Evaluation of reproductive performance of *Archachatina marginata* snails using the number of whorls

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Abstract. This research investigated the reproductive performance of *Archachatina marginata* snails using number of whorls. The Experiment was conducted at the Snailry Unit of the Teaching and Research farm of Niger Delta University Wilberforce Island. The Experiment was carried out with Twenty-four snails, having eight snails per Treatment. The study was designated into 3 mating groups made up of Treatment 1 consisting 5 whorls snails, Treatment 2 consist of 4 whorls and Treatment 3 of 3 whorls snails. The study lasted for 5 months. The snails were raised on mixed feeding regime; water and feed were given *ad-libitum*. Results obtained from the study reveals that treatment 1 and 3 had higher egg weigh than treatment 2, which had a lower egg weight that was significant ($p<0.05$). Treatment two had the best hatchability which was significantly different from the other mating groups $p<0.05$, while treatment 3 had the second best hatchability followed by treatment 1 with the least hatchability which was significantly different ($p<0.05$). Result at Hatchling stage shows that Treatment 1 had the highest performance in all the measured traits followed by Treatment 2 and treatment 3 had the least performance. Conclusively, it was observed that Treatment 1 laid bigger eggs and had bigger hatchlings but their hatchability was lower than every other mating group, this indicates that the larger the egg the lower the hatchability. It is advisable to use four whorls snails for breeding to obtain better survivability since they are in their active reproductive phase.
Key Words: Achatinidae, gastropods, hermaphrodite, pulmonates.

Introduction. Snails are pulmonates nocturnal hermaphroditic gastropods, belonging to the family Achatinidae. In Sub-Saharian Africa, they are distributed from Gambia in the west to Lake Chad region in the east (Ejidike & Adewuyi 2018). Snails are generally hermaphrodites. Hermaphroditism refers to the presence of functional male and female reproductive systems in the same individual snail (Chase 2007). According to Okon et al (2012), the giant African land snail *Archachatina marginata* can be black or white skinned, but the focus of this study is on the black skinned snails of this species.

The giant African land snail has emerged as a notable experimental model for several fundamental and applied biological uses in the last few decades. The giant African land snails are terrestrial shell-bearing invertebrate animals that belong to the phylum Mollusca, and are gastropods used as human food. Horth (2007) showed that snails find their mates by chemical senses (olfaction sensation), locating potential mates by sensing cues in mucus trails, following the trails to find the source. *A. marginata* have a soft body and a covering of hard shell. It has a small body size and is easy to handle and manage.

Reproduction is an essential aspect of the life cycle of the snail. For the edible giant African land snails that use internal fertilization, courtship usually precedes mating. *A. marginata* depend on the stimuli that coordinate the reproductive function. Giant African land snails can lay 4-18 eggs within 1-2 min (Omole et al 2003). A classification of snails by their number of whorls may show their actual position and sizes differences. Between 3 and 4 whorls there was a high increment in body shell length of about 6 cm (Okon et al 2012). The differentiation of growth by the number of whorls will be beneficial for breeding in genetic improvement programs (Akpakpan et al 2009). When

there is an increase in the shell, growth is involved, a step by step elongation. Shell increments have been successfully used to demonstrate growth rates and ageing (Fontenelle & Miranda 2012). Body weight gain is used to depict the growth rate from birth to maturity in snails hatchlings, being the first indicator of hatchlings growth rate. The number of whorls can also be counted at hatch and used in measuring the snail growth rate (Okon & Ibom 2012). The only reliable age assessment based on shell features is provided by two methods: the ring-method, in which the seasonal growth breaks are counted can only be applied to snails with indeterminate growth; the second method of age determination is by the weight of the snails. Snails do not change shells when they grow, the shell growing along with them, its size reflecting the age (https://www.snail-world.com/).

A. marginata with 5 whorls have an age of 3 years, 4 whorls correspond to 2 years and 3 whorls correspond to 1 year. According to Snail World (2017), *A. marginata* are hermaphrodite, having both male and female reproductive organs. Therefore, it can produce both eggs and spermatozoa. *A. marginata* selected based on whorls on their shells may differ in many production qualities. It has been observed that the whorl of a snail can determine the age and their level of productivity. This study aims to evaluate the performance of *A. marginata* based on the number of whorls.

Material and Method. The experiment was conducted at the Snailry Unit of the Teaching and Research Farm of Niger Delta University, Wilberforce Island, Nigeria. The region exhibits a humid equatorial climate with an average annual rainfall of 2000 mm to 4000mm and a temperature range of 29-31^{o}C (https://weatherandclimate.com/nigeria/bayelsa).

Twenty four snails were obtained from Songhai Farms, Amukpe, Sapele Delta State. The experiment was divided into three mating groups designated as T1, T2 and T3, with four replicates having 2 snails per replicate. T1 had snails with 5 whorls, 3 year old snails, T2 had snails with 4 whorls (2 year old snails), and T3 had snails with 3 whorls (1 year old snails). The snails were acclimatized for one month in a wooden hutch and eggs laid in this period were discarded. The snails were raised on mixed feeding regime of concentrate feed and papaya leaves and feed and water were given *ad libitum*. The experiment lasted for five months. A completely randomized design (CRD) was used for this study and data such as egg weight, egg length, egg width, hatchling weight, shell length, shell width, shell mouth length, shell mouth width, percentage (hatchability, survivability and mortality) were collected. Egg weight and body weight at hatching (g) was obtained by placing the egg or the snailet on a S. Miller$^{(R)}$ digital scientific scale and then recording the displayed reading. Shell parameters (mm) were obtained by measuring the snail shell using a Vernier caliper. The hatchability, survivability and mortality rates were obtained by calculation. Data obtained from the study was subjected to the analysis of variance using SPSS version 23, while means were separated using Duncan Multiple Range Test.

