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ORIGINAL RESEARCH ARTICLE

ANALYSIS OF SEXUAL DIMORPHISM IN MORPHOMETRIC VARIABLES OF CANE RAT

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ABSTRACT

The sex effect and interrelationship between body weight and six linear body measurements of forty-five (15 bucks and 30 does) grasscutters aged between 12 and 24 months was assessed using path analysis. Body weight, and linear body measurements: hind leg length, rump height, paunch girth, face width, mouth width, and total body length were measured for the male and female grasscutter. Results showed that there were significant differences (p<0.05) between the male and the female cane rats for all the parameters measured indicating sexual dimorphism in the cane rat. All parameters assessed had highly significant (p<0.0001) and very strong positive correlation coefficients in both sexes. The path analysis indicated that in males, hind leg length (2.86; p<0.0001) had the highest direct effect on body weight, while rump height (-1.45; p<0.0001), had a negative direct effect. In the female group, all the parameters evaluated had a non-significant, positive direct effect. The hind leg length was observed to have the highest (0.29; p<0.0001) path coefficient while the mouth width (0.02; p<0.0001) had the least path coefficient. It was concluded that sex had an effect on the interrelationship between body weight and linear body measurements in grasscutter.

Keywords: *grasscutter, correlation, path coefficient, phenotypic indices.*

INTRODUCTION

There has been a constant reduction in the production and supply of animal protein to ever increasing population of Nigeria. To checkmate this trend, efforts have been made to boost development of the micro-livestock husbandry (Akpan *et al*., 2009; Owen and Dike, 2012). Micro-livestock are differentiated from conventional livestock by their small nature and are made up of small indigenous vertebrates and invertebrates alike- domesticated and wild. (De Wilde, 1991). This group of animals are made up of more than one thousand breeds of rabbits, rodents, reptiles, birds, insects and other small animals (Wilson, 2011). Rodents include guinea pigs, giant rats and cane rats and these animals are extremely prolific and highly adaptable.

The African giant or cane rat are either of two species of large, stocky rodent (Britannica, 2013). The greater cane rat (*Thyronomys swinderianus*) and the lesser cane rat (*T. gregorianus*). As the second largest wild rodent after porcupine in Africa, the cane rat is estimated to produce about 40,000 tonnes of meat per year in West Africa, out of which only 0.2% is produced by the domesticated counterpart (Mensah and Okoye, 2005). This owes to the exploitation of the cane rat from the wild which has called for the conservation programs for the species (Opara, 2010). Raising cane rats in captivity ensures controlled and improved productivity and favors breeding stock expansion. The giant cane rat can grow to attain a body weight of up to 7kg and a length of 61cm (Wilson, 2011; Britannica 2013).

Growth involves the interplay of very complex, highly dynamic physiological process that begins at conception until maturity and the interaction between the genetic potential and the environment (Kor *et al.*, 2006). Body component such as live weight and body measurements can be used to estimate growth in livestock (Wolanski *et al.*, 2006; Saatci and Tilki, 2007). However, the use of simple correlation coefficients between live body weight and linear type traits may be insufficient to explain complex relationships and also casual effects among the biologically related variables (Keskim *et al.*, 2005).

Path analysis, a subset of the structural equation modelling allows the examination of a set of relationships between one or more independent variables, either continuous or discrete (Ullman, 1996). This allows correlation between two variables to be split into direct effect of one on the other, indirect effect mediated by other variables, and spurious effects due to common causes (Yakubu and Salako, 2009). The computed path coefficients indicate the amount of change expected in the dependent variable as a result of a unit change in the independent variable (Smith *et al.*, 1997). Path analysis will indicate whether the association of these weight related variables or traits is due to the direct effect on weight (true association upon which selection can be made for improvement) or is a consequence of the indirect effects via some other variables or traits.

The cane rat has a wide range of genetic potential. However, there is dearth of information on the relationships between their bodyweight and body measurements with the aid of such statistical tool as path analysis. The current study therefore purposed to predict the most useful estimator of body weight from linear body measurements of male and female grasscutter.

