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Research Article
Differentiation in Growth of Body Components Between Two Ectotypes of Giant African Land Snails (*Archachatina marginata* S.) Based on Number of Whorls in Calabar, Nigeria

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Abstract
Two hundred snails of various sizes consisting of hundred each of the black-skinned ectotype and white-skinned ectotype were used for this study. Body components measured were body weight, body shell length, body shell width, mouth shell length and mouth shell width for the two ectotypes. The number of whorls on snail shell considered for the study were 2, 3, 4 and 5. Data were analyzed using t-test and the results showed that all the body components between the two ectotypes were significantly different ($p<0.05$) based on the number of whorls. The white-skinned ectotype recorded higher percent body component increment for snails between 2 and 3 whorls, whereas the black-skinned snails recorded higher percent body component increment for snails with 3 and 4 whorls. This means that the two ectotypes besides their differences in foot colouration varied in terms of growth of body components. It is therefore suggested that both ectotypes of *Archachatina marginata* S.) should be tested for differentiation in growth of body components with higher number of whorls, as this will be very beneficial to breeders for genetic improvement of the snail.

Key words: Black-skinned, white-skinned, snails, ectotypes, body component, growth differentiation

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Giant African land snails (*Archachatina marginata*) are terrestrial shell-bearing invertebrate animals that belongs to the phylum mollusca or alternatively, any of the twelve species of land pulmonata gastropoda, which is the most successful of all classes of mollusks used as human food (Oyeleye *et al*., 2012). It is air-breathing, usually herbivores, with a complex hermaphroditic reproductive system though depends on cross fertilization to produce viable eggs. This is because the giant African land snails produce sperm before eggs (Plummer, 1975).

Giant African land snails (*Archachatina marginata*) consist of many species and among the various species commonly found in the Southern part of Nigeria are the black-skinned and the white-skinned ectotypes (Ogogo, 2004). The black-skinned ectotypes are bigger than white-skinned ectotypes morphologically. These species can fed with natural foods (pawpaw fruits and leaves, sweet potato leaves, cocoyam leaves and tuber among others) with a mixed feed regime to obtained satisfying growth and reproductive performance (Ibom and Okon, 2010).

In studies involving animal species, growth in terms of body weight gain is the most widely used growth index from birth to maturity. In snails, weight at hatch is the first indicator of hatchling growth rate and is useful as a starting point for measuring subsequent indices, such as body parameters (body weight, shell width and shell thickness) and aperture (shell 'Mouth') parameters (shell 'Mouth' length and shell 'Mouth' width) and the number of whorls can also be taken at hatch and used in measuring subsequent snail growth rate (Okon and Ibom, 2012). This study was carried out to access the differences in growth of body components between the two ectotypes of *Archachatina marginata* snails using the number of whorls on the snail shells.

MATERIALS AND METHODS

Experimental site/procedures: The study was conducted at the botanical garden of the University of Calabar, Calabar, Nigeria. Description of the area and climate were prescribed in Akpakpan *et al*. (2009) and Okon *et al*. (2009). Two hundred snails of different sizes consisting of 100 each of black-skinned and white-skinned ectotypes of *Archachatina marginata* S.) were used for the study. The black-skinned ectotype ranged from 0.7-153.90 g, while the weight of the white-skinned ectotype ranged from 0.06-72.10 g. The two ectotypes were selected based on number of whorls (2, 3, 4 and 5) and other criteria for selection in Okon and Ibom (2012). The management of snails were done as prescribed by Ibom (2009), Akpakpan *et al*. (2009) and Okon *et al*. (2009). The snails were managed in two wooden cages compartment kept outside under tree shades. Each cell of the cage compartment measured 40 cm (length) × 40 cm (width) × 30 cm (height) and housed the two ectotypes separately. The snails were fed on a mixed feeding regime of forage (pawpaw leaves) supplemented with compounded diet. The compounded diet contained 24% Crude Protein (CP), 2650 kcal kg^{-1} Metabolizable Energy (ME) and 15% Ca with the following ingredients: Maize, soybean meal, fish meal, bone meal, oyster shell and vitamin premix. Feed and water in shallow troughs were given *ad libitum* throughout the study period (14 weeks).

