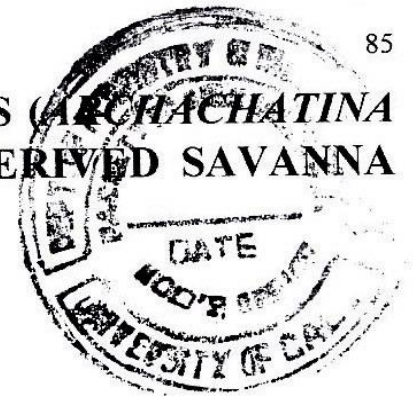


OPTIMAL STOCKING DENSITIES OF SNAILS (*ARCHACHATINA MARGINATA OVUM*, SWAINSON) IN THE DERIVED SAVANNA ZONE OF NIGERIA

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ABSTRACT

Human Consumption of snail is as old as man himself. Interest in snail farming in Nigeria is on the increase. No work has been done on the stocking density of this species of snails in the Derived Savanna Zone of Nigeria. Optimal stocking densities of breeding and hatchling snails of *Archachatina marginata ovum* (A. m. o. wainson) were determined through two experiments between January and August 1999. In the first experiment, reproductive performance of *Archachatina marginata ovum* (Swainson) stocked in cages at increasing density levels of 8, 20, 40, 60 and 80 snails m² was determined using 208 adult snails in a randomised complete block design. Reproductive indices measured included: the number of clutches, the number of egg per clutch, mortality of adult snails, percentage hatchability of eggs, and mass (g) of day-old hatchlings. In the second experiment, growth indices of hatchling snails of *Archachatina marginata ovum* (Swainson) stocked in cages at increasing density levels of 25, 50, 75, 100 and 125 snails m² were measured using 60 hatchlings with a mean mass of 13 ± 2.5 g and mean shell length of 3.9 ± 0.25mm in a randomised complete block design. The growth parameters measured included mass (g), shell length (mm) and feed intake (g). Analyses of variance (ANOVA) followed by Duncan's Multiple Range Test where necessary were used to analyse data. For the breeding snails, treatments with 8, 20 and 40 snails m² had mean mortalities of 0.0%, 8.3% and 6.0%, respectively. These were not significantly different from each other but were significantly different ($P < 0.05$) from treatments with 60 and 80 snails/m² (15.9% and 19.4% respectively). Eight snails m² was found to be uneconomical. Twenty to 40 snails/m² was found to be the optimal stocking density of breeding snails of A.m.o. This range is recommended for use in snail farms. For the snail hatchlings, treatments with 50, 75 and 100 snails /m² had mean daily mass gains of 6.6g, 3.8g and 3.3g; mean feed conversion ratios of 4.3, 8.7 and 12.4; and mean shell length gains of 3.0 mm, 2.5 mm and 1.6 mm respectively, which gave some significant differences ($P < 0.05$) from each other. Fifty snail hatchlings/m² was found to be uneconomical. The optimal stocking density of snail hatchlings of A.m..o.was found to be between 70 -100 snails m². This range is therefore recommended to be used in snail farms. It is also recommended that the surface area of any snail enclosure be increased by placing objects like logs, broken earthen pots and old tyres which could help to increase the stocking density of snails.