MATERIALS AND METHODS

The study was conducted in Ibadan metropolis, Ibadan, Nigeria. Forty-five (45) unrelated cane rat of both sexes (15 bucks and 30 does) aged between 12 and 24 months of age were utilized for this study. Data were collected on live weight, hind leg length, face width, body length, rump height, paunch girth, and mouth width for each animal classified based on sex alone.

Measurements were restricted to apparently healthy rats that conformed to the species classification description. A 20-kg measuring scale was used for the weight measurement, a wooden catcher was used to catch the grasscutter and the wooden catcher was used to zero the scale before the grasscutter was weighed. The wooden catcher allows the grasscutter attain a relaxed posture on the scale in order to attain precision of measurement and prevents injury to the rats and the handler. The length, width and height measurements were effected using a measuring tape calibrated in centimeters. All measurements were taken by the same individual early in the morning before the animals were fed.

The determined body measurements on cane rats include:

(a) **Body length (BL):** this is the average of left and right-side measurement of the distance between the nose and the pin bones.
(b) **Body Weight (BW):** this is the total weight of the entire body dimensions.
(c) **Paunch girth (PG):** this is the minimal circumference of the body immediately after the pelvic girdle.
(d) **Rump height (RH):** this is the distance from the floor beneath the animal to the top of the rump directly above the center of the hind limb.

(e) **Hind leg length (HLL):** this is the distance from the hind limb attachment to the toes.

(f). **Mouth width (MW):** this is the measurement of the wideness of the mouth of the animal usually from the corner of the lip to the other.

(g) **Face width (FW):** Measured as the widest length across the cheekbones.

Means and standard deviations (SD) of live weight and linear body measurements were calculated. The ANOVA was used to assess the effect of sex on body parameters. The statistical model for the analysis of variance was:

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

where Y_{ij} *= individual observation;* μ *= overall mean;* S_i*= fixed effect of the* i^{th} *sex (i= male, female);* e_{ij} *= random error associated with each record (normally, independently and identically distributed with equal variance and zero mean).*

Pearson pair-wise correlation among body weight and morphometric variables of each sex was explored to determine the degree of association between measured variables. Standardized partial regression coefficients called path coefficients was used to determine the direct and indirect effect of linear body measurements on live weight.

The path coefficient from an explanatory variable (X) to a response variable (Y) was as described by Mendes et.al (2005). The significance of each path coefficient was tested using the t-statistics.

The indirect effects of Xi on Y through Xj was calculated as

$$IE_{YXi} = r_{XiXj}P_{Y.Xj}$$

where IE_{YXi} *= the direct effect of Xi via Xj on Y;* r_{XiXj} *= correlation coefficient between the* i^{th} *and* j^{th} *independent variables;* $P_{Y.Xj}$ *= path coefficient that indicates the direct effect of the* j^{th} *independent (exogenous) variable on the dependent (endogenous) variable.*

All statistical analysis was done using SAS 9.4 (2013).

RESULTS AND DISSCUSSION

The result of the morphometric characteristics of male and female grasscutters is as shown in Table 1. It was observed that sexual dimorphism was in favour of the male grasscutter for all the parameters measured.

Table 1: Mean and standard deviations (SD) of Morphometric characteristics of cane rats

Parameters	Male (mean ± SD)	Female (mean ± SD)	Total (mean ± SD)
Body weight (kg)	3.18 ± 0.76 [a]	2.42 ± 0.52 [b]	2.68 ± 0.70
Hind leg length (cm)	15.16 ± 2.01 [a]	13.32 ± 1.47 [b]	13.93 ± 1.87
Face width (cm)	3.56 ± 0.61 [a]	2.90 ± 0.21 [b]	3.12 ± 0.50
Body length (cm)	41.02 ± 4.34 [a]	37.41 ± 2.31 [b]	38.61 ±3.53
Rump height (cm)	12.74 ± 2.27 [a]	11.03 ± 1.45 [b]	11.60 ± 1.92
Paunch girth (cm)	36.11 ± 6.71 [a]	32.20 ± 5.63 [b]	33.50 ± 6.22
Mouth width (cm)	2.71 ± 0.67 [a]	2.01 ± 0.28 [b]	2.24 ± 0.56

Means with the same superscripts along the same row are not significantly different (p>0.05)

The Correlation coefficient between body weight and body measurements of cane rats are presented in Table 2. Correlation between body weights and the body measurements were all positive and highly significant in the bucks and does alike.

