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RESEARCH PAPER

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A study of the relative growth of the *Achatina fulica* Snail (Bowdich, 1820) carried out in a breeding environment

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Abstract

Achatina fulica snails from two environments (Natural and Breeding) were subjected to two diets, one based on green fodder and the other based in the form of concentrate flour in order to evaluate linear growth. Thus, at the end of this study, we testify that *Achatina fulica* in the natural environment as well as in the breeding environment has a lower linear growth at the level of l/w; l/h relationship. Then, it grows less in width and height than in length. However, in terms of the height-width relationship, the linear growth is greater in the breeding environment than in the natural environment where *Achatina fulica* has a lower growth. With regard to weight growth, it should be testified that *Achatina fulica* generally gains less weight than it grows in length regardless of environment, either in natural environment or in breeding environment where snails are fed on concentrate.

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Introduction

Snail farming is growing in sub-Saharan Africa. Its tender, tasty chair, very rich in proteins, in salts minerals and especially in iron, represents an alternative source of animal protein ((Zongo *et al.,* 1990; Otchoumou *et al.,* 2003a; 2003b; 2004a; 2004b; N'da *et al.,* 2004). The species concerned are *Achatina achatina*, *Archachatina ventricosa*, *Achatina fulica*, *Archachatina marginata*, a species increasingly consumed in Côte d'Ivoire (Agongnikpo *et al.,* 2010, Dosso *et al* 2007a, Dosso *et al.,* 2007b). Research related to a snail crop focused on certain species. The choice of organic buying as a biological model for our Study is not for a star of giant snails, this species is consumed in parts of Nigeria, Togo, Liberia, Benin (Egonmwan, 1988; Edjidike *et al.*, 2004; Fagbuaro *et al.,* 2006) and Ivoiry coast.

But the pickup, consequence of an increasing demand, led to a reduction of the workforce (Stievenart and Hardouin, 1990). Thus, for its preservation, many researchers have contributed by studies to the development of purchase-farming by basing their work on breeding techniques (Upatham *et al.,* 1988, Hodasi 1989, Hardouin *et al.,* 1993), on nutrition (Ireland, 1991), on growth (Otchoumou *et al.,* 2003b, Adou *et al.,* 2011) only young adults. The success of production and especially the extension of the purchase of only by knowing the species of snails best suited to the conditions breeding, but also by controlling certain biotic and abiotic factors that directly influence their production.

It is therefore necessary to continue research on key areas for improvement. It's about determining:

1- the nutritional needs of spat for the purpose to improve their growth, to advance the age of maturity sexual

2- To reduce the development cycle while associating a high productivity. For our part, we will focus on subjecting a concentrated feed to Achatina fulica spat in order to appreciate the effect of feeding on its biological performance in aboveground breeding.

Material and methods

Study area

This center includes a shelter-based building where breeding is under shelter and an outdoor experimentation area. The average monthly relative temperature and humidity in the livestock building were 26.7 ± 1.4°C and 82.6 ± 1.4%, respectively. The photoperiod was 12 hours of light and 12 hours of darkness

Animals

The animals used in this work are Molluscs, Gastropods, Pulmonates. They belong to the order of Stylommatophores, the Super family of Achatinaceae, the family of Achatinidae, the genus *Achatina* and the *Achatina fulica* species (Bowdich, 1720).

Breeding enclosures

The snails were raised in plastic bins of 0.66 m long, 0.6 cm wide and 0.2m high, giving a base area of about 0.4 m2 and a volume of 0.08 m3. The enclosures are equipped with mosquito net type lid making a leak-proof facility. Their bottom is covered with compost from a height of 4cm thick.

Methods

240 snails, of which 120 from the natural environment and 120 from the breeding environment were used in this study. Snails from the natural environment (fed with green fodder) were picked up in the scrub around housings and garbage dumps. As for the snails from the breeding environment, they come from a breeding farm and are fed with a concentrate food formulated under the basis of the work of Otchoumou (2005).

These animals from the natural environment and the breeding environment were subsequently broken down in 5 repetitions per diet depending on the length of their shell: [3-4cm]; [4.1-5cm]; [5.1 - 6cm]; [6.1 - 8cm]; [8.1 - 10cm]. And afterwards, we carried out the weighting of the snails in each class of length according to each environment (natural and breeding) in order to compare the evolution of various parameters. The green forage plant diet was made up of *Lactuca sativa* (Asteraceae), *Carica papaya* (Caricacea), *Brassica oleracea* (Brassicaceae), *Cecropia peltata* (Moracae), *Laportea aestuans* (Urticaceae) and *Phaulopsis falcisepala* (Acanthaceae) leaves.

