## DEPARTMENT OF ANIMAL SCIENCE

Faculty of Agriculture, Forestry and Wildlife Resources Management


UNIVERSITY OF CALABAR

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VICE CHANCELLOR


The Department of Animal Science, University of Calabar, Calabar was created from the then single unit of Agriculture in January, 1986. From the initial first degree (B. Agric.) Programme, it has grown in infrastructure, number of students and staff population. It now offers Post Graduate Diploma (PGD), Master of Science (M.Sc.) and Doctor of Philosophy (Ph.D) Programmes.

The Department is devoted to producing undergraduate and post graduate students with an environment and opportunity to expand their knowledge and to develop their creative and scholarly abilities.

Based on the above premise, the Department of Animal Science is proud to partner the Research Network on Giant African Land Snails (NetGALs) in hosting the 5th International Conference/Workshop on Giant African Land Snails (GALS) with the theme: *Sustainable Snail Farming as an enterprise for economic empowerment* from 5th to 9th June, 2016. This conference is apt and timely particularly now that the modern trend in animal production is geared towards enhancing animal protein intake adequacy for the teeming population through micro livestock production. Snail farming (heliculture or Achatiniculture) is novel and there is dearth of snail - based research information/data in the current animal agriculture paradigm. Hence, all hands must be on deck to support this worthy initiative by NetGALs.

Furthermore, I hope that the participants (scholars/researchers, entrepreneurs and students) would find a niche in snail farming through this auspicious conference/ workshop.

Finally, may I seize this opportunity to welcome all participants to Calabar (**Come and Live and Be at Rest**). Enjoy the warmest hospitality of our people, alongside the clean and green environment and above all the serenity and peace of the 'Peoples Paradise'.

Thank you for coming and wishing you journey mercies to your various Institutions/destinations.

Dr. M. I. Anya
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PROCEEDINGS OF THE 5TH INTERNATIONAL CONFERENCE/WORKSHOP ON GIANT AFRICAN LAND SNAILS (NetGALS) 5TH-9TH JUNE.

NetGALS

# PROCEEDINGS OF 5th INTERNATIONAL CONFERENCE/WORKSHOP ON GIANT AFRICAN LAND SNAILS (NetGALS)

THEME:

# SUSTAINABLE SNAIL FARMING AS AN ENTERPRISE FOR ECONOMIC EMPOWERMENT

DATE: 5TH - 9TH JUNE, 2016

HELD AT
**NEW SENATE CHAMBERS**
**UNIVERSITY OF CALABAR, CALABAR.**


EDITED BY
PROF. B. OKON, DR. L. A. IBOM & PROF. B. O. ASUQUO



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# RESEARCH NETWORK ON GIANT AFRICAN LAND SNAILS

NetGALS

## PROCEEDINGS OF 5$^{TH}$ INTERNATIONAL CONFERENCE/WORKSHOP

EDITORS
PROF. B. OKON, DR. L. A. IBOM & PROF. B. O. ASUQUO

DEPARTMENT OF ANIMAL SCIENCE
FACULTY OF AGRICULTURE, FORESTRY &
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**TABLE OF CONTENTS**

*Proceedings of the 5th International Conference/Workshop on Giant African Land Snails (NetGALS) 5th-9th June.*

Proceedings of the 5th International Conference/Workshop on Giant African Land Snails (NetGALS) 5th-9th June.

# REPRODUCTIVE PERFORMANCE OF $F_2$ *ARCHACHATINA MARGINATA* SNAILS OBTAINED BY CROSSING FIRST FILIAL GENERATIONS OF HETEROZYGOUS AND HOMOZYGOUS BLACK-SKINNED SNAILS IN CALABAR, NIGERIA

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**Abstract:**
The reproductive performance of $F_2$ snails (Archachatina marginata var. saturalis) obtained by crossing first filial generation heterozygous snails and first filial generation homozygous snails was evaluated. 40 sexually matured $F_1$ snails, 20 each of homozygous black and heterozygous black were crossed to generate the $F_2$snails. The $F_2$snails were raised to sexually maturity and their reproductive performance monitored and compared to that of their parents. The results shows a significant ($p<0.05$) difference in thereproductive parameters of the three mating groups from the terminal point of the juvenile phase up to the point of sexual maturity with exception of the mean hatchling shell 'mouth' length which was not significantly ($p>0.05$) different. The results confirmed an improvement on the reproductive performance of the $F_2$ snails compared to the parents crossbred snails in all the parameters under study with exception of percent (%) hatchability in which the $F_1$ heterozygous snails performed better than the $F_1$ homozygous and $F_2$ snails. The result of this study further established the possibility of improving the performance of snails to produce a hybrid snail that can meet the expectations of farmers through cross breeding.