Data collected on growth of both components for the two ectotypes were body weight, body shell length, body shell width, mouth shell length and mouth shell width. The body weights were measured using electronic scale with sensitivity of 0.01 g, while the other growth parameters were measured by vernier caliper based on number of whorls (2, 3, 4 and 5) for the two ectotypes. The collected data were analyzed using t-test statistical tool as modified by Madukwe (2004) for comparison of the measured body components between the two ectotypes.

RESULTS AND DISCUSSION

The results of body weight between the black-skinned and white-skinned ectotypes are presented in Table 1. The results revealed that mean body weights of black-skinned ectotype were 1.113, 4.147, 97.364 and 123.117 g, while the body weights of white-skinned snails recorded were 1.300, 9.620, 31.987 and 61.260 g for 2, 3, 4 and 5 whorls of the two ectotypes, respectively. These differences in mean body weights between the two ectotypes showed significant differences ($p<0.05$) for the different number of whorls studied. The results further revealed that the mean body weight obtained for white-skinned snails with 2 and 3 whorls were quite higher than that of the black-skinned. This is quite

Table 1: The t-test values of body weights (g) between black-skinned and white-skinned snail ectotype

No. of whorls	Black-skinned	White-skinned	SEM
2	1.113[a]	1.300[b]	0.040
3	4.147[a]	9.620[b]	1.558
4	97.364[b]	31.987[a]	14.991
5	123.117[b]	61.260[a]	33.083

[ab]Means along the same row bearing different superscripts are significantly different ($p<0.05$) and SEM: Standard error of mean

Table 2: Percent increment of body weights (g) for the two ectotypes based on number of whorls

	Black-skinned ectotype		White-skinned ectotype	
No. of whorls	Increment (cm)	Increment (%)	Increment (cm)	Increment (%)
2-3	3.04	73.16	8.320	86.49
3-4	93.217	95.74	22.367	69.93
4-5	25.753	20.92	29.273	47.78

Table 3: T-test values of body shell length (cm) between black-skinned and white-skinned ectotypes

No. of whorls	Black-skinned	White-skinned	SEM
2	1.770[a]	1.828[b]	0.014
3	2.895[a]	3.828[b]	0.057
4	8.986[a]	6.294[b]	0.037
5	9.871[a]	7.830[b]	0.046

[ab]Means along the same row bearing different superscripts are significantly different ($p<0.05$) and SEM: Standard error of mean

Table 4: Percent (%) increment of body shell length (cm) for the two ectotypes based on number of whorls

	Black-skinned ectotype		White-skinned ectotype	
No. of whorls	Increment (cm)	Increment (%)	Increment (cm)	Increment (%)
2-3	1.125	38.86	2.000	52.25
3-4	6.091	67.78	2.466	39.18
4-5	0.885	8.97	1.536	19.62

interesting as it is a known fact that black-skinned snails are bigger than white-skinned snails. Thus, classification of the snails on their number of whorls shows their actual position and size differences. The highest percentage weight increment of 73.16% was recorded for black-skinned snails with 2-3 whorls, whereas 86.49% was recorded for white-skinned ectotype with 2-3 whorls (Table 2). However, values of the weight increment dropped to 20.92% for black-skinned snails and 47.78% for the white-skinned snails with 4-5 whorls (Table 2). This might be due to the fact that as the snails grew to maturity at this phase or state, the snails have developed secondary sexual characteristics, thereby slower percent increment. The mean body weight values obtained in this study for the two ectotypes on the number of whorls did not agree with the views of CAB (2003) and Vanette and Larson (2004) that *Archachatina marginata* is the largest snail among the gaiant African land snails. On one hand, the results on body weight of snails in this study agreed with the results obtained by Okon *et al*. (2010), while on the other hand, the results of this study with respect to snails with 4 whorls did not agree with earlier findings by Okon *et al*. (2008) for *A. marginata* with the same number of whorls. This might be attributed to differences in the snail's size and number of whorls under the study. On the size of snails, Venette and Larson (2004) opined that fully grown snails have between 7 and 9 whorls but in this study, the snails used had whorls ranging from 2-5, meaning they were not fully matured (e.g., growing snails).

