-43.

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

[22] Omole, A. J., Tewe, O. O., Adebowale, E. A., Oluokun, J. A., Ogundola, F. J., and Nworgu, F. C., 2000, Performance of different breeds of snails under the same management conditions. *Tropical Journal of Animal Science* 3 (1): 133-138.

[23] Sam, I. M., Okon, B., Edem, W., and Ukpanah, U. A., 2016, Quantitative traits measurements as predictor of body weight in black-skinned and white-skinned *Archachatina marginata*. Proceedings of the 5th International Conference/Workshop on Giant African Land Snails (NetGALS), 5th - 9th June, 2016, Calabar, Nigeria, Pp. 97-102.

[24] Omole, A. J. 2010, Performance and carcass Analysis of growing snails fed Calopogonium mucunoidis (Calopo) and Pueraria phasioloides (Kudzupuero). *Nigerian Journal of Animal Production*, Vol. 37 (1&2), Pp. 85-90.

[25] Mackerras, M. J. and Sandars, D. F. 1954, Life-history of the rat lung-worm and its migration through the brain of its host. *Nature*, 173 (4411): 956-57.

[26] Morgenstern, A. V. 1949, (Repartee) Atlantic, 184 (4): 17.

[27] Fromming, E. 1952, Unsere Wegschnecke (Arion) als Ubertrager von Krankheiten fiir Mensch und Pflanze. Zeitsch. f. Hygienische Zool. u. Schadlings, 40 (11/12): 376-79.

[28] Mead, A. R. 1961, The giant African snail: A problem in economic malacology. The University of Chicago press published. Pp. 1-255.