Sumerianz Journal of Biotechnology, 2024, Vol. 7, No. 3, pp. 34-39
ISSN(e): 2617-3050, ISSN(p): 2617-3123
Website: https://www.sumerianz.com
DOI: https://doi.org/10.47752/sjb.73.34.39

Original Article Open Access

Quantitative Differentiation of Phenotypic Traits and Correlations between *Achatina achatina* and *Achatina fulica* Snails Based on Five Whorls

Etukudo O. M.*
Department of Biological Sciences, Topfaith University, Mkpatak, Akwa Ibom State, Nigeria
Email: o.etukudo@topfaith.edu.ng

Adam A. J.
Department of Animal Science, University of Uyo, Uyo, Akwa Ibom state, Nigeria

Bassey N. S.
Department of Biological Sciences, Topfaith University, Mkpatak, Akwa Ibom State, Nigeria

Article History

Received: 5 June, 2024

Revised: 10 August, 2024

Accepted: 20 August, 2024

Published: 25 August, 2024

How to Cite

Etukudo O. M., Adam A. J. and Bassey N. S., 2024. "Quantitative Differentiation of Phenotypic Traits and Correlations between *Achatina achatina* and *Achatina fulica* Snails Based on Five Whorls". *Sumerianz Journal of Biotechnology*, Vol. 7, No. 3, pp. 34-39.

Abstract

Three hundred (300) adult black-skinned snails, consisting of one hundred and fifty (150) snails each of *A. achatina* and *A. fulica* with 5 whorls were procured from a snail farm in Ogun state, Nigeria and used for this study. The body weights of the snails used ranged from 130.82 g to 268.70 g (average 136.89 g) for *A. achatina* species, and 48.70 g to 120.10 g (average 61.20 g) for *A. fulica* respectively. The results obtained in this study indicated that genetically, the *A. achatina* species are heavier and larger than the *A. fulica* counterpart with the same number of whorls (5). The results of the phenotypic correlation coefficient among the phenotypic traits of the two species of snails showed negative, weak, low significant ($P<0.05$) and mostly non-significant ($P>0.05$) differences between body weight and other phenotypic traits studied. The positive, low significant ($P>0.05$) phenotypic correlation coefficient (r_p) obtained was r = 0.531 between body weight and aperture width, and r = 0.561between aperture width and spiral width respectively for *A. achatina* species of snails. The only positive and highly significant ($P<0.01$) phenotypic correlation coefficient of r = 0.610 was obtained between body shell width and aperture width for the same *A. achatina* species of snails. Species type, age and size differences of the snails used, number of whorls and body weight ranges have high effects on phenotypic trait differentiation and phenotypic correlation coefficient of estimation. Thus, the phenotypic traits of *A. achatina* and *A. fulica* species of snails studied could be selected for quantitative differentiation and characterization snails.
Keywords: *Achatina*, Black-skinned, correlations, differentiation, *fulica*, phenotypic, quantitative, snails,traits.

1. Introduction

Snail management and production is a lucrative and interesting venture if breeding stocks of snails with reproductive potentials are employed and managed properly either intensively or extensively. Many species of snails (*Archachatina marginata*, *Achatina achatina* and *Achatina fulica*) have been found in large numbers in different parts of Nigeria. Consumers, farmers, producers, sellers and researchers have currently drawn their attention towards the management and production of these enormous species of snails for proper documentation of the information and findings for future use [1, 2]. *Achatina achatina* is the largest gastropod that has been documented in the Guinness Book of Records among the giant African land snails, with a maximum shell length of 27cm as reported by Okon, *et al.* [3]; while *A. fulica* is the smallest [4, 5], but according to Okon and Ibom [1], Etim [6], the largest species of giant African land snail that has been kept and reared especially in Nigeria, is the *A. marginata*, followed by *A. achatina.*

The second biggest giant African land snail *Achatina achatina* in Nigeria (Figure 1) has been found and distributed across Nigeria, Sierre Leone, Togo, Guinea, Cameron, Benin Republic, Liberia, Ghana and Cote d'Ivore [5, 7]. This species of snail can be identified by having a shell with a conical shape and pointed fairly than other snail species, also with a pattern of black wavy streaks on a yellowish background, and in terms of their growth, their shell length and width can grow to 30 cm and 25 cm respectively, and their meats contain a lot of nutrients [2, 8]. This snail species can be sexually mature between 10 and 12 months with a laying capacity of between 30 and 300 eggs/clutch with a diameter ranging from 4 to 10 cm per egg, if managed intensively in captivity [9]. It can weigh up to 500g at maturity, and because of their attractive weight, consumers prefer eating them after *A. marginata* species [10].

