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Repeatability Estimate of Egg Weight, Egg Number and Body Weight of Tortoise (*Pelusios castaneus*) breeds in Lowland Ecological Zone, Nigeria

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Abstract

The study was conducted to determine the repeatability estimate of Egg Number (EN), Egg weight (EWT) and body weight (BWT) in tortoise (*Pelusios castaneus*) were estimated based on daily basis for EN and weekly basis for EWT and BWT. Tortoises were measured from 32 to 52 weeks of rearing period. A total of fifty (50) tortoises were purchased from rural farmers for the study. The tortoises were reared on the deep litter and fed *ad libitum* with concentrate feed, clean and cool water. At end of 52 weeks of age, data collected on EWT, BWT and EN were analyzed for fixed effect of repeatability estimate. The result reveals a range from 0.071 to 0.084, 0.084 to 0.096 and 0.075 to 0.084 for EWT, BWT and EN, respectively. Therefore, the repeatability for entire estimate for egg traits varies from 0.070 to 0.096. There is inconsistent increase and decrease in the repeatability estimate for the traits as laying age progressed. However, there is low repeatability in general for all the traits implying that the tortoises are not productive. Also, the expected relative genetic gain increases with increasing number of records used on all individuals at all ages. The decrease in the repeatability of each trait indicates that more records will be required to adequately characterize the inherent transmitting capacity of the females as laying age progresses. However, increase in the repeatability implies that fewer records will be adequate to characterize the inherent producing ability of the female's tortoise.

Keywords: Egg weight, body weight, repeatability estimates, egg number, egg traits

Introduction

Repeatability in tortoises, referring to how consistently an individual tortoise exhibits a trait across different instances, varies for EWT, BWT and EN. Egg weight and BWT tend to show moderate to high repeatability, indicating a good ability to predict future performance based on past measurements. Egg number, however, often exhibits lower repeatability, suggesting that factors beyond genetics play a larger role in determining how many eggs a tortoise lays in a given season (Daikwo *et al.*, 2014; Goto *et al.*, 2015; Adeoye *et al.*, 2020). Repeatability is influenced by the degree to which a trait is genetically determined. Traits with higher heritability tend to have higher repeatability. Tortoise farming in Nigeria has been increasing drastically due to different researches that have been conducted on the different fields: genetic make-up, nutrition, health status, physiology, breeding as well as the effect of habitat system on tortoises. Certain economic characters in captive tortoises are being measured in their life time. These characters include BWT, EWT, EN and egg size measured at different growth periods. It is of a great importance to consider the production percentage as well as the weight gain in the selection of stock. There is also need to select among the stock those that will meet the farmers' and consumer's needs. Also, caution should be taken to prevent loss of already gain genetic make-up because of the problem of negative correlation (John-Jaja *et al.*, 2016; Ahmed and Al-Barzinji, 2020; Udoh *et al.*, 2020). Genetic relationships existing between EWT, BWT, sexual maturity and egg production in various of layer breeds of tortoise as well as

crosses of exotic breed with local breed and management have been established (Platt and Platt, 2020; Pike *et al.*, 2021). Thus, in order to make savings and increase production efficiency on the tortoise farm, an early determination of the future probable performance of each female tortoise would be helpful, tortoises with high estimated future performance for such traits can be selected and those with low values culled (Elliott *et al.*, 2019; Eustace *et al.*, 2020; Ewart *et al.*, 2022)

Repeatability is the correlation between two or more several measurements on each individual in a given population (Yakubu *et al.*, 2017; Petrozzi *et al.*, 2020). It is more importance in the profitability of the tortoise enterprise it as characters for the breed to repeat their egg production (EP), EWT as well as their BWT. Understanding repeatability is important for tortoise breeders, as it helps them predict which individuals are likely to produce offspring with desirable traits. High repeatability for traits like EWT and BWT suggests that selection for these traits can be more effective, while lower repeatability for EN indicates that environmental management plays a crucial role in optimizing egg production. Repeatability estimates for EP in tortoises are reported to be generally low varying from 0.02 to 0.32 (Berry and Murphy, 2019; Pere-Garzia *et al.*, 2020; Berry *et al.*, 2020; Blonder *et al.*, 2021; Cohen *et al.*, 2022), and estimates for EWT are high and range from 0.57 to 0.78 (Bernheim *et al.*, 2020; Petrozzi *et al.*, 2020; Kperegbeyi, *et al.*, 2024). Epperson *et al.*, 2020 however reported a wide variation of

0.15 to 0.80 for EWT of the local breed of tortoise in Nigeria. There is less information on the repeatability of egg shape (de la Fuente *et al.*, 2020; Agnolin, 2021; da Silva *et al.*, 2022) however reported values of 0.58 to 0.68 for this trait.

