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Original Article

Influence of Parity on Clutch Traits of Breeding Tortoises in a Humid Tropical Environment of South-South, Nigeria

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ABSTRACT: *Data from Serrated Hinged Terrapin (SHT) and African Spurred Tortoise (AST) strains of tortoise and their crosses were used to assess the influence of parity on clutch traits of breeding tortoises. A total of forty-five (45) breeder tortoises (5 Sires and 40 Dams) were used to constitute the three mating groups. The mating groups were: SHT x SHT, AST x AST, and SHT x AST. The mating ratio was 1 male to 4 females. Five parities per female per mating group were monitored, giving a total of sixty (60) clutch sizes. Records were obtained on clutch sizes and weights at hatchling and juvenile stages. The clutch size trend in AST x AST was similar to that of SHT x SHT, with the highest clutch size recorded in the first parity. The level of heterosis in clutch size at hatchling was 4.63% this value, though relatively low, reflects a better genetic constitution of the crossbred than the parents. Clutch weight recorded at third and fifth parities with clutch sizes of 5.6 and 4.6, respectively, was higher than the corresponding weight for the clutch size of 6.5; the trend differs within the AST x AST group. Clutch size at the juvenile stage ranged between 4.3 and 8.3 for SHT x SHT, with a mean of 6.3. Significant (p<0.05) differences within parities were recorded for clutch size at hatchling and juvenile stages for the SHT x SHT breed. Conclusively, any of the three genotypes may be kept for optimum production, although the crossbred exhibited better performance numerically.*

KEYWORDS: *Parity, Mating Ratio, Clutch Size, Breeder, Clutch Trait, Hatchling.*

1. INTRODUCTION

Domesticated tortoise produced in the tropics serves as an alternative to red meat as a source of protein for reasons of improving good health, and creates employment opportunities in related areas. These benefits are often outweighed by the long-term economic benefits of conservation and ecotourism. [1] added that tortoises offer various economic benefits, such as seed dispersal and maintaining healthy waterways, and also support local agriculture and fisheries. In tortoise breeding, parity (the number of times a female has reproduced) can significantly affect clutch traits, such as clutch size, egg size, and overall reproductive output [2,3,4].

Parity affects clutch traits such as clutch size, as older tortoise, more experienced females often produce larger clutches compared to younger tortoise, first-time breeders. However, other factors, such as environmental conditions like rainfall, temperature, and food availability, can affect egg size and clutch frequency; and individual females may exhibit variations in their reproductive strategies based on their age, size, and other factors to maximize their reproductive success [5,6,7]. Lastly, optimal propagule size theory suggests that females may optimize their reproductive output by balancing egg size and number.

In clutch frequency, older females may lay more clutches per season or year than younger females. While egg size in some studies suggests a positive correlation between female size and egg size, others find no significant relationship. However, larger females might have the potential to produce larger eggs, especially if they are in good condition. The reproductive output showed that the overall number of eggs produced in a season is influenced by clutch size, clutch frequency, and the female's ability to recover and reproduce again. Nevertheless, egg shape and weight can vary among different-sized clutches, and larger females may produce eggs with different shapes or weights [8,910,11].

It has become necessary to assess clutch traits of tortoises with respect to parity. [12] identifies parity among other factors as affecting clutch traits of tortoises. The numerical weight attached to each trait after every parity becomes important, as this will determine the period for which a particular animal can be kept for productivity. The objective of this study is to evaluate and compare the effect of parity on clutch traits of breeding tortoises. This will also determine the most suitable genotype for optimum clutch trait performance as parity increases.

2. MATERIALS AND METHODS

2.1. EXPERIMENTAL SITE

The research was conducted at the Department of Animal Production Research Farm (DAPRF), Southern Delta University (SDU), Ozoro, situated between Latitude 5^0 32^I N and Longitude 6^0 15^IE of the Greenwich meridian in mid-western Nigeria's rainforest zone. The mean annual rainfall in the area averages between 2500 and 3000 mm while the mean temperature and Relative Humidity are 27.4^0C and 85 %, respectively [13].