INTRODUCTION

Human consumption of snails is as old as man himself. West Africa and Western Europe have been identified as the two main areas of snail consumption today (Elmslie 1982). There is also a booming international trade in snails worldwide. France, Italy and the United States of America are the major importers of snails (Cobbinah, 1993). Snail meat is of high nutritive value, having a crude protein value of 18% and 51.30% for *Archachatina marginata* and *Achatina achatina*, and an iron content of 12.2% and 45.7%, respectively (Graham, 1978; Imevbore and Ademosun, 1989). This makes snail meat richer than most conventional sources of animal protein like beef and chicken. Interest in snail farming in Nigeria is on the increase. A number of snail farms have been established by some individuals and institutions especially in the south western and south eastern parts of the country. Research work on the giant African snail (*Archachatina marginata*, Swainson) done so far has been in the area of the snails' anatomy (Segun, 1975), nutrition and reproductive rate (Ajayi *et al.*, 1978 ; Plummer, 1975; Amubode and Ogogo, 1995), housing, pests and diseases (Akintomide, 1997 and Elmslie, 1982). No work has been done on the stocking density of this species in the Derived Savanna zone of Nigeria. Information on the optimal stocking density is required for a reliable feasibility study to be carried out and a model snail farm established. This work was undertaken to determine the optimal stocking densities of breeding and growing snails of *Archachatina marginata ovum* in order

Keywords: Nigeria, Hatchling snails, Stocking rate, Increasing densities.

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to recommend them to snail farmers.

MATERIALS AND METHODS

Two experiments were performed, one on the reproductive performance of adult snails stocked at increasing density levels and the other, on the growth rate of snail hatchlings stocked at increasing density levels.

Experiment I: Reproductive performance of adult snails of *Archachatina marginata ovum* (Swainson) stocked at increasing density levels

Four snail breeding cages measuring 2.28 m in length by 0.66 m in width were constructed with sawn hard wood and wire mesh. The bottom and sides were covered with 0.025 m thick planks while the top cover was made of wooden frames and covered with wire mesh of 0.02 m mesh size. The depth of the cages was 0.48 m. The bottom was perforated to allow drainage of irrigation water. Each cage was subdivided into five compartments with internal dimensions of 0.60 m by 0.42 m giving an area of 0.252 m² per compartment. Each compartment had a separate cover affixed with hinges staple and padlock. The compartments were each filled with garden topsoil to a height of 10 cm from the bottom. Heating it in a drum up to boiling point and leaving it to cool for 48 hours had previously sterilized the soil. The legs of the cages were placed inside metal cans in which some quantity of used engine oil was put. This was to prevent ants and other crawling insects from climbing up into the snail cages. The cages were placed underneath *Mangifera indica* trees behind the crop science unit in Okuku Campus, of the University of Calabar.

Two hundred and eight (208) adult snails of *Archachatina marginata ovum* (Swainson) with a mean mass of 125 ± 25 g were obtained directly from snail gatherers who picked them from forests around Boki Local Government Area of Cross River State, Nigeria. There were five treatments with four replicates each in a randomised complete block design. Treatments 1 to 5 had 8, 20, 40, 60 and 80 snails /m², respectively. The snails were numbered from 1 to 208 with a blue marker and randomly distributed into the compartments. The snails were fed with fresh *Carica papaya* leaves supplemented with a compounded feed mash containing 140.1 g protein kg⁻¹, 1950 k. Cal ME kg⁻¹ and 1180 ppm calcium kg⁻¹ as recommended by Amubode and Ogogo (1995). Feed was given *ad libitum*.

Two litres of water was used to irrigate each compartment daily to provide a moist environment required for optimal performance of snails. Feeding and irrigation were done only in the evening between 1700 hours and 1800 hours. A piece of foam was placed inside each compartment and soaked with water to provide drinking water for the snails. *Musa paradisiaca* leaves were used to mulch each cage in order to conserve moisture and protect the snails from direct sunlight.

The number of clutches of eggs, number of eggs, and mortality of adult snails, was obtained by observing and recording these parameters at 0700 hours and 1800 hours daily. Hatchlings were removed, cleaned and weighed as soon as they emerged from incubating eggs to obtain the mass of 1-day old hatchlings.