While much work has been done on the repeatability of egg traits in temperate countries, there is comparatively scanty information on these traits in the tropics. Since almost all the tortoises are in the wild ecological zone, there is need to see their performance under the prevailing tropical environmental conditions has to be continually monitored. Therefore, this research was carried out to estimate the repeatability of EWT, EN and BWT in a laying breed of tortoise.

MATERIALS AND METHODS

Experimental site

The research was conducted at the Department of Animal Production Research Farm (DAPRF), Southern Delta University (SDU), Ozoro. Latitude 5° 32' N and Longitude 6° 15' E of Greenwich meridian place the center in mid-western Nigeria's rainforest. Average rainfall ranges from 2500-3000 mm per year and 27.4°C and 85 % are the mean temperature and relative humidity (SDU, 2025).

Experimental Animal and Management Practices

A total of fifty (50) West African Black mud females' sub-adult tortoises were purchased from rural markets in Isoko North and South Local Government Areas in Delta State. The female tortoises were individually housed and intensively reared, feed and water were given *ad libitum* throughout the duration of the research with commercial layers mash containing 16% CP and 2,700 kcal/kg ME. The experiment started when the female tortoise was weighing 1674g as an adult tortoise. The study lasted for 52 weeks. The daily records of EN were observed from point of lay (32 weeks) till 52 weeks. The BWT was however measured on monthly basis using a 10kg measuring scale while the EWT was taken on weekly basis using an electronic balance of 0.01gram sensitivity. The eggs collected were numbered according to each experimental house until for proper identification.

Statistical Analysis

The data collected were subjected to one-way ANOVA using SPSS (1999). General linear model and restricted maximum likelihood (REML) computer programming was used to estimate the variance components using the following model.

$$Y_{ij} = \mu + S_i + E_{ij}$$

Where,

Y_{ij} = records of the j^{th} egg laid by the female tortoise

μ = Overall mean

E_{ij} = error term

S_i = fixed effect of the i^{th} female

Repeatability was estimated using the expression below:

$$R = \frac{\delta^2_B}{\delta^2_B + \delta^2_W}$$

Where:

δ^2_B = variance component due to different among individual individual tortoise

δ^2_W = Error variance component within flock

The expected genetic gain per generation from selection based on repeated record compared with selection on a single record was computed with the following as described by Lush (1945).

$$\frac{K}{[1 + (k - 1) R]^{0.5}}$$

Where:

k = Number of records per tortoise

R = Repeatability

RESULTS

The repeatability estimates of EWT, BWT and EN of West African Black mud species of layer tortoise is shown in Table 1. The repeatability estimates of these characters for week 32 to 52 weeks laying periods were low. EWT values ranged from 0.058 to 0.086, BWT values ranged from 0.086 to 0.096, EN values ranged from 0.075 to 0.085. Low repeatability estimates were observed throughout the experimental periods except in week 32 and 42 (BWT), 41 and 47 (EN). Repeatability of EWT, BWT and EN increased linearly with the laying age.

Table 2 shows the variance components and repeatability of EWT, BWT and EN in tortoises at week 32 to 52 laying period. The value for δ^2_B (variance component due to difference between individual tortoise) ranged from 0.0005 to 0.0458 for all variables. The δ^2_W (Error variance component within flock) varied from 0.0254 to 0.0741. The repeatability estimates for the variables were also high ranging 0.686 to 0.832. Result indicated that the relative genetic gain increased with increasing number of records of each individual.

Relative efficiencies of characterizing individual female tortoise at different ages are presented in Table 3. These estimates were generally low for EWT, BWT and EN implying that a greater number of records per individual are required to characterize inherent transmitting abilities. Generally, the estimated repeatability values for egg parameters ranged from 0.70 to 0.92 for the parameter measured. Repeatability of EWT and BWT increased also as the age of the tortoise's increases except for EN.

Table 1. Repeatability estimates of egg weight, body weight and egg number traits of West African Black mud tortoise

