

MORPHOMETRIC STUDY ON THE MALE REPRODUCTIVE ORGANS OF THE AFRICAN STRIPED GROUND SQUIRREL (*Xerus erythropus*).

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Abstract

Ten African striped ground squirrels were caught alive from the wild with the aid of specialized traps in Zaria and environs between the months of January and May, 2017 and transported in constructed cages to the research laboratory of the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria, Nigeria, where this study was conducted. The animals were acclimatized for a period of twenty one days, and during the period of acclimatization, they were fed with groundnut, sweet potato, cabbage, tomatoes and water ad libitum. The body weights of all the animals were taken prior to sacrifice using a weighing balance (Fuji Keiryō weighing scale K-1, 210 × 210, 200g - 8kg) and then euthanized with 30mg/ kg body weight of thiopental sodium. The body length (distance from the top of the nose, to the tip of the tail) of each animal was measured using a measuring tape. The reproductive organs; the testes, epididymis, ductus deferens and penis were located by making a mid-line incision into the pelvic region to expose them. Measurements of length, width and weight were taken and recorded. Anogenital distance was the distance between the anus and the penis, which

had a mean length of $8.9 \pm 0.37\text{cm}$. The African striped ground squirrel (ASGS) had a mean body weight of $636.80 \pm 45.31\text{g}$, and mean body length of $39.42 \pm 0.78\text{cm}$. The right testicular mean weight was $2.3 \pm 0.14\text{g}$, and this was slightly higher than that of the left testicular mean weight by 0.2g . The testicular mean length was $2.06 \pm 0.16\text{ cm}$ and $1.86 \pm 0.12\text{ cm}$ for right and left testes respectively, and mean breadth of $1.09 \pm 0.06\text{ cm}$ and $0.96 \pm 0.05\text{ cm}$ for right and left testes respectively. The penis had a mean length of $8.50 \pm 0.39\text{cm}$, and the Os penis located on the glans penis had a mean length of $1.9 \pm 0.16\text{cm}$. There was a strong positive correlation between body weight and anogenital distance (0.916), and a positive correlation (0.766) and (0.791) for body weight and right and left testicular weights respectively. There was also a positive correlation between penile length and testicular weight as 0.529 and 6.00 for right and left testis respectively.

In conclusion, this study has established that there is a positive correlation between the anogenital distance and body weight (0.916), and this signifies that larger animals would have a longer AGD. Also, the right testis of the African striped squirrel is slightly higher than the left testis by 0.2g , and the penis of ASGS has a mean length of $8.50 \pm 0.39\text{cm}$, and an Os penis with a mean length of $1.9 \pm 0.16\text{cm}$, the penile length and presence and length of Os penis are important modifications of the genital tract of the African striped ground squirrel.

Keywords; Morphometry, Reproductive, Squirrel

1.0 Introduction

The African striped ground squirrel (*Xerus erythropus*) is found in Africa (Skinner and Smithers, 1990). Sub-species include *Xerus erythropus chadensis* and *Xerus erythropus erythropus*. *Xerus erythropus chadensis* is usually found in Chad, Kenya and Senegal, while *Xerus erythropus erythropus* is found in Northern Nigeria (Grubb *et al.*, 2008). Ground squirrels eat bulbs, fruits, grasses, herbs, insects and shrubs (Skursky and Watermann, 2005). A ground squirrel's daily activities are made of around 70% feeding, 15-20% being vigilant and around 10% socializing (Steppan *et al.*, 2004). The

squirrels use the position of the sun as an orientation marker to either hide or look out for food (Waterman, 2010).

Most species of ground dwelling squirrels mate and reproduce year-round (Watermann, 1996), but mating occurs mostly in the dry harmattan months (Nowak, 2004; Skurki and Waterman, 2005). Reproductive strategies of seasonal breeders is an adaptation to annual changes of environment, in which the animals' energetic efforts for reproduction are minimized. The wild ground squirrel is a typical seasonal breeder, with a short breeding season lasting from April to May and a long period of sexual dormancy from June to the following March (Sheng *et al.*, 2008). After copulation, males usually masturbate which serves to keep the genitals clean and reduce the risk of sexually transmitted infections (Waterman, 2010). In groups, only one female enters oestrous at a time which lasts around three hours. Gestation lasts around 48 days (Waterman, 1996). Males reach sexual maturity at eight months while female mature at 10 months (Waterman, 2010).

The information on anatomy of the male reproductive organs of the African striped ground squirrel is still lacking, and therefore this research was carried out to set a baseline for further research. Morphometry of the male reproductive organs is necessary to understand certain dynamics and functions of these organs, for example, the varying testicular size and weight as it relates to the specie, and the presence or absence of a baculum and the significance.