The results of mean body shell lengths of the two ectotypes are presented in Table 3. The results revealed that the body shell length of white-skinned snails with 2 and 3 whorls were 1.828 and 3.828 cm, respectively. They were quite higher than those of the black-skinned snails with the same whorls. On the other hand, the body shell lengths for black-skinned snails with 4 and 5 whorls were 8.986 and 9.871 cm, respectively. These values were quite higher than those of the white-skinned ectotype that recorded 6.294 and 7.830 cm for the 4 and 5 whorls, respectively (Table 3). The results further revealed that the increment of body shell length from 2-3 whorls in black-skinned ectotype was 1.125 cm (38.86%) and 2.000 cm (52.25%) in white-skinned ectotype (Table 4), almost double the amount showing a slow body component growth in black-skinned snail at this stage.

However, between 3 and 4 whorls, there was a high accurate increment in body shell length of about 6.091 cm (67.78%) for black-skinned snail and a lower increment of 2.466 cm (39.18%) in body shell length for white-skinned snail. In fact, between 4 and 5 whorls, low increment in body shell length of 1.536 cm (about 19.62%) was obtained for white-skinned snail, whereas, it was quite lower (about 8.97%) in the black-skinned ectotype with the same whorls. Nevertheless, there were significant differences ($p<0.05$) in mean body shell lengths between the black-skinned and white-skinned snails based on number of whorls. The results obtained on body shell length did not agree with the reports of Olawoyin and Ogogo (2006) and Okon *et al*. (2012). This

Table 5: The t-test values of body shell width (cm) between black-skinned and white-skinned ectotypes

No. of whorls	Black-skinned	White-skinned	SEM
2	1.310[a]	1.310[b]	0.004
3	1.808[a]	2.335[b]	0.011
4	5.118[a]	3.510[b]	0.014
5	5.566[a]	4.210[b]	0.009

[ab]Means along the same row bearing different superscripts are significantly different (p<0.05) and SEM: Standard error of mean

Table 6: Percent (%) increment of body shell width (cm) for the two ectotypes based on number of whorls

	Black-skinned ectotype		White-skinned ectotype	
No. of whorls	Increment (cm)	Increment (%)	Increment (cm)	Increment (%)
2-3	0.498	27.54	1.025	43.90
3-4	3.310	64.67	1.175	33.48
4-5	0.448	8.05	0.700	16.63

Table 7: The t-test values of mouth shell length (cm) between black-skinned and white-skinned ectotypes

No. of whorls	Black-skinned	White-skinned	SEM
2	1.293[a]	1.377[b]	0.004
3	1.925[a]	2.528[b]	0.015
4	5.143[a]	3.766[b]	0.012
5	5.577[a]	4.460[b]	0.020

[ab]Means along the same row bearing different superscripts are significantly different (p<0.05) and SEM: Standard error of mean

Table 8: Percent (%) incremnet of mouth shell width (cm) for the two ectotypes based on number of whorls

	Black-skinned ectotype		White-skinned ectotype	
No. of whorls	Increment (cm)	Increment (%)	Increment (cm)	Increment (%)
2-3	0.632	32.83	1.151	45.53
3-4	3.218	62.57	1.238	32.87
4-5	0.434	7.78	0.694	15.56

might be due to differences in average weight of the snails used for the study. Olawoyin and Ogogo (2006) used a lower average body weight of 13.57±1.18 g with 2 and 3 whorls. Okon *et al*. (2012) used higher average body weight ranging from 50.42-198.84 g for *Archachatina marginata* with 4 whorls. Whereas the weights of snails used in this study ranged from 0.70-153.90 g for black-skinned and 0.60-72.10 g for white-skinned ectotypes with 2-5 whorls.

The results of mean body shell width of the two ectotypes are presented in Table 5, while the results of the percentage increment for the two ectotypes are presented in Table 6. These differences obtained in the body shell width between the two ectotypes were significantly different (p<0.05) between the two ectotypes. The results of the increment of body shell width revealed that the increment from 2-3 whorls in black-skinned was 0.498 cm (27.54%) and 1.025 cm (43.90%) in white skinned, almost double the amount showing a slow body component growth in black-skinned snails at this age. However, between 3 and 4 whorls, there was a very high increment in body shell width of 3.310 cm (64.67%) for black-skinned snail and a lower increment in body shell length 1.175 cm (33.48%) in white-skinned snail. In fact, between 4 and 5 whorls, a very lower body increment of 0.448 cm (8.05%) was recorded for black-skinned snail against 0.700 cm (16.63%) recorded for white-skinned snail (Table 6). The mean body shell widths obtained in this study were not in line with the reports of Okon *et al*. (2012) with mean shell width of 4.97 mm for 4 whorls of *A. marginata* against 5.11 cm of the same whorls. This might be due to the disparity in total number, management practice and the initial weight of the snails used for the study.