2.2. EXPERIMENTAL ANIMAL AND MANAGEMENT PROCEDURES

Fifteen breeder tortoises, comprising 5 Serrated Hinged Terrapin - SHT (*Pelusios sinuatus*), 5 African Spurred Tortoise – AST (*Centrochlys sulcata*), and 5 of their crosses, were used for the experiment. Tortoises of different species were obtained from different ecological zones in Delta State, Nigeria. Experimental Animals were selected on the basis of sound health and pedigree records. The mean weight of the samples used was 48.35 g. The samples were raised to the juvenile stage for the purpose of the experiment.

An intensive housing system was used for this experiment. The dimension of the area is 12ft x 12ft. The house was ant-proof to prevent ants from invading the unit. A pen (ditched) was constructed measuring 8ft x 2ft. The animals were grouped into four (4) treatments. Animals were raised on a mixed feeding regimen and fed twice daily. Commercial concentrate pelleted feed was first given in the morning, and cabbage and fermented cassava in the evening to enhance intake. Table 1 shows the proximate analysis of the different feeds used during the experiment. Feeding was done twice (8:00 am and 5:00 pm) per day. Feed and water were given *ad libitum.*

TABLE 1 Proximate Analysis of Different Diets Used For Feeding Experimental Animals

Constitution	Top Omega concentrate feed (4.5mm)	Top Omega concentrate feed (9mm)	Cabbage Vegetable	Fermented Cassava (Akpu/Fufu)
Crude Protein (%)	36	30	1.55	2.0
Crude Fat (%)	6.0	9.0	0.1	0.83
Crude fiber (%)	3.5	3.5	2.05	1.0
Calcium (%)	1.15	1.15	0.029	0.015
Total Phosphorus (%)	1.1	1.1	0.021	0.025
Lysin (%)	2.0	2.3	0.04	0.010
Methionine (%)	1.16	1.3	0.015	0.3
Ash (%)	7.0	7.0	0.65	0.75
Energy (ME) (kcal/kg)	3100	3500	280	1300

The tortoises were given the same treatment throughout the experimental period under the same managerial conditions. The ditch was filled with enough water to reach the bridge where the top shell (carapace) meets the bottom shell (plastron). Some routine preventive hygiene was done frequently, such as providing fresh water, feeding, changing water regularly at all times, observing the behaviour of the tortoises, and signs or symptoms of any disease condition were noted by physical examination. The tortoises were properly identified with an indelible mark on their backs, labeling T1, T2**,** T3, and so on.

Tortoises were bred at the adult stage at a ratio of 1 male: 4 females in each mating group. Males and females were identified according to mating groups. The mating groups were SHT x SHT, AST x AST, and SHT x AST, and serve as treatments. Egg-laying status was monitored, ranging from 65 to 90 days. Five parities per female were monitored per mating group. Therefore, a total of sixty (60) clutches were obtained during the experimental period. The feeds were analysed for proximate chemical composition using the method of [14].

2.3. EXPERIMENTAL DESIGN

The design of the experiment was the randomized complete block design. The model for the analysis of variance was:

$Y_{ijk} = \mu + P_i + T_j + e_{ijk}$

Where,

Y_{ijk} = Observation

μ = Overall means of the trait of interest

P_i = The fixed effect of the i^{th} parity of the female (i =1-6)

T_j = The fixed effect of j^{th} treatment (j= 1-3)

e_{ijk} = error $ii^{nd}(0, d^2)$

2.4. EGG COLLECTION

Tortoises were observed in 52 weeks between January 2023 and November 2024. Nests were discovered incidentally while females were laying eggs on a heap of sand between May and July. Eggs were carefully removed from the nests, and the number of eggs per clutch was recorded.

2.5. DATA COLLECTION AND ANALYSIS

Parameters monitored were clutch sizes and weights at the hatchling and juvenile stages. Hatchling records were taken 24 hours after hatching, while juvenile parameters were taken at a mean weight of 126±5 g at age. Heterosis level was calculated for each parameter to compare the performance of the cross-breeds and parent crosses.