Experiment II: Growth rate of snail hatchlings stocked at increasing density levels

Four snail fattening cages measuring 1.15 m long by 0.25 m wide each, were constructed with sawn hardwood, wire mesh and nylon mosquito net. The legs were made of 0.05 m thick sawn hardwood while the bottom and sides were covered with 0.025 m thick planks. The top was covered with wire mesh of 0.02 m mesh size and nylon mosquito net was placed on top of the wire mesh to prevent escape of the small snails. The bottom of the cage was 0.2 m from the ground. Each cage was subdivided into five compartments measuring 0.2 m by 0.2 m each giving an area of 0.04 m². The depth of the compartments was 0.2 m. Sterilised soil was placed in each compartment up to a height of 0.05 m from the bottom. The legs of the cages were placed inside metal cans containing used engine oil as in experiment I above. The cages were placed underneath *Mangifera indica* trees behind the Crop Science unit at Okuku Campus, Yala, of the University of Calabar.

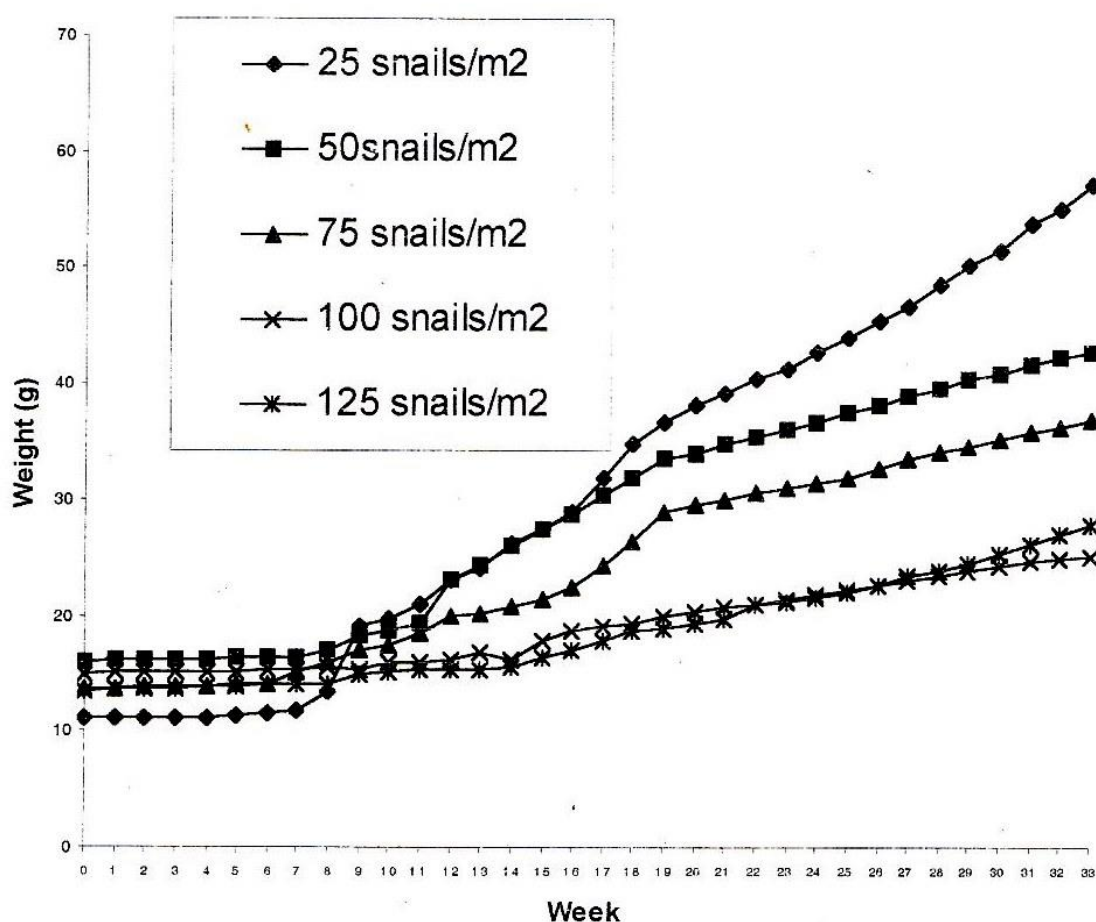
Sixty snail hatchlings of *Archachatina marginata ovum* (Swainson) with a mean mass of 13 ± 2.5 g were used for this experiment. There were five treatments with four replicates in a randomised complete block design. Treatments 1 to 5 had 25, 50, 75, 100 and 125 snails/m², respectively. The experiment lasted for 33 weeks.