Food is weighed before being served to the animals every two day. At the end of the two days, the feed refusals are weighed and the feeders cleanly washed before being reused.

For each food served, a100g control is placed under the same experimental conditions in bins containing no animals (Aboua, 1990); (Adeye, 1996). The weighing of these control feeds at the same time as the food refusals, makes it possible to correct the weight due to the desiccation for the green fodder plant diet and to the hydration for the flour concentrate diets.

Table 1. Green fodder plant diet and to the hydration for the flour concentrate diets

Corn	Soybean meal	Soya bean	Soft wheat	Dicalcium phosphate	vitamin	Calcium carbonate	Salt	Trace elements	Total
19,3	16	16	15	4	0,5	28,7	0,4	0,1	100

Caracteristics (%MS)

Gross Energy cal/g	Nitrogenous material total	Calcium Total	Phosphate total	Fat	Starch	Free sugars	Free Cellulose	Ash	Total
2785	17,48	12,02	1,2	04,71	12,56	03,10	04,76	33,43	100

Table 2. Plant-based diet components.

Components (g) diets	
Carica papaya	16,66
Lactuca sativa	16,66
Brassica oleracea	16,66
Cecropia peltata	16,66
Phaulopsis falcisepala	16,66
Laportea aestuans	16,66
Total (g) 100	

Species	Sample Weight	Dry matter	Protein Total	Lipids	Mineral substances	Gross energy in cal/g
Lactuca sativa	45,12	88,42	22,28	1,26	1,1	4,195
Brassica oleracea	34,01	91,5	26,36	2,11	10,8	3,91
Laportea aestuans	48,84	94,13	32,22	4,37	23,71	3,644
Phaulopsis falcisepala	28,20	93,47	23,52	3,51	21,85	3,329
Xanthosoma mafafa	36,57	90,24	28.24	5,06	18,36	4,254
Carica papaya	56,47	92,48	27,69	4,08	13,58	3,588
Cecropia feltata	38,18	85,25	21,46	3,19	13,58	1,048

Study of relative growth

To study relative growth, several models have been proposed but the majority of them can be brought back to the law of simple allometry of HUXLEY and TEISSIER (1948). In fact, according to these authors, the relative growth in an animal boils down to the relationships between the size or the weight of an organ and the size or the weight of the whole body. This law of allometry is written as follows:

$Y = aX^b$ (1)

With,

Y: dependent variable, size or weight of the studied body;

X: independent variable, represents the reference length;

a: constant

b: coefficient of allometry

After a logarithmic transformation, the equation (1) is written:

$\text{Ln } y = \text{Ln } a + b \text{ Ln } X$ (2)

Thus, in order to determine the nature of allometry, the value of the slope (b) observed was compared with the theoretical value 1 (if these are allometric relations linking two linear parameters) or with the theoretical value 3 (if this is a linear measurement and a weight measurement).

In fact, when using the relative growth of the weight compared to a measurement of the length, it has been shown that the weight generally increases in proportion to the cube of the length. This being the case, for the weighting relation, three scenarios can occur:

- If b = 3: the growth is said to be isometric;
- If b <3: the growth is said to be minor;
- If b> 3: the growth is said to be major.

The dimensions measured in this section referred to length, width, the height of the shell and the weight of the snails (Fig.s 1 and 2). Correlations between these parameters have been studied, namely:
- live weight/shell length Combination;
- live weight/shell height Combination;
- live weight/shell width Combination.

For the linear relation, three scenarios also occur:
- If b = 1: growth is said to be isometric;
- If b < 1: growth is said to be minor;
- If b > 1: growth is said to be major.

And the relationships studied are as follows:
- length/width combination;
- length/height combination;
- width/height commination.

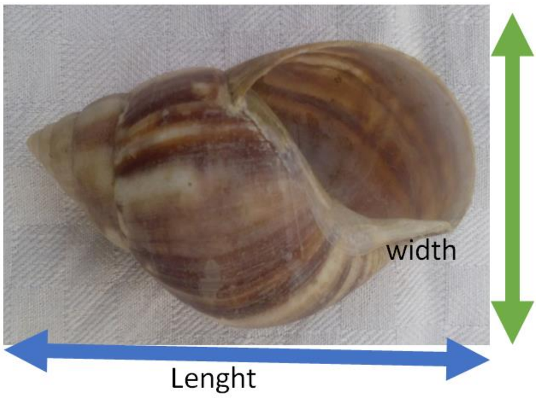


Fig. 1. Shell length and width measurements.