Data collected on clutch traits were subjected to ANOVA and significant means separated using Duncan Means Range Test (DMRT). All tortoises were weighed individually with an electronic scale, measured on a monthly basis in grams (g) to obtain the body weight (BWT). The experiment lasted for a period of 52 weeks.
Heterosis was calculated using the formula:

$$\% \text{ Heterosis} = \frac{\text{Av. P. offspring} - \text{Av. P. parents} \times 100}{\text{Av. P. parents}}$$

Where,
Av = Average
P. = Performance of

3. ETHICAL CONSIDERATIONS

All procedures involving animals were conducted in accordance with institutional and national guidelines for the care and use of laboratory animals. The study protocol was reviewed and performed under the oversight of the Department of Animal Production. Tortoises were housed and managed to minimize stress (controlled thermal gradient, UVB lighting, appropriate substrate, and *ad libitum* access to feed and water), and end-points were predefined to avoid unnecessary suffering. Where applicable, permits for animal use and handling were obtained from the relevant authorities. Detailed welfare measures and husbandry practices are reported in the materials and methods.

4. RESULTS AND DISCUSSION

4.1. CLUTCH SIZE AT HATCHLING

Clutch sizes at hatchling ranged between 4.6 and 8.5. These values fell within reported ranges of 2 to 9 [15] and 3 to 12 [16]. Mean clutch sizes and weights are shown in Table 2. In the SHT x SHT group, the highest clutch size of 8.5 was obtained at first parity. It was observed that clutch size decreased from the first to the third parity, thereafter increased to 6.5 in the fourth parity, and further decreased in the fifth parity. The least clutch size of 4.6 was recorded in the fifth parity.

The clutch size trend in AST x AST was similar to that of SHT x SHT, with the highest clutch size recorded in the first parity. The least clutch size value in this treatment was recorded in the fifth parity. Mean clutch size in SHT x AST was not significantly different from the parent groups. Clutch sizes obtained for this treatment are at variance with the trend observed for the other two treatments. The highest clutch size in SHT x AST was obtained at the first parity, which was not different from the trend in the parent groups.

The level of heterosis in clutch size at hatchling was 4.63%; this value, though relatively low, reflects a better genetic constitution of the crossbred than the parents. There was a significant ($p<0.05$) parity effect on clutch sizes at hatchling within SHT x SHT. Clutch size values among parities within AST x AST and SHT x AST were not significantly different. The results of the decreasing trend in clutch size at hatchling within parities for SHT x SHT and AST x AST were at variance with the results of [17], which reported an increasing trend in clutch size from first to second parity.

TABLE 2 Mean Clutch Size And Weight at Hatchling Stage (Grams)

	Mating groups					
	SHT X SHT		AST X AST		SHT X AST	
Parity	Clutch size	Clutch weight	Clutch size	Clutch weight	Clutch size	Clutch weight
P_1	8.5^a	43.48 ± 1.03^b	8.0^a	40.56 ± 1.12^c	7.5^a	45.76 ± 1.06^b
P_2	6.3^b	40.67 ± 1.10^c	7.0^b	38.56 ± 1.08^d	6.3^b	42.61 ± 1.20^c
P_3	5.6^b	41.54 ± 1.24^c	6.8^b	44.04 ± 1.25^a	6.0^b	48.14 ± 1.08^a
P_4	6.5^b	36.46 ± 1.11^d	5.6^c	42.67 ± 1.21^b	6.9^a	44.56 ± 1.06^b
P_5	4.6^c	49.43 ± 1.19^a	5.0^c	40.84 ± 1.36^c	5.0^c	42.58 ± 1.28^c

^{abcd}Means in a column bearing different superscripts differ significantly ($p<0.05$)
(Source: Self)