Table 2: Correlation coefficient between body weight and body measurements (male top of diagonal and female below the diagonal) of cane rat

Parameters	Body weight	Hind leg length	Face width	Body length	Rump height	Paunch girth	Mouth width
Body weight	1	0.99***	0.91***	0.98***	0.97***	0.97***	0.96***
Hind leg length	0.98 ***	1	0.89***	0.99***	0.99***	0.99***	0.96***
Face width	0.92 ***	0.88 ***	1	0.95***	0.88***	0.87***	0.95***
Body length	0.98 ***	0.98 ***	0.91 ***	1	0.96***	0.96***	0.98***
Rump height	0.98 ***	0.96 ***	0.89 ***	0.96 ***	1	0.98***	0.96***
Paunch girth	0.97 ***	0.95 ***	0.88 ***	0.94 ***	0.97 ***	1	0.95***
Mouth width	0.94 ***	0.94 ***	0.88 ***	0.94 ***	0.90 ***	0.94 ***	1

***= P<0.05, **= P<0.01, ***= P<0.001, [NS] = Not significant**

The result of the direct and indirect effects of morphometric variables on body weight of grasscutter buck and doe is as shown in Table 3 and 4. These allows the direct comparison of values that reflect the relative importance of independent variables in explaining variation in the dependent variables. The path analysis revealed that hind leg length had the highest direct effect on body weight (2.85) in buck, while all the morphometric traits have a direct positive contribution to the body weight in the doe.

Table 3: Direct and indirect effects of morphological traits on body weight of grasscutter buck

Traits	Correlation coefficient with body weight	Direct effect	Indirect Effect						
			HLL	FW	BL	RH	PG	MW	TOTAL
HLL	0.98	2.85^{***}	-	0.01	-0.28	-1.44	-0.38	0.22	-1.87
FW	0.91	0.01^{NS}	2.56	-	-0.27	-1.27	-0.34	0.22	-1.66
BL	0.98	-0.29^{NS}	2.79	0.01	-	-1.45	-0.37	0.23	-1.58
RH	0.97	-1.45^{***}	2.84	0.01	-0.28	-	-0.38	0.22	-0.43
PG	0.97	-0.39^{NS}	2.82	0.01	-0.27	-1.42	-	0.22	-1.46
MW	0.96	0.23^{NS}	2.74	0.01	-0.28	-1.38	-0.36	-	-2.01

***= P<0.05, **= P<0.01, ***= P<0.001, ^{NS}= Not significant; HLL – Hind leg length; FW – Face width; BL – Body length; RH – Rump height; PG – Paunch girth; MW – Mouth width**

Table 4: Direct and indirect effects of morphological traits on body weight of grasscutter does

Traits	Correlation coefficient with body weight	Direct effect	Indirect effect					
			HLL	FW	BL	RH	PG	MW
HLL	0.98	0.29^{NS}	-	0.1	0.18	0.25	0.14	0.02
FW	0.92	0.12^{NS}	0.25	-	0.17	0.23	0.13	0.02
BL	0.98	0.19^{NS}	0.28	0.11	-	0.25	0.14	0.02
RH	0.98	0.26^{NS}	0.28	0.1	0.18	-	0.14	0.02
PG	0.97	0.14^{NS}	0.27	0.1	0.18	0.26	-	0.02
MW	0.94	0.02^{NS}	0.27	0.1	0.18	0.24	0.13	-

*= P<0.05, **= P<0.01, ***= P<0.001, ^{NS}= Not significant; HLL – Hind leg length; FW – Face width; BL – Body length; RH – Rump height; PG – Paunch girth; MW – Mouth width