**Keywords:**

## Introduction

As the world is ushered into the modern era of civilization and increased global population, food and its availability will continue to be a major issue, which will definitely have profound impacts on the lives of humans than ever before. Unequivocally, protein is essential for the growth, development and maintenance of the body cells, tissues and organs. However, high levels of cholesterol have placed a limitation to the extent which most livestock contribute to the much needed animal protein intake (USDA, 2006). Availability of safe and reliable source of protein is an essential prerequisite for sustainable human development. Wosu (2003) reported that snails contain higher protein and low cholesterol levels when compared to other animal protein sources, thus making them health friendly.

The improvements of the reproductive performance of giant African land snails in order to increase their contribution to the much needed animal protein in Nigeria is inevitable, with the depleting population of wild snails due to drought, over hunting and effect of global warming in general. This could probably be done by making crosses of several generations and then evaluating the performance of the hybrid snails which can meet the productive expectation of farmers, and as such bring about quicker returns on investment. This research therefore focused on evaluation of the reproductive performance of hybrid snails generated by crossing heterozygous black-skinned first filial generation snails with Homozygous black-skinned first filial generation.

## Materials and methods

Forty sexually mature *Archachatina marginata* snails were used in this study, twenty each of the heterozygous black-skinned first filial generation and homozygous black-skinned first filial generation. The two snail groups were mated to each other, to generate the $F_2$ snails. The snails were managed intensively in wooden cages kept under trees with canopies to provide a suitable environment for optimum performance throughout the experimental period (41weeks). Data collected on the reproductive performance of the $F^2$ crossbred and the parent crossbred included: mean clutch size (number of eggs per lay), mean egg weight at lay (g), mean egg length at lay (mm), mean egg width at lay (mm), mean hatchling body weight at hatch (g), mean hatchling shell length at hatch (mm), mean hatchling shell width at hatch (mm), mean hatchling shell 'mouth' length at hatch (mm), mean hatchling shell 'mouth' width at hatch (mm), mean number of eggs hatched (per clutch), mean incubation period (days) and percent (%) hatchability.

Statistical analyses

The Completely Randomized Design (CRD) was used for this experiment. Data collected were subjected to statistical analysis using student t-test and observed means were separated using the least significant difference method.

The Statistical model used for the experiment is:

$Y_{ij}$ = $\mu + B_i + e_{ij}$

Where:

$Y_{ij}$ = Single Observation

$\mu$ = Common Mean

$B_i$ = Effect of Genotype on reproduction parameters

$E_{ij}$ = Random error effects iind $(0, \delta^2)$

### Results and Discussion

The results of the reproductive parameters of the $F_2$ snails and that of $F_1$ heterozygous and $F_1$ homozygous snails are presented on Table 1. The mean clutch size per lay of the three groups were significantly (p< 0.0.5) different. The $F_2$ snails recorded the highest mean value of 6.89 eggs followed by the $F_1$ homozygous snails which recorded 6.44 eggs, while the $F_1$ heterozygous snails recorded 6.00 eggs. These results compared favourably with the mean clutch size range of 5.08 to 6.58 reported by Owoyemi (2014) for *Archachatina marginata*. More so, the result is similar to the value of 5.23 for mean clutch size of the purebred White-skinned of *A. marginata* reported by Ibom *et al*. (2008). Ubua *et al.* (2012) also reported mean clutch size of 7.70 and 5.0 for *A. marginata ovum* and *A. marginata saturalis* respectively. These results go a long way to shows that there is a likely sustainable improvement in the clutch size of hybrid snails obtained through cross breeding as a result of bringing together of genes for egg production from the $F_1$ parents to the $F_2$ hybrid snail. The variation in the mean clutch size observed might be attributed to the age of the snails, size and the interactive effect of the environment. This is in agreement with the report of Okon and Ibom (2012) on variation of mean clutch size of *A. marginata* parent snails.