The understanding of the reproductive morphometrics would further give insights into the function of the male reproductive organs and also profer answers to the specie specific variations in size and weight of each organ as it relates to function, and natural tendencies of the animal. Knowing the normal adult weight of the reproductive organs would also prevent wrong or maldiagnosis of a large testis as testicular atrophy. And knowing the time of examination of these organs would also guide the pathologists to avoid misrepresenting a naturally non-breeding testis as a cryptochid testis.

The aim of this study was to conduct a morphometry study on the male reproductive organs of the African striped ground squirrel (*Xerus erythropus*). The objectives were to carry out measurements of weight, and length and correlate statistically with the body weight of the African striped ground squirrel (*Xerus erythropus*).



Figure 1: Photograph of one of an African striped ground squirrel taken at the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria prior to the commencement of this research.

2.0 Materials and Methods

Ten adult male African striped ground squirrels (*Xerus erythropus*) were obtained from the wild with the aid of traps around Zaria and environs, between the months of January and May, 2017. The animals were transported in constructed iron cages to the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria, Nigeria, and then acclimatized for a period of twenty-one days, and during the period were fed cabbage, groundnuts, water-melon, sweet potatoes and water *ad libitum*. Ethical approval was sought and obtained from the Care on Animal Use Committee (CAUC), Ahmadu Bello University, Zaria. The parameters routinely used for determining the age of rodents such as anogenital distance (Sacramento *et al.*, 2013), body weight and closure of the epiphyseal growth plate were used to ascertain the maturity of the squirrels. The body weights of all the animals were obtained using a weighing balance (Fuji Keiryō weighing scale K-1, 210 × 210, 200g - 8kg) and then euthanized with 30mg/ kg body weight of thiopental sodium anaesthesia. The reproductive organs were dissected out of the pelvic region and studied morphometrically by taking measurements of weight, width and length and then statistically analysed.

3.0 Results

Table 1 gives the descriptive statistical values for body weight, body length, Anogenital distance, Testes and penis. For body weight, the lowest value was 488.0g, and highest value was 890.0 g. Mean value for body weight was 636.8g. (**Table 1**). For body length, the minimum value was 35.80 cm, maximum value was 43.50 cm and the mean value was 39.4 cm (**Table 1**). The minimum value for anogenital distance was 7.20 cm, maximum value was 10.8cm and mean value was 8.9cm. (**Table 1**).

Table 2 shows the correlation between body weight and body length, anogenital distance, Testes weight and Penis weight. Correlation between body weight and body length was -0.23 (negatively correlated), body weight and anogenital distance was 0.916, body weight and right testis weight was 0.766, body weight and left testis weight was 0.791. **(Table 2).**

Table 1: Descriptive statistics for body weight, body length, anogenital distance and testicular weight.

Parameter	Mean (\pm SEM)	MINIMUM	MAXIMUM
Body Weight (g)	636.80 \pm 45.31	488.00 \pm 45.31	890.00 \pm 45.31
Body Length (cm)	39.42 \pm 0.78	35.80 \pm 0.78	43.50 \pm 0.78
Anogenital Distance (cm)	8.95 \pm 0.37	7.20 \pm 0.37	10.80 \pm 0.37
RTestisW (g)	2.34 \pm 0.14	1.80 \pm 0.14	3.10 \pm 0.14
LTestisW (g)	2.13 \pm 0.15	1.60 \pm 0.15	2.89 \pm 0.15
PenisW (g)	2.89 \pm 0.25	1.06 \pm 0.25	3.83 \pm 0.25
RTestisL (cm)	2.06 \pm 0.16	1.20 \pm 0.16	2.90 \pm 0.16
LTestisL (cm)	1.86 \pm 0.12	1.20 \pm 0.12	2.50 \pm 0.12
PenisL (cm)	8.50 \pm 0.39	6.40 \pm 0.39	9.80 \pm 0.39
RTestisB (cm)	1.09 \pm 0.06	0.80 \pm 0.06	1.40 \pm 0.06
LTestisB (cm)	0.96 \pm 0.05	0.80 \pm 0.05	1.20 \pm 0.05
OsPenisL (cm)	1.90 \pm 0.16	1.70 \pm 0.12	2.1 \pm 0.15

KEY

RTestisW= Right testicular weight

LTestisW= Left testicular weight

PenisW= Penis weight

RTestisL= Right testicular length

LTestisL= Left testicular length

PenisL= Penis length

RTestisB= Right testicular breadth

LTestisB = Left testicular breadth

Table 2: Correlations between body weight, anogenital distance, testicular weight and penis weight.