The giant East African land snail, the *Achatina fulica* (Figure 2) is found and distributed in Kenya, Tanzania, Liberia and Cote d'Ivore [1, 2, 5, 10]. Among the giant African land snails, the *A. fulica* species is the smallest with long and swollen body whorls [10, 11]. According to Okon, *et al.* [10], *A. fulica* has a narrow and conical shell that is about two times its width, and when fully grown, it has 7 to 9 whorls. The color of the shell is reddish brown with yellow and vertical marking coloration that differs with environmental factors and diet consumption. At the adult stage of development, *A. fulica* can have a shell length of 20 cm or more with a shell width of 7 cm. An optimum and favourable temperature for *A. fulica* hatchability is 15 ^{o}C with a large egg production that ranges from 4.5 cm to 5.5 cm in diameter [10, 12].

The reliability of parameters for a given trait to be estimated and for the inclusion of such trait in breeding programmes depend on the quantitative measurement of animal conformation [13]. On the other hand, Ibom [7]; Etukudo, *et al.* [12] reported that body traits such as body weight, body shell length and width, mouth shell length and width are phenotypic (quantitative) traits which can be used to measure growth and the rate of growth of snails. More so, phenotypic traits have been recommended by Okon and Ibom [13], Owoidihe, *et al.* [2] as good prediction tools of hatchling weights in the juvenile phase of development and F_1 crossbred of *A. marginata* snails. The authors also opined that due to the high demand of animal protein in Nigeria, the genetic improvement of any species of snail can be achieved via estimating the genetic correlations among performance traits in the breeding goal and selection strategies, program and development for effective planning. There is paucity of literature on the differentiation of phenotypic traits and correlations of *A. achatina* and *A. fulica*. Therefore, this study aims to provide information on the differentiation on phenotypic traits and correlations between *A. achatina* and *A. fulica* snails based on five whorls.

Figure-1. *Achatina achatina* species

Figure-2. *Achatina fulica* species

2. Materials and Methods

2.1. Study Area

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

2.2. Experimental Animals

Three hundred (300) adult black-skinned snails, consisting of one hundred and fifty (150) each of *A. achatina* and *A. fulica* were procured from snail farms in Ogun State, Nigeria. For identification of these snails into *A. achatina* species and *A. fulica* species, profile and template of Nisbert [14] were adopted. The *A. achatina* species of snails with five whorls had body weight ranges from 130.82 g to 268.70 g (average 136.89 g), while *A. fulica* with the same number of whorls had body weight ranges from 48.70 g to 120.10 g (average 61.20 g) respectively.

2.3. Data Collection

The phenotypic traits data measured from the two species of snails were body weight (BDW), body shell length (BSL), body shell width (BSW), aperture length (APL), aperture width (APW), spiral length (SPL) and spiral width (SPW). 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 [15] software package for mean and standard error; t-test and phenotypic correlations between body weights and other phenotypic traits were also analyzed.

3. Results

Table-1. Mean ± SE of Phenotypic Traits between *A. achatina* and *A. fulica* snails based on five whorls.

Phenotypic Traits	A. A ± SE	A. F ± SE	t-values	Significant level
BDW (g)	136.89±6.10	61.20±3.24	8.32	P<0.001
BSL (cm)	9.43±0.67	7.00±0.37	9.61	P<0.001
BSW (cm)	4.36±0.94	2.56±0.78	10.12	P<0.001
APL (cm)	4.85±0.78	3.16±0.81	9.81	P<0.001
APW (cm)	1.83±0.67	1.12±0.63	7.76	P<0.001
SPL (cm)	2.00±0.35	1.01±0.03	10.34	P<0.001
SPW (cm)	0.81±0.92	0.31±0.09	6.89	P<0.001

A. A = *Achatina Achatina*, A. F = *Achatina fulica*, BDW = Body weight, BSL = Body shell length, BSW = Body shell width, APL = Aperture length, APW = Aperture width, SPL = Spiral length, SPW = Spiral width, P<0.001 = Highly significant.

Table-2. Phenotypic Coefficient of Correlation (r_p) of Phenotypic Traits between *A. achatina* and *A. fulica* snails based on five whorls

Parameters	**BDW**	**BSL**	**BSW**	**APL**	**APW**	**SPL**	**SPW**
BDW	1.000	-0.510^{*}	-0.161^{NS}	-0.615^{**}	0.531^{*}	0.361^{NS}	-0.002^{NS}
BSL	-0.365^{NS}	1.000	-0.332^{NS}	0.316^{NS}	0.090^{NS}	-0.547^{*}	0.004^{NS}
BSW	-0.261^{NS}	-0.230^{NS}	1.000	-0.310^{NS}	0.610^{**}	-0.060^{NS}	0.251^{NS}
APL	0.190^{NS}	-0.241^{NS}	-0.289^{NS}	1.000	-0.274^{NS}	-0.183^{NS}	-0.026^{NS}
APW	-0.072^{NS}	-0.070^{NS}	0.114^{NS}	0.138^{NS}	1.000	0.143^{NS}	0.561^{*}
SPL	0.470^{NS}	-0.476^{NS}	0.078^{NS}	0.281^{NS}	0.089^{NS}	1.000	-0.320^{NS}
SPW	0.330^{NS}	-0.068^{NS}	0.086^{NS}	-0.004^{NS}	-0.096^{NS}	-0.341^{NS}	1.000