One of the traits of utmost importance in livestock breeding is the body weight which is also an important criterion for selection. The average body weight of bucks was (3.18±0.76kg) while values for does were (2.42±0.52kg). The assertion that cane rats' body weight is higher in bucks than in does with an average weight of about 4.5kg in bucks and 3.5kg in does by Merwe (2000) was confirmed. All morphometric measurements of males in this study were higher than those of the females. This sexual dimorphism of the male and female could be linked to the effect of various hormones that leads to a different growth rate (Baeza *et al*., 2001). These parameters can be used to readily distinguish the males from the females.

The high correlation among body parameters indicates that the same genes may be responsible for the expression of these body parameters or that the parameters considered were covariates. This further indicates that any one of them could be used to estimate body weight. This trend is in line with the findings in rabbits (Chineke, 2000). Selection for increased measurement in any of the parameters would mean positive significant influence on the other and would lead to increased skeletal stature with concomitant increases in other body measurement (Ikpeze and Ebenebe 2004).

Path analysis is simply standardized partial regression coefficient that permits the partitioning of correlation coefficient into component parts (Woods *et al*., 2003) usually, the measures of direct and indirect effects of a set of independent variables. The first component is the path coefficient (beta weight) that measures the direct effect of the predicator variable on the response variable. The second component estimates the indirect effect of the predicator variable on the response variable through other predicator variables (Pfeiffer and Morriis, 1994).

Path coefficient analysis of body weight and other morphometric traits in other species have been reported (Yakubu and Salako, 2009; Yakubu, 2010, and Ogah *et al*., 2011).

The estimated direct effects of hind leg length (+2.85), and rump height (-1.45) were significant, however those of face width, body length paunch girth and mouth width were not significant in grasscutter bucks. There were no significant direct effects in grasscutter doe. In the grasscutter bucks, the effects of FW, BL, PG and MW were realized through HLL. In grasscutter doe, the effect of HLL was realized through RH while the effects of FW, BL, RH, PG and MW were realized through HLL. The higher values of the direct effect of HLL in the grasscutter bucks is an indication that HLL is an important trait to be considered while selecting grasscutter for broiler production.

CONCLUSION

The study revealed that the body weights of cane rats can be predicted using body measurements especially hind leg length in bucks. This is particularly relevant to the breeder for understanding the pattern of growth. Such Knowledge will enhance development of the cane rat husbandry and the consumers can make fair predictions of weight by simple linear measurements.

REFERENCES

Akpan I.A, Wogar G.S.I, Effiong O. O. and Akpanenua, E. J. 2009. Growth performance of grasscutter fed diets treated with urea and urine solutions. Proc. Nig. Soc. for Anim. Prod. 34th Ann. Conf., 15th - 18th March, Uyo, Nigeria. pp 163 - 164.

Baeza, M. J., 2001. Aspectos ecológicos y técnicas de control de combustible (roza y quema controlada) en matorrales con alto riesgo de incendio dominados por Ulex parviflorus(Pourr.). Ph.D. Thesis. Departamento de Ecología. Universidad de Alicante.

Encyclopaedia Britannica 2013. Cane rat (genus Thyronomys). Encyclopaedia Britannica Ultimate Reference Suite. Chicago: Encyclopaedia Britannica.

Chineke, C.A. 2000. Characterization of physical body traits of domestic rabbit in humid tropics. Pages 237 – 239. In: S. N. Ukachukwu, J. A. Ibeawuchi, S. N. Ibe, A. G. Ezekwe, S. E. Abasiekong (Eds). Book of Proceedings of the 25thAnnual Conference of the Nigerian Society for Animal Production. 19 – 23 March 2000, Michael Okpara University of Agriculture, Umudike, Abia State.

De Wilde, J. 1991. Micro livestock: Little known small animals with a promising economic future, BOSTID (1991), 435p.