	BW	BL	AD	RT	LTW	PW	RTL	LTL	PL	RTB	LTB
BW	1	-	.916	.766*	.791	.098	.592	.464	.396	.740	.517
BL		1	-	-	-	-.447	-.107	-.084	-	.005	-
AD			1	.872*	.886	.398	.663*	.546	.388	.745	.576
RT				1	.899	.343	.715*	.668*	.529	.563	.336
LT					1	.207	.682*	.610	.600	.485	.346
PW						1	.315	.372	-	.310	.205
RTL							1	.962**	.750	.706	.568
LTL								1	.743	.549	.352
PL									1	.297	.216

RT	.740	.005	.745	.563	.485	.310	.706*	.549	.297	1	.892
B	*		*								**
LT	.517	-	.576	.336	.346	.205	.568	.352	.216	.892	1
B		.071								**	

KEY

BW= Body weight

BL= Body length

AD= Anogenital distance

RTW= Right testicular weight

LTW= Left testicular weight

PW = Penis weight

RTL= Right testicular length

LTL =Left testicular length

PL= Penis length

RTB= Right testicular breadth

LTB= Left testicular breadth

4.0 Discussion

The mean anogenital distance in the African striped ground squirrel was 8.95 ± 0.37 cm, and this serves as a baseline for further research on anogenital distance in this specie. Anogenital distance has been defined as the distance from the anus to the penis

(Sathyanarayana et al., 2010). The in utero development of the perineum and caudal migration of genital tubercles in relation to the anus, are androgen dependent in humans and rodents (Bowman *et al.*, 2003). Therefore, the variation in AGD is a reflection of foetal androgen exposure during its embryonic development in different species (Macleod *et al.*, 2010; Dean *et al.*, 2012). Several studies have demonstrated that the AGD is approximately twice as long in males as in females (Salazar-Martinez *et al.*, 2004; Swan, 2008; Thankamony *et al.*, 2009; Macleod *et al.*, 2010; Sathyanarayana *et al.*, 2010). Hence, AGD is not only a biological indicator of prenatal androgenization, but also a sexually dimorphic trait that may be used to determine fetal sex during early pregnancy.

Correlation between body weight and anogenital distance was positively significant, which means that anogenital distance increased with body weight. Anogenital distance may be used to ascertain the age of squirrels along side other parameters, since body weight is not only a factor of age, but diet and genetic factors could also influence the body weight of individual squirrels.

The mean testes length of the African striped ground squirrel for right and left testes was 2.06 ± 0.16 cm and 1.86 ± 0.12 cm. This shows that the right testis was slightly longer than the left testis. Table 1 also shows a higher value for weight of the right testis. This suggests that the right testis has more testicular tissue than the left testis. These values are similar to what was obtained in the Persian squirrel by Akbari *et al.*, 2016. A positive correlation was observed between body weight and testicular weight in the African striped ground squirrel. Raji et al., 2008 also reported a similar finding in indigineous goats in semi arid regions of Nigeria.

The mean length of penis from the root to its free end was $8.5\text{cm} \pm 0.39$ cm, and an Os penis of mean length 1.90 ± 0.16 cm. This result differs from that obtained in the Persian squirrel (*Sciurus anomalus*), in which, the mean length was 5.87 ± 0.86 cm without the Os penis (Akbari *et al.*, 2014), and in the male greater cane rat (*Thyromomys swinderianus*), the mean penile length was 5.46 ± 0.36 cm (Adebayo *et al.*, 2011). This variation observed among the species of even same family could be best linked to their competitive reproductive tendencies which are common with polygynous rodents. It has been documented that length of penis evolves with levels of sperm competition among

the male rodents, and thus higher levels of sperm competition favour increased penile length (Ramm, 2007). For example, males coexisting with other males in the presence of females tend to have a longer penile length than the males existing without their male counterparts.

Correlation between body weight and body length was -0.23 (negative correlation), and this value is not statistically significant.

5.0 Conclusion

In conclusion, this study has established that the mean anogenital distance in the adult male African striped ground squirrel is 8.95 ± 0.37 cm, and a positive correlation, $r = (0.916)$ exists between body weight and anogenital distance in the adult male African striped ground squirrel. Also, a positive correlation exists between body weight, and testicular weight as 0.766 and 0.791 for right and left testis respectively. The mean penile length is $8.5 \text{ cm} \pm 0.39$ cm, with a baculum or Os penis of a mean length of 1.90 ± 0.16 cm. Penile length increased with testicular weight with a positive correlation as 0.529 and 0.600 for right and left testis respectively.

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