Fig. 2. shell height measurements.

Results and discussion

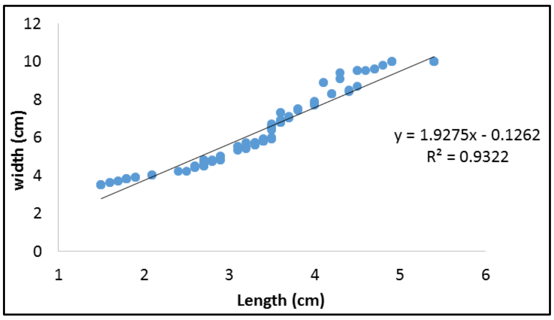
Allometry Relationship in Achatina fulica

240 individuals classified according to the length of the shell, with different weights and from different environments were submitted to this study in order to establish the allometric relations between the determined parameters.

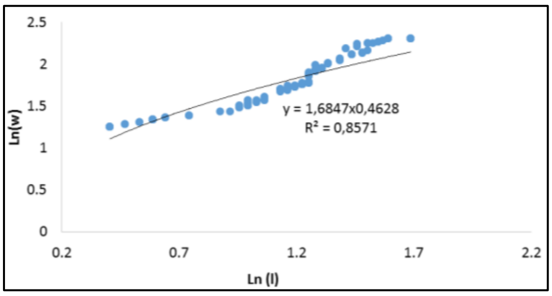
dimension/Size relationship

length-width relationship (l/w)

The adjustment line obtained in both natural and breeding environment from the logarithmic coordinates is shownd in Fig. 3 and 4. In snails from the natural environment, the correlation coefficient (R = 0.92) between the length and the width is very high and the allometry coefficient (b = 0.46) is less than 1. This value obtained is significantly different from 1 (Student test-t: p> 0.05). For those from the breeding environment, the correlation coefficient (R = 0.94) between the length and width is also very high. The coefficient of allometry (b = 0.54) is less than 1 and this value is significantly different from 1. From these remarks, *Achatina fulica* has a growth proportionally less rapid in width than in length.

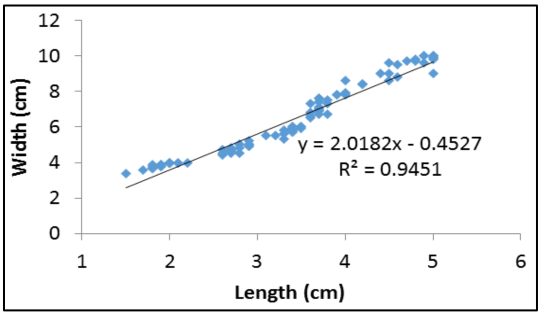


a-Linear trend curve

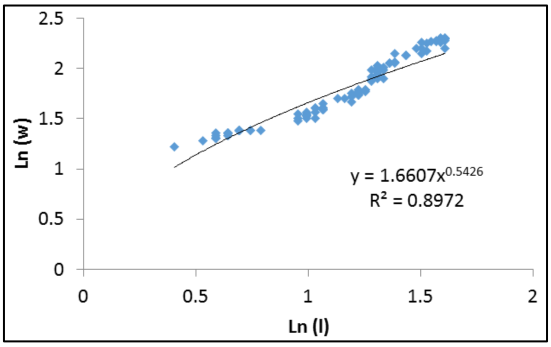


b- Power trend curve

Fig. 3. Length-width relationship in snails from natural environment.



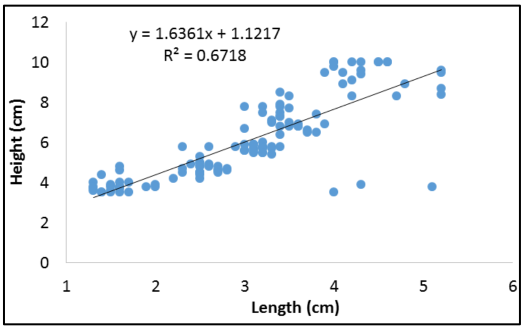
a- Linear trend curve



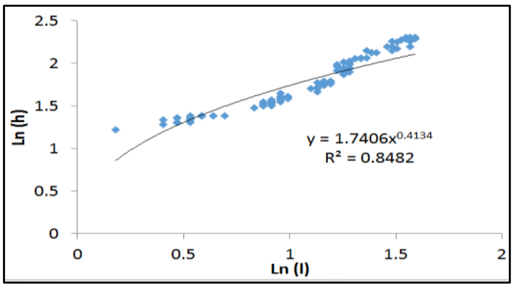
b- Power trend curve

Fig. 4. Length-width relationship in snails from the breeding environment.