BDW = Body weight, BSL = Body shell length, BSW = Body shell width, APL = Aperture length, APW = Aperture width, SPL = Spiral length, SPW = Spiral width, NS = P>0.05 (Non- significant level), ** = P<0.01 (High significant level), * = P<0.05 (Lower significant level).

4. Discussion

The results of the phenotypic traits measured between *A. achatina* and *A. fulica* were presented as Mean ± standard error of mean and t-values for each phenotypic measurement (Table 1). *Achatina achatina* species had the highest values for all the phenotypic traits measured than *Achatina fulica* species. There were great disparities between the two species of snails that resulted in significant differences (P<0.001) between the mean body weights of 136.89 g for *A. achatina* and 61.20 g for *A. fulica* respectively (Table 1). More so, all other phenotypic traits measured for *A. achatina* species were bigger and higher than *A. fulica* species. The results indicated that *A. achatina* species of snails are bigger, larger 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 tandem with the results obtained by CAB [4], Venette and Larson [5]; Okon, *et al.* [10] that the largest snail among the giant African land snails is *A. achatina*, while the smallest is the *A. fulica* species.

On the other hand, the mean body weights of 136.89 g and 61.20 g obtained in this study for *A. achatina* and *A. fulica* respectively, were lower than the values of 182.00 g and 65.05 g for *A. achatina* and *A. fulica* with the same number of whorls (5) by Etim [6], but the results were almost in tandem with values of 138.60 g and 59.58 g obtained for *A. achatina* and *A. fulica* with the same number of whorls by Okon, *et al.* [10]. The difference in body weight here may be due to what they fed the snails before the commencement of the study, and the age and size of the snail species.

There was a large disparity among the phenotypic traits measured in this study which were significantly (P<0.001) different between the mean shell parameters with the number of whorls in these two species of snails (Table 1). The results obtained in this study for shell parameters were larger and longer than the values of 10.440 mm, 5.087 mm, 5.291 mm, 2.990 mm obtained for body shell length, body shell width, aperture length and aperture width respectively for *A. fulica* species as reported by [16]. On the other hand, the results obtained in this study for shell parameters were almost in line the values of 3.243 cm, 1.061 cm, 6.786 cm, 2.661 cm, 1.118 cm, 0.261 cm; and 4.763 cm, 1.732 cm, 9.258 cm, 4.063 cm, 1.979 cm 0.705 cm for aperture length, aperture width, body shell length, body shell width, spiral length, and spiral width respectively for *A. fulica* and *A. achatina* species of snails with 5 whorls as reported by [10].

The results obtained for phenotypic correlations among phenotypic traits in this study for the two species of snails with 5 whorls (Table 2) indicated negative, weak, low and non-significant (P>0.05) correlation coefficient (r_p) between body weights and most of the bod shell parameters studied for *A. achatina* and *A. fulica* species of snails with 5 whorls. The only strong, positive and highly significant (P<0.01) correlation coefficient of r = 610 was obtained between body shell width (BSW) and aperture width (APW) for the *A. achatina* species. More so, there was a lower significant (P<0.05) correlation coefficient (r_p) of r = 0.531 and 0.561between body weight (BDW) and aperture width (APW), and aperture width (APW) and spiral width (SPW) respectively for the same *A. achatina* species (Table 2). On the other hand, negative and highly significant (P<0.01) correlation coefficient of r = -0.615 was obtained for body weight (BDW) and aperture length (APL) for *A. achatina* species, while negative and low significant (P<0.05) correlation coefficient r = -0.510 and -0.547was obtained between body weight (BDW) and body shell length (BSL), and body shell length (BSL) and spiral length (SPL) for *A. achatina* species respectively. All other phenotypic correlation parameters were non-significantly (P>0.05) correlated with positive and negative values between them, especially the *A. fulica* species.

The positive correlation between body shell width (BSW) and aperture width (APW) obtained in this study is in tandem with the report of Ibom [7], Okon and Ibom [13], Okon, *et al.* [17]. This signifies that the pairs of phenotypic 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 agreed with that of Ehiobu and Kyado [18], Ibom [7], Okon, *et al.* [17] with the view that correlations between phenotypic traits could be high or low, positive or negative. On the other hand, these results of negative, low, non-significant phenotypic correlations between body weights and most of the measured body shell parameters studied were not in agreement with Okon and Ibom [13], Okon, *et al.* [19], Okon, *et al.* [20] earlier observation of high correlated responses of phenotypic traits for selection and cross breeding for genetic improvement.