The results of mean mouth shell length and percentage increment of mouth shell length of the two ectotypes are presented in Table 7 and 8, respectively. The results of the increment in the mouth shell length revealed that the increment in mouth shell length from 2-3 whorls in black-skinned was higher with 0.632 cm (32.83%) than 1.151 cm (45.53%) in white-skinned. However, between 3 and 4 whorls, there was quite higher increment in mouth shell length with 3.218 cm (62.57%) in black-skinned snail and a lower increment in the mouth shell length with 1.238 cm (32.87%) in white-skinned snail. In fact, between 4 and 5 whorls, a lower body increment of 0.434 cm (7.78%) was recorded for black-skinned snail against a lower value of 0.694 cm (15.56%) for white-skinned snail (Table 8), although the differences obtained between the two ectotypes were

Table 9: The t-test values of mouth shell width (cm) between black-skinned and white-skinned ectotypes

No. of whorls	Black-skinned	White-skinned	SEM
2	0.707[a]	0.752[b]	0.001
3	1.060[a]	1.374[b]	0.005
4	3.239[a]	2.407[b]	0.031
5	3.583[a]	3.100[b]	0.023

[ab]Means along the same row bearing different superscripts are significantly different (p<0.05) and SEM: Standard error of mean

Table 10: Percent (%) increment of mouth shell width (cm) for the two ectotypes based on number of whorls

	Black-skinned ectotype		White-skinned ectotyp	
No. of whorls	Increment (cm)	Increment (%)	Increment (cm)	Increment (%)
2-3	0.353	33.30	0.622	45.27
3-4	2.179	67.27	1.033	42.92
4-5	0.350	9.77	0.693	22.35

significantly different (p<0.05). The mean mouth shell lengths obtained in this study were not in agreement with those reported by Okon *et al.* (2012) with mean mouth shell length of 5.04 and 5.30 mm for 4 whorls of *A. marginata* and *A. fulica* against 5.143 and 3.766 cm of the same whorls for black-skinned and white-skinned ectotypes in the present study. This might be due to the disparity in total number, season, management practices and initial weight of snails in the study.

The results of mean mouth shell width and percentage increment of mouth shell width of the two ectotypes are presented in Table 9 and 10, respectively. The results of increment of mouth shell width from 2-3 whorls in black-skinned was 0.353 cm (33.30%) and 0.622 cm (45.27%) in white-skinned snails. However, between 3 and 4 whorls, there was a higher increment in mouth shell width of 2.179 cm (69.27%) in black-skinned snail and a lower increment in mouth shell width of 1.033 cm (42.92%) in white-skinned snail. Interestingly, between 4 and 5 whorls, the higher body increment of 0.693 cm (22.35%) was obtained for white-skinned snail against a lower increment of 0.350 cm (9.77%) recorded for black skinned snail (Table 10). These differences obtained between the two ectotypes were significantly difference (p<0.05) based on 2-5 whorls.The mean shell widths obtained in this study were not in lined with those reported by Okon *et al.* (2012) and Okon and Ibom (2012). Okon and Ibom (2012) reported that mean of 0.67±0.02 and 0.56±0.01 mm for both black-skinned and white-skinned juvenile snails. These differences might be due to the disparity in total number, size and initial weight of the snails used for the study.

CONCLUSION

The study on differentiation in growth of body components between black-skinned and white-skinned ectotypes of giant African land snails (*Archachatina marginata* S.) based on number of whorls in Calabar, Nigeria indicated that growth parameters (body weight, body shell length, body shell width, mouth shell length and mouth shell width) are significantly different (p<0.05) between the black-skinned and white-skinned ectotypes. There was an increasing percent increment in all body components of the black-skinned snails from 2-4 whorls studied, whereas, there was a decreasing percent increment in body components of the white-skinned snails from 2-5 whorls. Again, the highest percent increment in all the body components studied for the black-skinned snails occurred between 3 and 4 whorls, whereas this occurred in the white-skinned snail between 2 and 3 whorls. It is therefore recommended that the two ectotypes should be tested for differentiation in growth of body components with higher number of whorls as this will be very beneficial to breeders for genetic improvement of snails.

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