The adjustment lines obtained in both environment from the logarithmic coordinates are shown in Fig. 5 and 6. The correlation coefficient (R = 0.78) of the natural environment between length and height is low, unlike that of the breeding environment (R = 0.92) which is very high. With regard to the allometric coefficients (b = 0, 319) and (b = 0.413), the values obtained are less than 1 and different from 1. *Achatina fulica* has a faster and higher growth in length than in height and this in breeding environment compared to the natural environment.

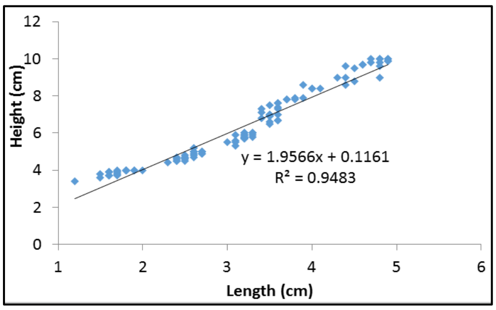


a- Linear trend curve

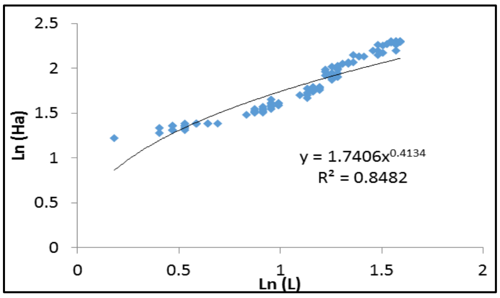


b- Power trend curve

Fig. 5. Length-height relationship in snails from the breeding environment.



a- Linear trend curve



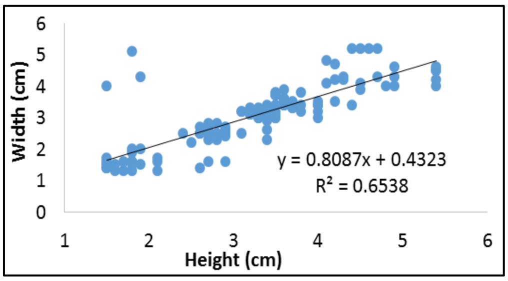
b- Power trend curve

Fig. 6. Height-width relationship in snails from the natural environment.

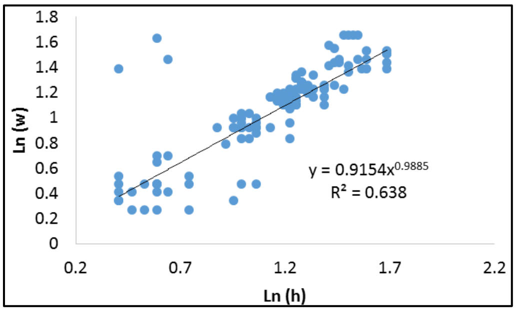
Height-width relationship (h/w)

The adjustment lines obtained in the two media from the logarithmic data are given in Fig.s 7 and 8. The correlation coefficient (R = 0.78) of the natural environment between height and width is small and the coefficient of allometry (b = 0.98) is less than 1 but close to 1.

The snails of this medium have an almost equal increase in width and height. At the rearing level, the correlation coefficient (R = 0.99) between height and width is very high. The allometric coefficient (b = 1.26) is greater than 1. *Achatina fulica* in breeding has a faster and higher growth in height than width.