The differences in correlation coefficients could be due to species effect, age and size variations of the snails used, body weight ranges as well as number of whorls. Some authors had used some species of snails as cited in some literature either at juvenile or growing phases without taking cognizant of their ages and number of whorls.

The species type and the number of whorls used have high effects on the phenotypic correlation coefficient (r_p) estimates as reported by [17].

5. Conclusion

Higher values were obtained in all the phenotypic trait parameters measured in this study for *A. achatina* species than the *A. fulica* species. High variations and disparities were observed in this study for the phenotypic traits studied which were significantly different (P<0.001) between body weight (BDW) and all other phenotypic traits. Genetically, the *A. achatina* species were heavier and larger than the *A. fulica* counterpart with the same number of whorls (5), which was further confirmed by the test of significance of the difference (t-test). The phenotypic correlations obtained in this study among phenotypic traits of the two species of snails were negative, weak and of low significant (P<0.05) and non-significant (P>0.05) correlation coefficient (r_p) between body weight (BDW) and some of the body shell parameters studied. These showed that species type, age, and size differences of snails used, number of whorls and body weight ranges, have high and pronounced effects on the phenotypic traits' differentiation and correlation coefficient of estimation. Thus, the phenotypic traits of the two species of snails studied could be selected for quantitative differentiation and characterization of snails.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

[1] Okon, B. and Ibom, L. A., 2012. *Snail breeding and snailery management*. Nigeria: Freshdew Production, Calabar. p. 90.

[2] Owoidihe, M. E., Anthony, J. U., Nya, E., Veronica, N., Tentishe, L. T., Abasisma, S. E., Nko, S. B., Agnes, U. L., Nsude., O., *et al.*, 2024. "Evaluation of physiological indices of giant african land snail (achatina achatina) from niger delta regions of Nigeria." *Asian Science Bulletin,* vol. 2, pp. 345-350.

[3] 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,* vol. 2, pp. 179-185.

[4] CAB, 2003. *Crop protection compendium: Global module. Commonwealth agricultural bureau international*. Wallingford, UK.

[5] Venette, R. C. and Larson, M., 2014. *Mini risk assessment, giant african snail, achatina fulica (bowdich) (gastrops: Achatinidae)*. Department of Entomology, University of Minnesota, St. Paw, MN55108, pp. 1-30.

[6] 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*. Calabar, Nigeria: Department of Animal Science, University of Calabar. p. 211.

[7] 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. Ph. D. Thesis*. Calabar, Nigeria: Department of Animal Science, University of Calabar. p. 166.

[8] Cobbinah, J. R., Vink, A., and Onwuka, B., 2008. *Snail farming* vol. 47. CTA Agrodok, p. 78.

[9] King, P., 2008. "Identifying your snail." Available: www.petsnails.co.uk

[10] Okon, B., Ibom, L. A., A., H., and Onwuka, P. O., 2017. "Comparative morphometric traits differentiation and phenotypic correlations between Achatina achatina (Linne, 1758) and Achatina fulica (Bowdich, 1822) snails with four and five whorls." *Journal of Animal Science and Veterinary Medicine,* vol. 2, pp. 102-108.

[11] Jummai, A. T. and Okoli, B. J., 2013. "Compositional evaluation of Giant East African Snail." *Research Journal in Engineering and Applied Science,* vol. 2, pp. 391-401.

[12] Etukudo, O. M., Ekerette, E. E., and Umoyen, A. J., 2017. "Phenotypic correlations and body weight prediction of two ectotypes of giant African land snail (A. marginata) based on number of whorls in calabar, Nigeria." *Asian Journal of Agriculture,* vol. 5, pp. 1-8.

[13] Okon, B. and 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,* vol. 4, pp. 7-11.

[14] Nisbert, R. N., 1974. "The life of achatinidae in London." *Proceedings of the Malacological Society of London,* vol. 41, p. 1171.

[15] Genstat, 2011. "Genstat release 10.3 de (pc/windows 7), vsn international ltd (rothansted experimental station)."

[16] 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." In *Proceedings of 4th International Conference/Workshop on Giant African Land Snails (NetGALS) 1 st – 4 th June, 2015, Nnamdi Azikiwe University, Awka.* pp. 40-48.

[17] 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,* vol. 60, pp. 153-156.

[18] Ehiobu, N. G. and Kyado, J. A., 2000. "Heritability, repeatability and genetic correlation of swine." In *Proceedings of the 25th Annual Conference of Nigerian Society for Animal Production (NSAP). March 19 - 22, 2000, Umudike, Nigeria.* pp. 260- 261.

[19] 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,* vol. 3, pp. 36-43.

[20] 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,* vol. 3, pp. 44-54.