Randomisation, feeding and irrigation was done as in experiment I. Measurements taken included mass (g), shell length (mm) and feed intake (g). Mass was measured with an electronic weighing balance. A TP 20 Oertling with maximum capacity of 1300 g. Shell length was measured with a vernier caliper. Cumulated data were analysed using analysis of variance (ANOVA) and where necessary Duncan's Multiple Range Test. This was in line with the methods of Wahua (1999). Correlation coefficients and prediction equations of stocking density versus the variables measured were also obtained.

Table 1. Reproductive performance of adult snails of *A. m. o.* stocked at increasing density levels.

Densities Per m ²	Variables									
	Mean number of clutches of eggs		Mean number of eggs		Mean % Hatchability of eggs		Mean % mortality of adult snails		Mean Mass of day- old hatchlings (g)	
	Mean	σ_{n-1}	Mean	σ_{n-1}	Mean	σ_{n-1}	Mean	σ_{n-1}	Mean	σ_{n-1}
8	2.50ns	1	23.0ns	5	65.60ns	12	0.0 ^a	0	2.72ns	1
20	2.00ns	2	5.8ns	8	50.60ns	10	8.3 ^b	7	2.35ns	1
40	2.50ns	2	21.5ns	12	51.00ns	9	6.0 ^b	3	2.08ns	1
60	0.25ns	2	1.2ns	16	100.00ns	8	19.9	6	2.80ns	1
80	0.50ns	3	3.5ns	17	83.30ns	6	19.4 ^d	6	2.50ns	1
Correlation coefficient	-0.84*		-0.64ns		+0.66ns		+0.93*		+0.112 ^{ns}	
Prediction equation	y = 2.9-0.13x		-		-		y = -48+x		-	

Note: (i) Values with different superscripts in the same column were significantly different ($P < 0.05$)
(ii) NS: indicates they there were no Significant difference ($P > 0.05$)
(iii) *: Indicates that there was a Significant difference ($P < 0.05$).
(iv) σ_{n-1} = Sample Standard deviation

Figure 1. Mean weekly mass of snail hatchlings of *A. m. o.* stocked at increasing density levels

RESULTS AND DISCUSSION

In experiment I, treatments with 25, 50, and 75 snails/m² had mean mortality rates of 0.0%, 8.3% and 6.0% respectively. These were not significantly different from each other, but were significantly different ($p < 0.05$) from treatments with 100 and 125 snails/m² which were 15.9% and 19.4 %, respectively (Table 1). There was no significant difference between the treatments in the other indices measured. This indicates that the treatments with 75 snails/m² and below had higher survival rate of snails in captivity than those with higher densities. This agrees with the findings of Elmslie (1984) that high stocking rates result in high mortality rates.

The highest mean number of clutches of eggs (2.5) obtained in treatments with 25 and 75 snails/m² was slightly lower than the mean clutch number of 2.6 obtained by Ogogo (1989) for the same species. Regression analysis gave significant correlation coefficients ($P < 0.05$) for stocking density versus mean number of clutches of eggs ($r = -0.84$) and stocking density versus mean percentage mortality of adult snails ($r = +0.93$). The prediction equation indicated that as stocking density increased, the mean number of clutches of eggs decreased and the mean percentage mortality of adult snails increased. This agrees with the findings of Cobbinah (1993), that density affects the growth and breeding capacity of snails and that if snails are densely packed, they may not breed at all.