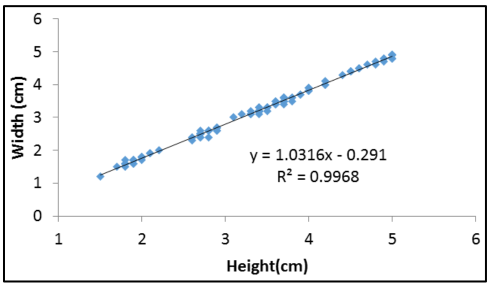


a- Linear trend curve

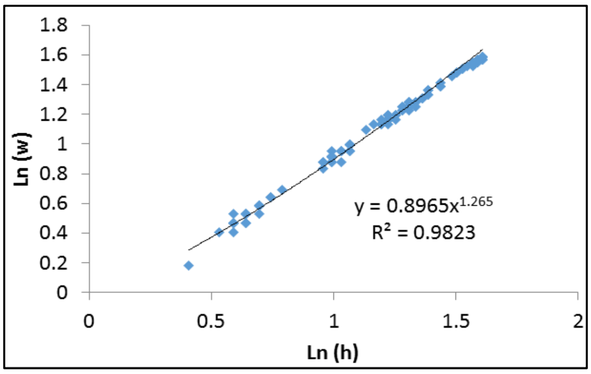


b- Power trend curve

Fig. 7. Height-width relationship in snails from breeding environment.



a- Linear trend curve



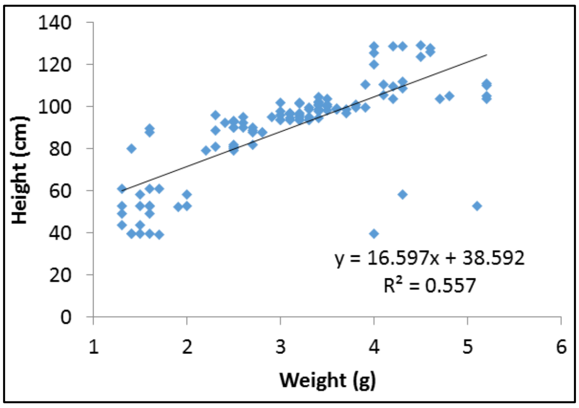
b- Power trend curve

Fig. 8. Height-width relationship in snails from breeding environment.

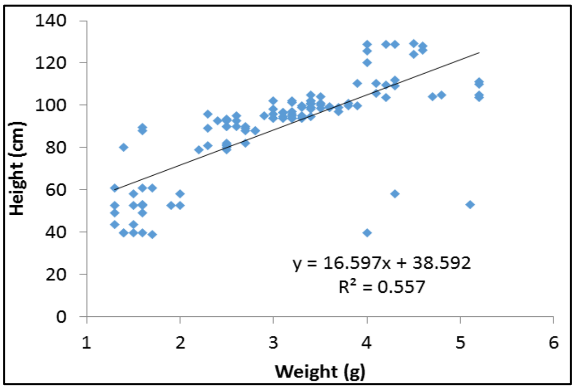
Size-Weight relationship

Weight-Height relationship (wt/h)

The adjustment lines obtained from the logarithmic coordinates of the natural environment and in the breeding environment are shown in Fig. 9 and 10. The allometric coefficients are 0.12 for the natural environment and 0.16 for the breeding environment. In both environments, the values are statistically less than 3. The increase in height is proportionally less than that of the weight. The correlation values are 0.78 for the natural environment and 0.94 for the breeding environment.

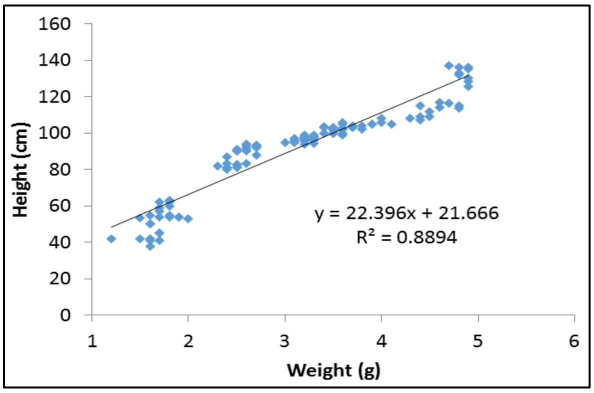


a-Linear trend curve

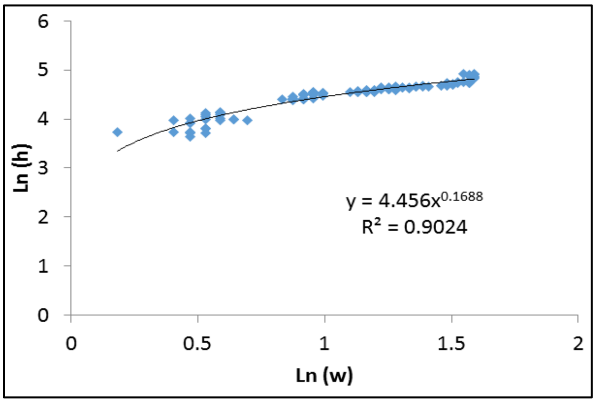


b- Power trend curve

Fig. 9. Weight-height relationship in snails from the natural environment.