The mean egg weight at lay of the three groups of snails were significantly (p<0.0.5) different. The $F_2$ snails recorded the highest mean egg weight value at lay value (1.49g), followed by the $F_1$ homozygous snails which recorded 1.46g, while the $F_1$ heterozygous snails recorded 1.24g. The results are similar to 1.20g for Black-skinned × Black-skinned (BS × BS) mating group and 1.01g for White-skinned × White-skinned (WS × WS) mating group reported by Owoyemi (2014). Okon (2013) reported similar mean egg weight values of 1.83g for Black-skinned snails and 1.08g for white-skinned (albino) snails. More so, the results recorded in this study are similar to the mean value of 1.05g for albino snails reported in Ibom *et al.* (2008). However, the results were lower than the mean egg weight of 1.73g and 1.57g reported by Ubua *et al.* (2012) for *A. marginata ovum* and *A. marginata saturalis* respectively. The variation in the mean egg weight at lay may be attributed to variation in the body weight of the $F_1$ parent snails used in the study, genotype, age of the parent snails at point of lay and the prevailing environmental or climatic conditions during the period of study. These findings are in agreement with the report of Okon *et al.* (2010a) on the variation of mean egg weight of *A. marginata* snails.

The mean egg length values of the crossbred snails at lay were significantly (p<0.05) different between the three groups. The $F_2$ snails recorded mean egg length value of 1.59mm, followed by the $F_1$ homozygous snails that recorded 1.51mm, while $F_1$ heterozygous recorded 1.35mm. The values obtained in this study compared favourably with the values of 1.61mm and 1.43mm for black-skinned snails and white-skinned (albino) snails respectively reported by Ibom *et al.* (2008). However, the results of this study were lower than the mean egg length values of 16.8mm for Black-skinned snails and 14.3mm for white-skinned (albino) snails reported by Okonta (2012). More so, the results differed from the mean egg length values of 19.70mm for Black-skinned snails





reported by Amubode (1994). The variations observed between the groups in this study could be attributed to the inherent genetic composition of the snails and the weight and age of the snails at point of lay. This corroborated the report of Okon *et al.* (2010a). The mean egg width of the crossbred snails at lay were significantly (p<0.05) different between the groups. The $F_2$ snails recorded mean egg width value of 1.43mm, followed by the $F_1$ homozygous snails which recorded 1.25mm, while the $F_1$ heterozygous recorded 1.22mm. The values obtained in this study compared favourably with the values of 1.29mm and 1.05mm for black-skinned snails and white-skinned (albino) snails respectively, as reported by Ibom *et al.* (2008). However, the results of this study were lower than the mean egg width at lay values of 13.2mm for Black-skinned snails and 10.7mm for white-skinned (albino) snails reported by Okonta (2012). More so, the results differ from the mean egg width values of 14.20mm for Black-skinned snails reported by Amubode (1994). However, the variations observed within the groups for this trait could be attributed to the inherent genetic makeup of the snails, the weight and age of the snails at point of lay, which agree with the report of Okon *et al.* (2010a).

Mean hatchling body weight at hatch of the three groups were significantly (p<0.0.5) different. The $F_2$ group recorded the highest mean value of 0.97g, followed by $F_1$ homozygous group with 0.92g, while the $F_1$ heterozygous recorded 0.83g. The results recorded in this study compared favourably with 1.14g for Black-skinned × Black-skinned (BS × BS) mating group and 0.77g for White-skinned × White-skinned (WS × WS) mating group reported by Okon *et al.* (2012). Okon (2013) reported similar mean hatchling weight values at hatch; 1.21g for Black-skinned snails and 0.87g for white-skinned (albino) snails. The results recorded in this study were higher than the mean hatchling weight values at hatch; 0.73g and 0.53g reported by Owoyemi (2014) for Black-skinned × Black-skinned (BS × BS) mating group and White-skinned × White-skinned (WS × WS) mating group of *Archachatina marginata* respectively. The variation in mean hatchling weight at hatch may be attributed to variation in the mean egg weights of the crossbred parent snails used in the study, genotype, age and size of the parent snails at point of lay and the prevailing environmental or climatic conditions during the period of study. The results of this study have shown a probable predictable developmental pattern of the three mating groups of snails, as reflected by the hatchlings mean weight at hatch. This finding compares with the report of Ibom (2009) who opined that the weight of hatchlings at day-old is an indicator for hatchlings developmental pattern.

The mean hatchling shell length at hatch of the three groups of snails were significantly (p<0.0.5) different. The $F_2$ snails recorded the highest mean value of 1.66mm, followed by the $F_1$ homozygous snails which recorded 1.39mm, while the $F_1$ heterozygous snails recorded 1.14mm. The results recorded in this study compared favourably with 1.41mm for Black-skinned × Black-skinned (BS × BS) mating group and 1.32mm for White-skinned × White-skinned (WS × WS) mating group reported by Ibom *et al.* (2011). The results also compared favourably with the range of 1.15mm to 1.38mm reported by Okon *et al.* (2010a) for hatchlings shell length at hatch of *Archachatina marginata* snails. However, Okon *et al.* (2012) reported very high mean hatchlings shell length at hatch value of 14.30mm for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 14.0mm for White-skinned × White-skinned (WS × WS) *A. marginata* snails. The variation in the mean hatchlings shell length at hatch of the parent snails could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the snails, incubation conditions as well as other environmental conditions during incubation and eventual hatching of eggs. These findings agreed with the postulations of Okon *et al.* (2012) that body measurements could reflect a probable predictable developmental pattern of snails, as reflected by the hatchlings shell length at hatch. This finding also corroborated the report of Ibom (2009) that day-old hatchling shell length could serve as an indicator for hatchlings development pattern.