Ikpeze, O.O. and Ebenebe, C.I. 2004. Relationships between physical body traits of the grasscutter (Rodentia: Thryonomyidae) in Akpaka Forest Reserve, Onitsha. *Animal Research International* 1(3): 160-163.

Keskin, S., Daskiran, I. and kof, A. 2007. Factor analysis scores in a multiple linear regression model for the prediction of carcass weight in Akkeci kids. *J. Anim. Res.*, 31: 201-204

Kor, A., Baspinar, E., Karaca, S. and Keskin, S. 2006. The determination of growth in Akkeci (White goat) female kids by various growth models. *Czech. J. Anim. Sci.*, 51: 110-116

Mendes M, Karabayir A, and Pala A. 2005. Path analysis of the relationship between various body measures and live weight of American Bronze turkeys under three different lighting programs. *Tar. Bil. Der*, 11, 184-188.

Mensah, G.A. and Okeyo, A.M. 2005. Continued harvest of the diverse African animal genetic resources from the wild through domestication as a strategy for sustainable use: A case of the larger grasscutter (*Thryonomys swinderianus*). International Livestock Research Institute, http://agtr.ilri.cgiar.org/agtrweb/index.php?option=com_content&task=view&id=177&Itemid=199

Merwe, M. 2000. Tooth successions in the greater cane rat (*Thryonomys swinderianus*) (Temminck, 1827). *J. Zool.*, 251: 535-547.

Ogah D. M., Yusuf N.D. and Ari M.M. 2011. Path coefficient model for assessment of weight using linear traits at birth and at weaning in Nigeria indigenous pig. In Proc. Of 34th conf. Of Tanzania soc. Of Anim. Prod. 2011.

Opara, M.N. 2010. The grasscutter I: A livestock of tomorrow. *Res. J. For.*, 4: 119-135.

Owen O. J. and Dike, U.A. 2012. Grasscutter (*thyonomys swinderianus*) husbandry in Nigeria: a review of the potentialities, opportunities and challenges. *Journal of Environmental Issues and Agriculture in Developing Countries* Vol. 4, No. 1: 104 - 111.

Pfeiffer, D.U. and Morris, R.S. 1994. Comparison of four multivariate techniques for causal analysis of epidemiological field studies. *The Kenyan Veterinarian*, 18: 165- 170.

Saatci, M. and Tilki, M. 2007. Zoometrical body measurements and their relation with live weight in native Turkish geese. *Turk. J. Vet. Anim. Sci.* 31: 47-53

SAS Institute (2008): SAS System for Statistical Analysis. Release 9.2., SAS Inst., Inc., Cary, NC.

Smith, F.A., Brown, J.H. and Valone, T.J. 1997. Path analysis: a critical evaluation using long term experimental data. *The American naturalist*, 149: 29-42.

Ullman, J.B. 1996. Structural equation modelling (In: using multivariate statistics, 3rd Edition, B.G. Tabachnick and L.S. Fidell, Eds). Harper Collins College Publishers, New York, NY. Pp 709-819

Wolanski, N.J, Renema, R.A, Robinson, F.E, Carney, V.I. and Fanchert, B.I. 2006. Relationship between chick conformation and quality measures with early growth traits in males of eight selected pure or commercial broiler breeders' strains. *Poultry science*, 85: 1490-1497

Wilson, R.T. 2011. Small Animals for small farms. Rural Infrastructure and Agro-Industries Division Food and Agriculture Organization of the United Nations Rome.

Woods, P.S.A, Wynne, H, Ploeger, H.W. and Leonard, D.K. 2003. Path analysis of subsistence farmers' use of veterinary services in Zimbabwe. *Preventive Veterinary Medicine*, 61: 339-358.

Yakubu, A. 2010. Path coefficient and path analysis of body weight and biometric traits in Yankasa lambs. *Slovak Journal of Animal Science*, vol. 43 (1), 2010, p. 17-25.

Yakubu, A. and Salako, A. E. 2009. Path coefficient analysis of body weight and morphological traits of Nigerian indigenous chickens. *Egyptian Poultry Science*, vol. 29 (3), 2009, p. 837-850.