a-Linear trend curve



Weight-Length relationship (wt/l)

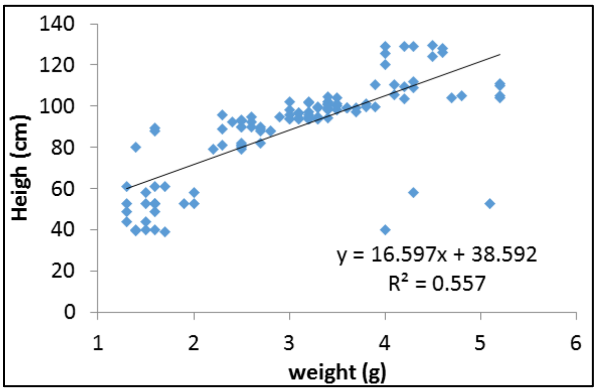
b- Power trend curve

Fig. 10. Weight-height relationship in snails from the breeding environment.

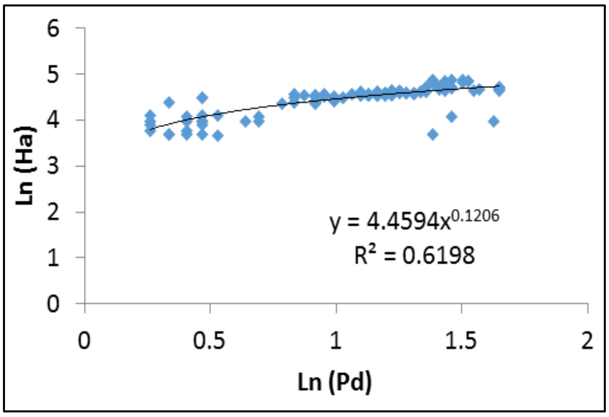
Dimension-weight relationship

Weight-Width relationship (wt/w)

The adjustment lines obtained from the logarithmic coordinates of the natural environment as in the rearing medium are presented in Fig. 11 and 12. The allometric coefficients are 0.12 for the natural environment and 0.16 for the breeding environment. In both environments the values are statistically less than 3. The increase in height is proportionally less than that of weight. The correlation values are 0.78 for the natural environment and 0.94 for the rearing environment.

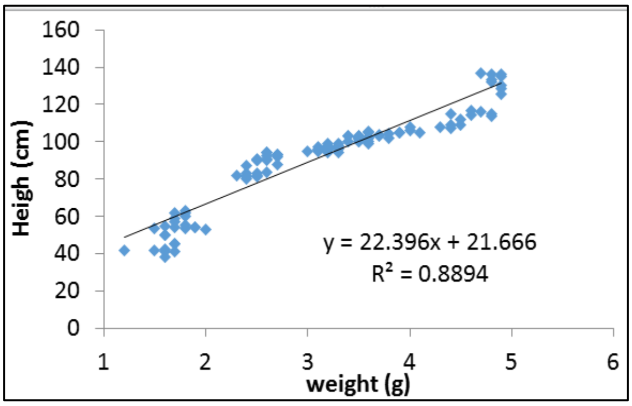


a- Linear trend curve

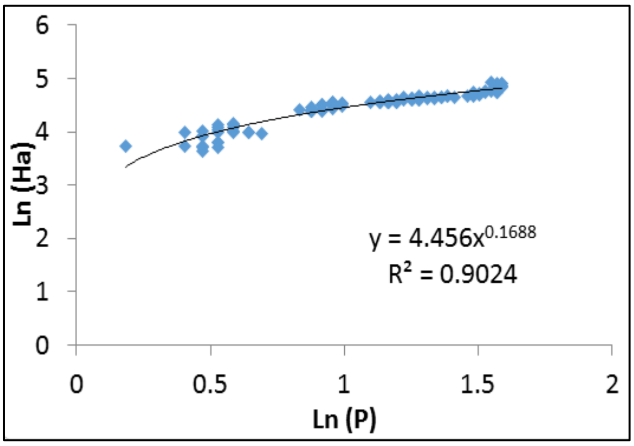


b- Power Trend Curve

Fig. 11. Weight-height relationship in snails from the natural environment.