Mean hatchlings shell width at hatch of the three mating groups were significantly (p<0.0.5) different. The $F_2$ hybrid snails recorded the highest mean value of 1.28mm, followed by the $F_1$ homozygous which recorded 1.09mm, while the $F_1$ heterozygous recorded a mean value of 0.94mm. These results are similar to 1.16mm for Black-skinned × Black-skinned (BS × BS) mating group and 1.08mm for White-skinned × White-skinned (WS × WS) mating group reported by Ibom *et al.* (2011). However, the results were lower than the mean hatchlings shell width at hatch value of 11.80mm for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 10.30mm for White-skinned × White-skinned (WS × WS) *A. marginata* snails reported by Okon *et al.* (2012). The variation in the mean hatchling shell width at hatch of the parent snails could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the snails, incubation conditions as well as other environmental conditions during incubation and eventual hatching of eggs. These findings agreed with the postulations of Okon *et al.* (2012) that body measurements could reflect a probable predictable developmental pattern of the two mating groups of snails, as reflected by the hatchlings shell width at hatch. This finding also corroborated the report of Ibom (2009) that day-old hatchlings shell width could serve as an indicator for hatchlings development.

The mean hatchlings shell 'mouth' length at hatch results of the three mating groups (Table 1) were not significantly (p>0.0.5) different. $F_2$ group recorded the highest numerical mean value of 1.15mm, followed by the $F_1$ homozygous which recorded 0.92mm, while the $F_1$ heterozygous recorded 0.89mm. The results are similar to 1.05mm for Black-skinned × Black-skinned (BS × BS) mating group and 0.96mm for White-skinned × White-skinned (WS × WS) mating group reported by Ibom *et al.* (2011). However, Owoyemi (2014) reported hatchlings shell 'mouth' length value at hatch of 0.90cm for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 0.80cm for White-skinned × White-skinned (WS × WS) *A. marginata* snails. The variation in the mean hatchlings shell 'mouth' length at hatch of the snails could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the snails, incubation conditions as well as other environmental conditions during incubation and eventual hatching of eggs. These findings also agreed with the postulations of Okon *et al.* (2012) that body measurements could reflect a probable predictable developmental and morphological pattern of the two mating groups of snails, as reflected by the hatchlings shell 'mouth' length at hatch.

The mean hatchling shell 'mouth' width at hatch of the three mating groups (Table 1) were significantly (p<0.0.5) different. The $F_2$ snails recorded the highest numerical mean value of 0.95mm, followed by $F_1$ homozygous which recorded 0.84mm, while the $F_1$ heterozygous recorded 0.74mm. Also, there is similarity between the results of this study and 0.67mm for Black-skinned × Black-skinned (BS × BS) mating group and 0.65mm for White-skinned × White-skinned (WS × WS) mating group reported by Ibom *et al.* (2011). Owoyemi (2014) reported hatchlings shell 'mouth' width value at hatch of 0.51cm for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 0.30cm for White-skinned × White-skinned (WS × WS) *A. marginata* snails. The variation in the mean hatchlings shell 'mouth' width at hatch of the parent snails could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the snails, incubation conditions as well as other environmental conditions during incubation and eventual hatching of eggs. These findings agreed with the postulations of Okon *et al.* (2012) that body measurements could reflect a probable predictable developmental and morphological pattern of the two mating groups of snails, as reflected by the hatchlings shell 'mouth' width at hatch.

