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Estimation of variance components for body weight of grasscutters (*Thryonomys swinderianus*) using a repeatability model

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Abstract

Genetic parameters for growth and other economically important traits of grasscutters are scant in literature. Therefore, the aim of this study was to estimate variance components, heritability and repeatability of body weight of grasscutters using restricted maximum likelihood method in a repeatability animal model. Sixteen grasscutter families were used for the study. Each family was made up of one male and four females. Each grasscutter has four repeated records giving a total of 320. The pedigree consisted of 80 animals, progenies of 16 sires and 16 dams. Fixed factors included in the model were family and sex. The WOMBAT program was used for the analysis. The heritability of body weight of grasscutters ranged from 0.23±0.04 to 0.68±0.10, thus implying that mass selection will be appropriate for this population. The repeatability estimates ranged from 0.82±0.08 to 0.93±0.11. It can be concluded that the number of body weight records was a good indicator of the animal's growth potential and that mass selection will be reliable.

Keywords: Heritability, mass selection, repeatability, WOMBAT

Introduction

Grasscutters (*Thryonomys swinderianus*) also called greater cane rat are the most popular type of grasscutters in West and Central Africa. The meat is a delicacy and therefore commands premium price in Ghana (Adenyo *et al*, 2016) and also in Nigeria. Compared to other meats such as rabbit meat, grasscutter meat is very low in cholesterol and high in protein (Adu *et al*, 2017). Attempts have been made over the years to domesticate the grasscutters in order to meet the demand of the consumers (Adenyo, 2014). In order to facilitate the breeding of highly prolific, docile and fast growing grasscutters there is need to characterize its phenotype and genotype (Annor *et al*, 2012). Estimation of genetic parameters for economically important traits is required for designing breeding plan for genetic improvement of the domestic grasscutters. The use of repeated records will improve the accuracy of genetic parameters and estimate permanent environment effects. Genetic parameters for grasscutter traits are scant in literature. Therefore, the aim of this study was to estimate variance component, heritability (h^2) and repeatability (r_{pe}) of body weight of grasscutters at 4, 6 and 8 months of age using restricted maximum likelihood (REML) procedure.

Materials and methods

The study area

The study was conducted at the grasscutter unit of teaching and research farm of Department of Animal Science, Delta State University, Asaba Campus, Asaba, Nigeria.

Animal and its management

Sixteen (16) grasscutter families made up of 1 male and 4 females per family were procured from a reputable farm in Lagos, Nigeria at 3½ months of age and used for the study. Each family was a progeny of 1 male and 1 female. The animals were housed in concrete cages with each cage partitioned to a room and a parlour. All the cages were of similar dimension and managed alike. The cages were constructed within a building with dwarf wall. The building was roofed with corrugated iron. The feeding of the grasscutters was based on elephant grass (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*) supplemented with maize grain and concentrate ration containing 14% crude protein. Water was also provided *ad libitum.*

Data

Data consist of body weight taken at 4, 6 and 8 months of age. The total number of animals with records was eighty (80) while 32 animals were without records. Each animal had four repeated records giving a total of 320 records per age period.

Estimation of variance components

Estimation of variance components was implemented by the restricted maximum likelihood (REML) procedure, using WOMBAT software (Meyer, 2007). The following single trait repeatability animal model was used. Y=Xb + Za +Wpe + e where Y= vector of observations, b= vector of fixed effects, a= vector of random animal effects, pe= vector of random permanent environmental effects, e= vector of random residuals. X, Z and W were incidence matrices relating records to fixed, random animal and permanent environmental effects respectively. The fixed effects considered were family and sex. The mixed model equations solved to obtain the solutions of fixed effect (b) and random effects (a, pe) is presented in matrix notation as follows:

$$\begin{bmatrix} b \\ a \\ pe \end{bmatrix} = \begin{bmatrix} X^1X & X^1Z & X^1W \\ Z^1X & Z^1Z + A^{-1}\alpha_1 & Z^1W \\ W^1X & W^1Z & W^1W + 1\alpha_2 \end{bmatrix}^{-1} \begin{bmatrix} X^1Y \\ Z^1Y \\ W^1Y \end{bmatrix}$$

Where $\alpha_1=\sigma^2e/\sigma^2a$, $\alpha_2=\sigma^2e/\sigma^2pe$. It is assumed that E(Y)=Xb and variance(V) of $a=A\sigma^2a$, $pe=I\sigma^2pe$, $e=I\sigma^2e$, where A is additive relationship matrix. Therefore, $var(Y)=ZAZ^1\ \sigma^2a + WI\sigma^2peW^1 + I\sigma^2e$. Residual variance ($\sigma^2e$) was assumed to be independently and normally distributed.