a- Linear trend curve

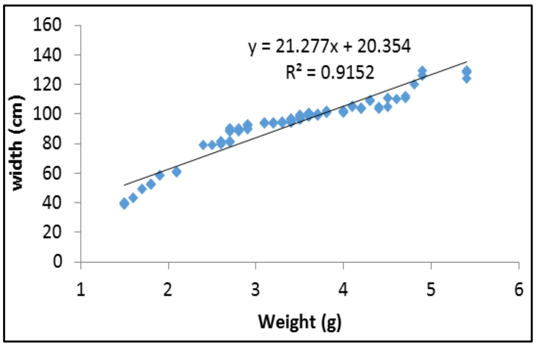


b- Power Trend Curve

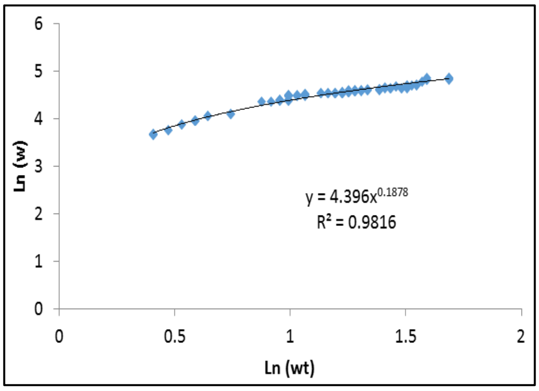
Fig. 12. Weight-height relationship in snails from the breeding environment.

Weight-width relationship

The adjustment lines obtained from the logarithmic coordinates of the two environments are shown in Fig. 13 and 14. The allometry coefficients 0.18 and 0.21 are statistically less than 3. The increase in width is proportionally weak than that of the weight. The correlation values are 0.99 for the natural environment and 0.96 for the breeding environment.

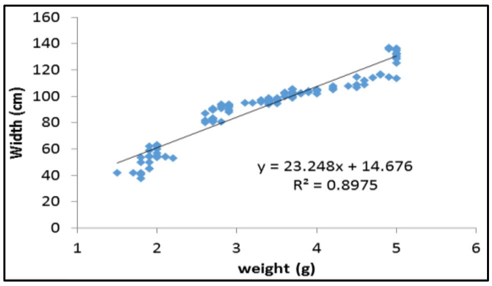


a- Linear trend curve



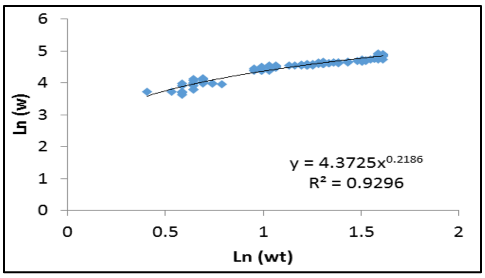
b- Power trend curve

Fig. 13. Weight-width relationship in snails from the natural environment.



Weight-length relationship

a-Linear trend curve

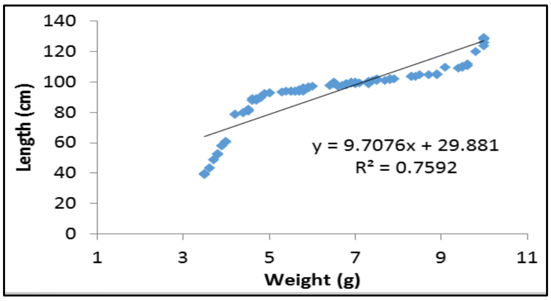


b- Power trend curve

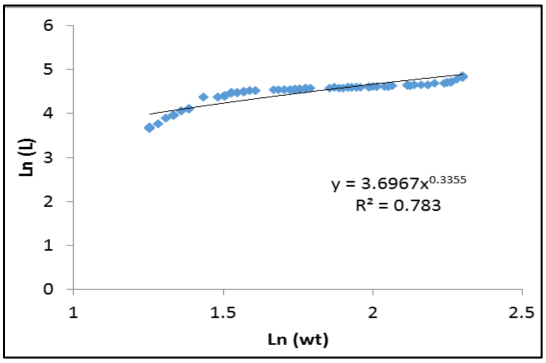
Fig. 14. Weight-width relationship in snails from the breeding environment.

Weight-length relationship

The adjustment lines from the logarithmic coordinates of the natural environment and the breeding environment are shown in Fig. 15 and 16. The allometry coefficients 0.33 and 0.35 are statistically less than 3. The increase in length of the shell is proportionally weak than that of the weight. The correlation values are 0.88 for both environnements.