Results and Discussion. Table 1 shows the reproductive performance parameters of the snails in the 3 treatments. The mean egg weight in T2 was significantly lower ($p<0.05$) than in T1 and T3. The mean length was similar among treatments ($p>0.05$). The egg width was higher in T1 ($p<0.05$) than in T2 and T3, but the clutch size was lower ($p<0.05$) in T1 than in T2 and T3. Hatchability was highest in T2, survivability was highest in T1.

Table 2 presents the morphometric parameters of the hatchlings. The body weight, shell length, shell width, shell mouth length and shell mouth width were all higher in T1 compared to the results from T2 and T3.

Table 1

Reproductive and egg laying performance parameters of *Archachatina marginata*

Parameters	*T1*	*T2*	*T3*
Mean egg weight (g)	2.78±0.43^{a}	1.94±0.31^{b}	2.63±0.13^{a}
Mean egg length (mm)	2.26±0.24^{a}	2.15±0.35 ^{a}	2.06±0.24^{a}
Mean egg width (mm)	1.86±0.18^{a}	1.65±0.21^{b}	1.53±0.22^{b}
Mean egg clutch size	5±0.14^{b}	7.25±0.24^{a}	7.25±0.16^{a}
% Hatchability	89.57±0.43^{c}	95.44±0.15^{a}	92.3±0.04^{b}
% Survivability	94.12±3^{a}	91.8±4.02^{a}	86.5±0.3^{b}
% Mortality	5.89±0.12^{b}	8.2±2.1^{b}	13.5±0.52^{a}

Note: means with different superscripts in the same row are significantly different ($p<0.05$).

Table 2

Hatchlings body parameters of *Archachatina marginata*

Parameters	*T1*	*T2*	*T3*
Body weight (g)	1.89±0.20^{a}	1.67±0.04^{b}	1.36±0.06^{c}
Shell length (mm)	1.65±0.26^{a}	1.63±0.32^{a}	1.49±0.27^{b}
Shell width (mm)	1.28±0.02^{a}	1.15±0.19^{b}	1.10±0.19^{b}
Shell mouth length (mm)	1.83±0.04^{a}	1.72±0.03^{b}	1.48±0.57^{c}
Shell mouth width (mm)	1.43±0.35^{a}	1.24±0.34^{ab}	1.06±0.24^{b}

Note: means with different superscripts are significantly different ($p<0.05$).

The results of the reproductive performance evaluated in Table 1 show significant differences ($p<0.05$) among the treatments. The egg weight results in this study confirm the findings of Okon et al (2011), who reported ranges from 2.3-2.9 g. Etukudo et al (2015) also reported weights between 0.85 and 0.87 g. The variation in the mean egg weight between the three treatments might indicate variation in feed intake, genetic composition of the snails and environmental factors (Etukudo et al 2015). The egg length and width were higher than the findings of Etukudo et al (2015), namely 1.32 mm and 0.98, respectively. Ejidike & Adewuyi (2018) reported the mean egg length and mean egg width between 2.1-2.4 mm, and 1.5-1.8 mm, which are in agreement with the findings of this study. The high values recorded for these eggs according to whorls imply that the traits are influenced by the same genes in the same direction.

The mean clutch size in this study is similar to the results of Etukudo et al (2015), who reported ranges from 7 to 7.23. The results obtained in this study are also similar to those of Ibom et al (2008), who reported a range from 5.23 to 7.81. The difference in the mean number of eggs among the different treatments might be due to age, size and periods of mating.

The percentages of survivability and mortality obtained in this study are in line with those reported by Ibom et al (2013). Okon et al (2009) recorded a mortality between 6.52 and 9.05%. The reasons for the variations in this report on mortality could be because a bigger size of *A. marginata* implies a higher tolerance to extended starvation periods (Okon et al 2009).

The results revealed that treatment T1, which had a better performance in all the parameters. This is in tandem with the findings of Okon et al (2008), who also reported that bigger snails produce better results. According to Okon *et al* (2010), the morphometric traits are good predictors of hatchling weight in *A. marginata*.

Conclusions. T1 (five whorls, 3 year old snails) had a better performance in most of the measured parameters, followed by T2 (four whorls), and T3 (3 whorls). T2 had the highest performance in hatchability, followed by T1 and T3. T2 and T3 had the highest performance for clutch size. Although the 5 whorls *A. marginata* had the best performance in most of the measured traits, it had a poor clutch size and hatchability, which are important in reproductive efficiency. 4 whorls snails should be used for

productions and breeding purposes, since they perform moderately well and they are in their active reproductive phase.

Conflict of Interest. The authors declare that there is no conflict of interest.

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Received: 16 May 2023. Accepted: 29 May 2023. Published online: 30 June 2023.
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How to cite this article:
Inemotimineri P., Dudutari P. E., Yeigba J. B., Prayer E. D., 2023 Evaluation of reproductive performance of *Archachatina marginata* snails using the number of whorls. ABAH Bioflux 15(1):24-28.