AGES (Weeks)	EWT	BWT	EN
32	0.073±0.0325	0.096±0.0460	0.078±0.0203
33	0.076±0.0357	0.089±0.0420	0.082±0.0412
34	0.078±0.0372	0.093±0.0452	0.082±0.0353
35	0.074±0.0328	0.094±0.0425	0.080±0.0361
36	0.072±0.0306	0.091±0.0462	0.077±0.0402
37	0.073±0.0301	0.088±0.0443	0.075±0.0368
38	0.073±0.0394	0.086±0.0452	0.079±0.0403
39	0.076±0.0342	0.087±0.0476	0.081±0.0375
40	0.075±0.0343	0.089±0.0482	0.083±0.0416
41	0.076±0.0401	0.093±0.0480	0.084±0.0404
42	0.075±0.0369	0.096±0.0437	0.082±0.0328
43	0.073±0.0403	0.093±0.0473	0.080±0.0357
44	0.058±0.0352	0.094±0.0445	0.080±0.0358
45	0.083±0.0423	0.086±0.0482	0.083±0.0361
46	0.084±0.0352	0.084±0.0423	0.081±0.0382
47	0.082±0.0374	0.092±0.0472	0.084±0.0302
48	0.080±0.0364	0.088±0.0357	0.079±0.0469
49	0.086±0.0452	0.094±0.0472	0.080±0.0307
50	0.084±0.0364	0.091±0.0476	0.078±0.0371
51	0.079±0.0364	0.092±0.0492	0.079±0.0366
52	0.081±0.0467	0.089±0.0472	0.083±0.0373
Mean value	0.081±0.0376	0.091±0.0473	0.085±0.0375

EWT= Egg weight, BWT= Body weight, EN = Egg Number, SE, Standard error

Table 2. Variance components and repeatability estimate of egg weight, body weight and egg number of West African Black mud tortoise breed.

Traits	δ^2_B	δ^2_w	R	SE
EWT	0.0005	0.0254	0.686	0.0003
BWT	0.0458	0.0632	0.732	0.0010
EN	0.0037	0.0741	0.832	0.0302

EWT = Egg weight, BWT = Body weight, EN = Egg Number, δ^2_B = Variance among tortoises, δ^2_w = Variance Within Tortoises

Table 3. Relative efficiencies of characterizing individual female tortoise at different ages (%)

No. of record	Age	EWT	BWT	EN
1	32 (POL)	12.36	13.96	15.57
2	33	12.90	14.42	15.94

No. of record	Age	EWT	BWT	EN
3	34	13.46	14.87	16.29
4	35	14.54	15.68	16.82
5	36	15.67	16.55	17.44
6	37	16.49	17.18	17.87
7	38	17.82	18.17	18.52
8	39	17.53	18.02	18.70
9	40	18.72	18.88	19.05
10	41	18.20	18.93	19.67
11	42	18.65	19.41	20.18
12	43	19.38	21.01	22.64
13	44	19.78	21.35	22.92
14	45	19.93	21.91	23.89
15	46	20.05	22.39	24.73
16	47	21.58	23.40	25.22
17	48	22.64	24.30	25.96
18	50	22.91	24.76	26.61
19	51	23.30	25.36	27.43
20	52	23.85	26.40	28.96
Mean value		18.49	19.85	21.22

EWT= Egg weight, BWT= Body weight, EN = Egg Number

DISCUSSION

The variation in EWT, BWT and EN for repeatability estimate for tortoise were in line with the findings of Pike *et al.*, (2021). These researchers reported high repeatability estimates for egg parameters in tortoise. The high repeatability estimate varying from 0.058 to 0.086 of the measured traits in this present study were in agreement with the work of Platt and Platt (2020) with the exception of EN at 44 weeks, which was low at 0.058. The application is low repeatability is that fewer records will be required to characterize the inherent producing capacity of individuals. These led to same savings in the cost of collecting additional data. These observations on the present study were grossly not in line with findings of many authors like Oyedapo *et al.*, (2007);

Petrozzi *et al.*, (2020); and Kperegbe, *et al.*, (2024). All these authors observed values that were generally low for repeatability estimate. This may be attributed to the influence of environmental and age-related factors (Falconer, 1989; Yakubu *et al.*, 2017 and Udoh *et al.*, 2020) and due to different species of poultry birds involved. These authors were on layers and not on tortoises.

The coefficients obtained in the study are lower than those reported by (Ballouard *et al.*, 2020; Averill-Murray *et al.*, 2020; Ali and Fritz, 2021). These variations might due to differences in the breed, environment and the ages of tortoise studied.

The linear increase of EWT, BWT and EN values reveals an indication that repeatability estimate increases as all the variables increases. This also implies that there would be an age at which repeatability in these traits is optimum and this optimum repeatability age that the prediction of most probable transmitting ability on individuals for the traits under consideration for selection purpose is best done. Result obtained agrees with the reports of (Ardjima *et al.*, 2020; Averill-Murray *et al.*, 2021) on the rate of increase for highly repeatable traits. At the 52nd week, the relative efficiency of measuring 20 records instead of one for characterized females were 254, 632 and 83% for EWT, BWT and EN respectively.

CONCLUSION

In this study, the general decrease in the magnitude of repeatability values of the traits studied was attributable to tortoises laying age/weight. As a result, a greater number of records will be required to adequately characterize individual for their producing capacities.

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