The mean percentage hatchability of 65.6% obtained for snails in the treatment with 25 snails/m² was close to the percentage hatchability of 68.4% obtained by Ogogo (1989) for the same species. The higher percentage hatchabilities (100% and 83.3%) obtained in treatments with 100 and 125 snails/m² respectively, are unreliable as these treatments had only one clutch of eggs each.

In experiment II, treatments with 25, 50 and 75 snails/m² gave growth rates which were not significantly ($P > 0.05$) different from each other but were significantly ($P < 0.05$) different from those of treatments with 100 and 125 snails/m² (Table 2). The mean weekly mass and mean weekly shell length of the snail hatchlings used in this experiment are given in figures 1 and 2 respectively. In both parameters, treatments with 25, 50, and 75 snail hatchlings/m² stand out clearly, the increment in mean weekly mass and mean weekly shell length being higher than those of treatments with 100 and 125 snails/m². Again this indicates that treatments with 75 snails/m² and below had better growth rates than treatments with higher stocking densities. Figures 1 and 2 also show that stocking density did not significantly affect mean weekly mass and mean shell length of snail hatchlings from zero to the eight week of the experiment. Therefore, snail hatchlings could be stocked at higher density up to the eight week of life, and then, the density reduced to 75 snails/m² which is the lower limit of the optimum. Correlation of stocking density versus growth variables gave significant correlation coefficients ($P < 0.05$). The prediction equation indicated that mean daily mass gain and mean shell length gain decreased with increasing stocking density, while feed conversion ratio increased with increasing stocking density (i.e the feed efficiency ratio decreased with increasing stocking density, see table 2). These findings were in agreement with those of Mead (1961) and Elmslie (1984) who stated that high stocking densities result in dwarfing of snails.

The total mass of 31.9 g obtained in treatment 1 in the 17th week, which was the highest in this experiment, was poorer than the 42.7 g obtained by Ogogo (1989) for 17 weeks old snails of the same species at Ibadan. This difference in growth rate may be due to the climatic differences between Ibadan and Ogoja. Rainfall and relative humidity figures were higher at Ibadan (233.28 mm and 85.11% respectively, Department of Geography University of Ibadan, 1989 personal communications) than at Ogoja (178.12 m and 71.5 % respectively, Department of meteorological services, Ogoja 2000, personal communications), making Ibadan more conducive to snail rearing, thus the better growth rates obtained there.

Table 2. Growth performance of snail hatchlings (fattening snails) of A.m.o. stocked at increasing density levels.

Densities per m ²	Mean daily mass gain (g)	Mean feed conversion ratio	Mean shell length gain
25	6.6a	4.3a	3.0a
50	3.8b	8.7b	2.5ab
75	3.3bc	12.4b	1.6bc
100	1.5c	24.8c	0.9
125	1.7bc	22.2c	1.0c
Correlation coefficient	-0.93*	+0.94*	-0.95*
Prediction equation	$y = 7 - 1.2x$	$y = -1.1 + 5.2x$	$y = 3.5 - 0.55x$

Note: (i) Mean values with different superscripts are significantly different ($P < 0.05$)

(ii) * Indicates that there was a significant difference ($P < 0.05$)

(iii) NS indicates that there was no significant difference ($P > 0.05$.)