4.2. CLUTCH WEIGHT AT HATCHLING

An average clutch hatchling weight of 42.95g obtained from a clutch hatchling weight range of 36.46 to 49.43g (Table 2) was recorded for the SHT x SHT group. This average is comparable to the reported range of 33g to54g reported for Serrated Hinged terrapin tortoises [18]. The average values of 41.33g (AST x AST) and 42.32g (SHT x AST) fell within reported ranges of 38.70 to 56.73g and 40.36 to 49.10g for African Spurred Tortoise and cross-bred tortoises, respectively [19]. Clutch weight did not increase with clutch size across the mating groups (Table 2). In SHT x SHT, the highest clutch weight of 49.43g was recorded at the fifth parity for a clutch size of 4.6. This weight is larger than the weight recorded at first parity for a clutch size of 8.5. Clutch weight recorded at third and fifth parities with clutch sizes of 5.6 and 4.6, respectively, was higher than the corresponding weight for the clutch size of 6.5; the trend differs within the AST x AST group. Clutch weights increase with size except for the first parity in this group. However, this increase is not proportional to parity increases. For the SHT x AST group, the least clutch size of 5.0 was obtained at fifth parity, recorded weights which were not significantly ($p>0.05$) higher than the weight recorded for the clutch size of 6.9 (fourth parity). These weights were higher, though not significantly, than clutch weights of 45.76g and 42.61g recorded for the first and second parities, respectively. The level of heterosis was 9.52%, which was higher than the value obtained for clutch size.

4.3. CLUTCH SIZE IN THE JUVENILE

Mean clutch sizes are presented in Table 3. Among the mating groups, mean clutch size ranged between 4.3 and 8.3. This range was higher than the range of 3.5 to 4.0 reported by [20] for tortoises in Nigeria. This result compares with reported ranges of 4.6 to 8.2 [21, 22, 23, 24]. Clutch size at the juvenile ranged between 4.3 and 8.3 for SHT x SHT, with an average of 6.3. This average value is higher than 4.6 and 3.9 reported for Serrated Hinged Terrapin tortoises by [25] and [26], respectively. A similar within-group reported value was obtained for AST x AST. This value fell within the reported range of 4.5 to 5.6 recorded for African Spurred tortoises by [27]. The level of heterosis in clutch size at the juvenile stage was 6.36%. Clutch sizes among parities in SHT x SHT were significantly ($p>0.05$) different (Table 3). This agrees with reports by [28]. A non-significant ($p>0.05$) difference was recorded for the other two groups.

TABLE 3 **Mean Hatchling Size And Weight at the Juvenile Stage (Grams)**

	Mating group					
	SHT X SHT		AST X AST		SHT X AST	
Parity	Clutch size	Clutch weight	Clutch size	Clutch weight	Clutch size	Clutch weight
P_1	8.3^a	189.45 ± 2.43^a	7.6^a	173.58 ± 1.59^b	7.8^a	142.36 ± 1.35^c
P_2	6.0^b	158.72 ± 1.34^b	6.3^b	157.24 ± 1.36^c	7.4^a	139.52 ± 1.20^d
P_3	5.2^c	147.64 ± 1.36^c	7.2^a	151.12 ± 1.43^d	7.0^a	199.10 ± 2.47^b
P_4	6.0^b	159.03 ± 2.16^b	6.4^b	138.45 ± 1.82^e	7.6^a	210.65 ± 3.38^a
P_5	4.3^d	134.20 ± 1.21^d	6.8^b	200.49 ± 3.48^a	7.2^a	199.32 ± 2.46^b

^{abcd} Means in a column bearing different superscripts differ significantly ($p<0.05$)
(Source: Self)

4.4. CLUTCH WEIGHTS IN JUVENILES

Mean clutch weights at juveniles within parities across the mating groups showed variation. Although similar clutch sizes were recorded within mating groups at different parities, corresponding weights varied. Clutch weights were comparable to the reported range of 154.76 to196.43g for various breeds at 95days [29]. Results also fell within the range of 146 to 176g and 201 to 220g reported for pancake and Serrated Hinged Terrapin tortoises at juvenile [30]. Differences between groups were not statistically significant ($p>0.05$) different in this study.

5. CONCLUSION

Results of this study revealed that there was no significant parity effect among the mating groups. Rather, the parity effect was observed within the SHT x SHT group for clutch size at hatchling and clutch size at juvenile. Clutch size at hatchling will fluctuate (increase or decrease) as parity increases. Clutch weight at hatchling and juvenile may not be commensurate with size due to variation in individual body weights of hatchlings. Conclusively, any of the three genotypes may be kept for optimum production although, although the crossbred exhibited better performance numerically.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest concerning the publication of this paper.

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