The mean incubation period of the three mating groups were not significantly (p>0.0.5) different. The $F_2$ snails recorded the highest numerical mean value of 26.44 days, followed by $F_1$ homozygous which recorded 26.33 days, while the $F_1$ heterozygous recorded 25.44 days. The results recorded in this study compared favourably with a range values of 25 – 30 days for Black-skinned × Black-skinned (BS × BS) mating group and 20 – 37 days for White-skinned × White-skinned (WS × WS) mating group reported by Okon *et al.* (2012b). More so, Okon *et al.* (2012a) reported





incubation periods of 11 – 30 days, 16 – 30 days and 15 – 30 days for black-skinned x black-skinned purebred cross, white-skinned x white-skinned purebred cross and black-skinned x white-skinned crossbred cross of *A. achatina*. Owoyemi (2014) reported range of incubation period of 10 – 25days (mean of 18 days) for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 10 – 27 days (mean value of 17 days) for White-skinned × White-skinned (WS × WS) *A. marginata* snails. The differences in the mean incubation period could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the snails, incubation conditions as well as other environmental conditions during incubation.

These findings agreed with the findings of Okon *et al.* (2012). The results of mean percent (%) hatchability of the three mating groups were significantly (p<0.0.5) different. The $F_1$ heterozygous snails recorded the highest mean value of 88.41%, followed by $F_1$ homozygous which recorded 88.09%, while the $F_2$ snails recorded mean value of 87.43%. The results recorded in this study were higher than the value of 52.45% for Black-skinned × Black-skinned (BS × BS) mating group and 38.33% for White-skinned × White-skinned (WS × WS) mating group reported by Okon *et al.* (2010a) at the first filial generation ($F_1$). Percent hatchability value range of 29 to 100% (mean of 53.75%) for Black-skinned × Black-skinned (BS × BS) *A. marginata* snails and 0 to 83.0% (mean of 50.50%) for White-skinned × White-skinned (WS × WS) *A. marginata* snails was reported by Owoyemi (2014). Okon *et al.* (2012a) reported percentage hatchability of 76.28% for purebred black-skinned genotype, 76.28% for purebred white-skinned genotype and 69.27% for crossbred genotype of *A. achatina*. The differences in the mean percent hatchability could be attributed to differences in the strains used, the ages of the snails at mating, sizes of the eggs, incubation conditions as well as other environmental conditions during incubation. These findings agreed with the findings of Okon *et al.* (2009).

**Conclusion and Recommendations**

This study on the evaluation of the reproductive performance of $F_2$ *Archachatina marginata* snails obtained by crossing first filial generation heterozygous black-skinned and first filial generation homozygous black-skinned snails in Calabar has shown that there is possibility of improving on the reproductive performance of giant African land snails through cross breeding. This will result in the development of hybrid snails that can breed through, in order to increase their contribution to the much needed animal protein in Nigeria and as such feel the gap created by the depleting population of wild snails due to drought, over hunting and effect of global warming.

We therefore strongly recommend the intensification of crossbreeding research to take advantage of the additive genetic effect of genes so as to facilitate the development of hybrid snails which can meet the productive expectation of farmers, and as such bring about quicker returns on investment.

Table 1: Reproductive parameters of $F_2$ snails obtained by crossing first filial generations of heterozygous and homozygous black-skinned snails.

| Reproductive traits | Mating groups/crosses | | | |
|---|---|---|---|---|
| | $F_2$ | $F_1BB$ | $F_1BW$ | ± SEM |
| Mean Clutch Size (per lay) | 6.89[a] | 6.44[b] | 6.00[c] | 0.35 |
| Mean egg weight at lay (g) | 1.49[a] | 1.46[ab] | 1.24[c] | 0.06 |
| Mean egg length at lay (mm) | 1.59[a] | 1.51[ab] | 1.35[c] | 0.04 |
| Mean egg width at lay (mm) | 1.43[a] | 1.25[b] | 1.22[bc] | 0.04 |
| Mean hatchling Body weight at hatch (g) | 0.97[a] | 0.92[ab] | 0.83[c] | 0.03 |
| Mean hatchling shell length at hatch (mm) | 1.66[a] | 1.39[b] | 1.14[c] | 0.01 |
| Mean hatchling shell width at hatch (mm) | 1.28[a] | 1.09[b] | 0.94[a] | 0.01 |
| Mean hatchling Shell 'Mouth' Length at hatch (mm) | 1.15 | 0.92 | 0.89 | 0.02 |
| Mean hatchling Shell 'Mouth' width at hatch (mm) | 0.95[a] | 0.84[b] | 0.74[c] | 0.01 |
| Mean incubation period (days) | 26.44[a] | 26.33[ab] | 25.44[c] | 0.80 |
| % hatchability | 87.43[c] | 88.09[ab] | 88.41[a] | 3.69 |

$F_2$ = Second filial generation, $F_1BB$ = First filial generation Homozygous Black, $F_1BW$ = First filial generation Heterozygous Black, SEM = Standard Error of Mean
[ab]Means with different superscript along the same row are significantly different ($p<0.05$).

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