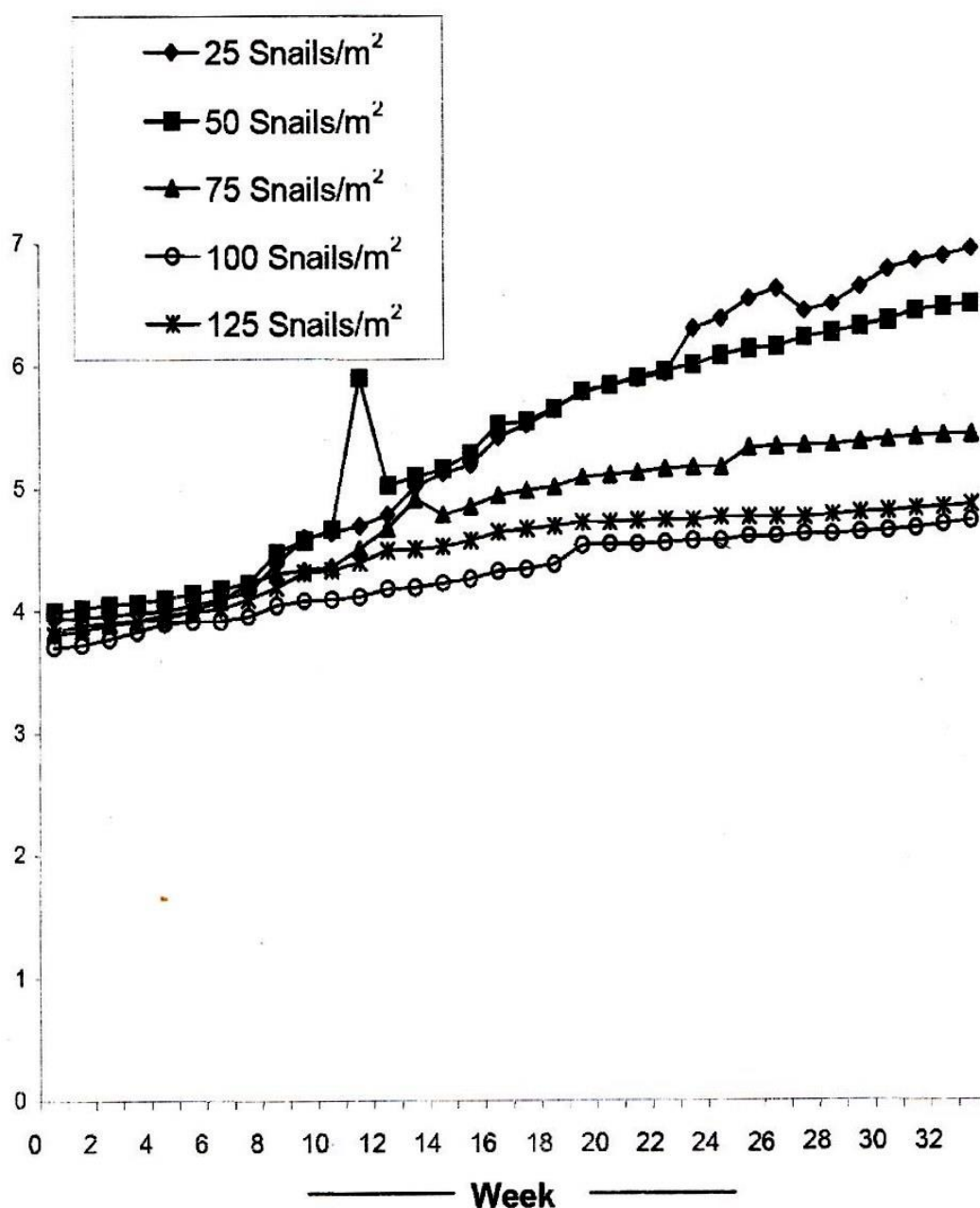


Figure 2. Mean Weekly Shell length of Snail Hatchlings of *A. m. o.* stocked at increasing density levels

CONCLUSIONS AND RECOMMENDATIONS

The result of this study indicated that the optimal stocking density of breeding snails of *Archachatina marginata* Ovum (S) lies between 20 and 40 snails per m² and that of growing snails of the same species lies between 75 and 100 snails per m². These stocking densities are therefore, recommended to be used in snail farms.

Lower stocking rates would result in uneconomic snail farming, while higher stocking rates would result in poor reproductive and growth rates, which would also bring in poor returns in snail farms.

It was also recommended that objects like logs of wood, broken earthen pots and wooden poles, be placed in the snail enclosure. These would increase the surface area of the snailery, thereby increasing the stocking density.

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