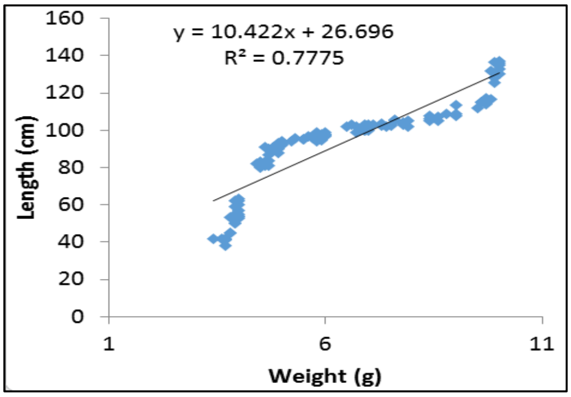


a- Linear trend curve

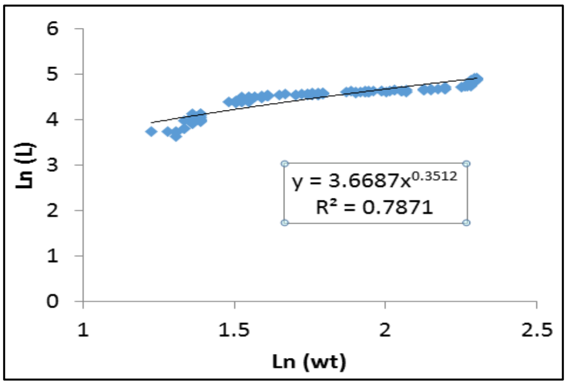


b- Power trend curve

Fig. 15. Weight- width relationship in snails from the natural environment.



a- Linear trend curve



b- Linear trend curve b- Power trend curve

Fig. 16. Weight-length relationship in snails from the breeding environment.

Table 3. Allometry relationship for Achatina fulica in natural and breeding environment.

Morphometric Report	b	R^2	R	P	Allometry P = 0,05
MN L/La ME	0,46	0,857	0,92	0,00	Lower bound
	0,54	0,897	0,94	0,00	Lower bound
MN L/Ha ME	0,39	0,6329	0,78	0,00	Lower bound
	0,413	0,8482	0,92	0,00	Lower bound
MN Ha/La ME	0,98	0,638	0,78	0,00	Lower bound
	1,26	0,9823	0,99	0,00	Higher bound
MN P/Ha ME	0,12	0,6198	0,78	0,00	Lower bound
	0,16	0,9024	0,94	0,00	Lower bound
MN P/L ME	0,18	0,9816	0,99	0,00	Lower bound
	0,21	0,9296	0,96	0,00	Lower bound
MN P/La ME	0,33	0,783	0,88	0,00	Lower bound
	0,35	0,7871	0,88	0,00	Lower bound

b: allometric coefficient; R: correlation coefficient

Discussion

The length-width, length-height and height-width ratios show that the linear growth of *Achatina fulica* is allometric (b < 1) in the natural environment. In terms of weight growth, we find that weight growth is also minor. This can be explained by the fact that in nature, several factors can influence the growth of snails including dry seasons. Indeed, according to Otchoumou, 2007, snails are in summer during these dry periods. This situation therefore causes the snails to stop growing because they stop feeding and bury themselves in the soil. However, the linear growth in the rearing environment is better than that of the natural environment.

In fact, the factors influencing growth in the wild are well controlled in the breeding farms, which has little influence on the growth of snails and thus favor activities such as the nutrition of these animals. Our results in terms of weight parameters indicate that the growth of *Achatina fulica* is also lower in both environments. In fact, the weight growth of the breeders in the wild is low compared to the snails from the breeding environment (Hodasi, 1979). And this goes in the direction of our results because in a breeding environment, animals are better fed with very rich concentrated foods that provide them with the nutrients they need for their development (Otchoumou, 2005). It should be noted, however, that the growth of snails in the wild may be greater than that of the rearing medium. This is somewhat the case with our results in the weight-length relationship, where growth in the rearing environment is lower than in the natural environment. This is explained by the fact that the density of more than 100 snails per m^2 for individuals around 9 months old is much higher than normal, which are 50 snails per square meter. This state of affairs is explained by the fact that stocking density is a significant factor for snail growth (Otchoumou, 1997).

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