Estimation of genetic parameters

Heritability (h^2) and repeatability (r_{pe}) were calculated using the following expressions: $h^2=\sigma^2a/\sigma^2a + \sigma^2pe + \sigma^2e$, $r_{pe}=\sigma^2a + \sigma^2pe/ \sigma^2a + \sigma^2pe + \sigma^2e$.

Results and discussion

Table 1 presents the descriptive statistics of body weight of grasscutters at 4, 6 and 8 months of age. The mean body weight of grasscutters at 4, 6 and 8 months of age was 0.79, 1.04 and 1.78kg respectively. This was lower than the range of 0.66-2.51kg reported by Ikpeze and Ebenebe (2004) for body weight of grasscutters at 5 months of age. Annor *et al* (2011) reported a range of 0.69-1.94kg for male and female grasscutters 4-5months of age. Udeh and Okonta (2013) reported an average body weight of 3.00 kg for grasscutters five months of age. The differences may be caused by the use of different species of grasscutters in the studies. As indicated by the standard deviation, the variability of body weight of grasscutters at 4, 6 and 8 months of age were similar.

Table 1: Descriptive statistics of body weight (kg) of grasscutters

Body weight	Mean	Sdev	Min	max	Nrec
4 month	0.79	0.31	0.30	1.82	320
6 month	1.04	0.36	0.50	2.20	320
8 month	1.78	0.32	1.30	2.60	320

Note: sdev=standard deviation, nrec=number of records

Table 2 presents the estimates of variance components, heritability and repeatability of body weight of grasscutters. The h^2 of body weight of grasscutters was moderate to high in magnitude and ranged from 0.23±0.04 to 0.68±0.10. This is much higher than the h^2 of 0.14, 0.10 and 0.12 for body weight of grasscutters at 4, 6 and 8 months of age respectively estimated from expectation maximization algorithm of REML (Udeh, 2017). Annor *et al* (2012) reported direct heritability of 0.48, 0.66 and 0.84 and maternal heritability of 0.76, 0.83 and 0.77 for body weight of grasscutters at 4, 6 and 8 months of age respectively which were higher than the range obtained in the present study. Annor *et al* (2012) concluded from their studies that opportunity exists for fast genetic gain in the improvement of growth and body weight traits of grasscutters. The implication of this result is that mass selection will be appropriate for the improvement of body weight of this population of grasscutters. The repeatability of bodyweight of grasscutters was much higher than the h^2 and ranged from 0.82 to 0.93. This sets the upper limit on the h^2 of body weight in this population of grasscutters (Boake, 1989). The high repeatability estimates reflect the fact that temporary environmental variance was low and that additive and permanent environmental variances made larger contributions to the phenotypic variance. The implication of this range of repeatability estimates is that the number of bodyweight records was a good indicator of the animal's growth potential. Therefore, selection based on this number of records per animal is reliable.

Table 2: Estimates of variance components, heritability and repeatability of body weight of grasscutters

Body weight	σ^2a	σ^2pe	σ^2e	h^2	r_{pe}
4 month	0.0834	0.0262	0.0123	0.68±0.10	0.90±0.12
6 month	0.0754	0.0373	0.0088	0.62±0.10	0.93±0.11
8 month	0.0197	0.0506	0.0150	0.23±0.04	0.82±0.08

Note: σ^2a: Additive genetic variance, (σ^2Pe): permanent environmental variance, (σ^2e): residual variance, h^2 : heritability, r_{pe}: repeatability.

Conclusion

The estimates of heritability and repeatability obtained in this study suggest that rapid improvement in the body weight of this population of grasscutters could be achieved through individual selection.

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