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Sexual Dimorphism with Respect to the Macro-Morphometric Investigations of the Forebrain and Cerebellum of the Grasscutter (*Thryonomys swinderianus*)

Dimorfismo Sexual en Relación con la Investigación Macro-Morfométrica del Cerebro y Cerebelo del Grasscutter (*Thryonomys swinderianus*)

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SUMMARY: This study was carried out to record the morphometric parameters of the brain of male and female grasscutters. Ten healthy grasscutters (5 males and 5 females) were used in this study. The mean brain weights were 9.80 + 0.50 g and 10.27 + 0.45 g for males and females respectively. The olfactory bulb mean weight was 0.57 + 0.05 g for males and 0.43 + 0.10 g for females. The cerebral and cerebellar mean lengths of 3.14 + 0.04 cm and 1.34 + 0.04 cm for males, 6.26 + 0.10 cm and 3.80 + 0.32 cm for females were observed. The cerebrum, cerebellum and olfactory bulb account for 70 %, 12 % and 6 % of the total brain weight in males and 64 %, 13 % and 4 % in the females respectively. The mean brain lengths were 5.63 + 0.07 cm and 6.26 + 0.1 cm for males and females respectively. There were significant differences in the body and olfactory bulb weights and also, in the whole brain and cerebral lengths between the males and females. In our present research, the ratios of 0.01 for males and 0.006 for females were observed. This suggests a relatively low brain weight in the ruminants. The olfactory bulb in the male is larger than that in the females. Females in turn have longer brain dimension than the males. Cerebellum has no sex variation both in weight and in length.

KEY WORDS: Brain; Sexual dimorphism; Males and females; Grasscutter.

INTRODUCTION

The greater cane rats (*Thryonomys swinderianus*) are close relative of porcupines and guinea pig. The genus, Thryonomys, also known as grasscutter, or cutting grass, is a genus of rodent and the only member of the family Thryonomyidae and the suborder, Hystricomorpha. Although many varieties have been described, they belong to two different species: the lesser or smaller and the greater or larger species (National Research Council, 1991). The smaller grasscutter (*Thryonomys gregorianus*) has a body length of 50 cm. They are found in countries like Cameroon, Sudan, Uganda and Ethiopia. The greater grasscutter (*Thryonomys swinderianus*) has a body length of up to 60 cm and spreads from Senegal to South Africa (all countries of the west, east and southern) Africa (National Research Council).

In Nigeria, Ghana and other regions of West Africa where grasses provide their natural habitat and food, they are called "grasscutters", while in South Africa where they are associated with cane plantations, they are called Cane rat (Baptist & Mensah, 1986); making them significant pests. The distribution of the greater cane rat is therefore determined by the availability or preferred grass specie for food.

The average adult weights reported by Eben (2004) were 3 kg for females and 4.5 kg for males. Grasscutter's meat is one of the most preferred and expensive bush meats in West Africa (Asibey & Addo, 2000). As a result, the animals are being hunted aggressively in the wild, leading to destruction of ecosystem and environmental pollution, through setting of bushfires by hunters in these areas (Yeboah & Adamu, 1995).

Rodents, particularly the grasscutters are exploited in these countries as source of protein (Asibey, 1974). In Nigeria today, the animal protein intake of an average citizen is below

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the recommended requirement. This has caused the rural dwellers to explore wild animals, particularly the grasscutter as an alternative source of the animal protein in order to complement the conventional livestock like sheep, cattle and goat.

Grasscutter is desirable for domestication because of its excellent taste and comparatively higher nutritional value (Asibey & Eyeson, 1973) and meat yield (Clottey, 1981) than most species of livestock. In the sub-region, attempts are being made to domesticate grasscutter by research institutes and local farmers through the intensive system (Eben). More recently, intensive production of Cane rats have been undertaken in countries such as Benin and Togo and agricultural extension services in Cameroon, Cote d'Ivoire, Gabon, Ghana, Nigeria, Senegal and Zaire have also encouraged farmers to rear these rodents in rural and per-urban areas. In most of these countries, the animals are bred in captivity for use as micro-livestock (National Research Council) and as laboratory animals (Asibey & Addo). Constraint to large scale production of grasscutter was and is still the inadequate information on its biology which can facilitate and enhance its domestication (Den Hartog & De Vos, 1973). Some vital anatomical and physiological aspects of this animal remain unwritten and generally not available to the interested breeders.

Brain is part of the nervous system that provides an animal with sensitivity to its environment. It initiates and control movement and most secretions and thus is responsible for all in born and learned behavior in man and animal (Fletcher, 2006). In this study, we report the brain morphometric studies on the male and female grasscutters. This work is intended to provide a baseline data for farmers and researchers to enable them expand this industry in order to reduce an over dependence on the wild stock. Further more, these results will support the behavioral researchers in keeping these animals for laboratories purposes.

MATERIAL AND METHOD

Ten grasscutters (5 males and 5 females) were used in this study. They were obtained from local farmers in Benin State, Nigeria. The animals were then transferred to a laboratory at the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria using laboratory rat cages. They were fed with elephant grasses and feed supplements and water was given ad libitum for three days before the experiment.

The animals were acclimatized and on the third day they were sedated in a closed container using gaseous chloroform. They were then weighed with a Mettler balance (Model, P 1210) and the weights were expressed in grams (g). The animals were later sacrificed. The method of brain removal from the cranium was done according to Harper & Maser (1975). The brains were properly cleaned and the meninges removed.

The morphometric studies were carried out after the brains were fixed in Bouin's fluid. The weights of the brains were taken before beingseparated into their various components like the olfactory bulb, cerebrum and cerebellum. Brain separation into its major components was done according to the method described by Fletcher. The two halves of the olfactory bulb were separated from the cerebral hemispheres by transverse incision through the rhinal fissure. The left and right cerebral hemispheres were separated from each other through the longitudinal fissure. The longitudinal fissure was gently widened using the thumb, forceps and scalpel blade. It was then cut through the entire length of the corpus callosum. Each hemisphere was lifted at the occipital lobe (caudal end) and the internal capsule was cut to separate the cerebral hemispheres from the brain stem. To separate the cerebral from the brain stem, the flocculi were manually raised to expose the cerebellar peduncles. The peduncles were then cut across.

Venier caliper, thread and meter rule were used for the measurement of lengths, widths and heights of the whole brain and its components and the result was recorded in centimeters (cm).

Statistical analysis. Statistical analysis was conducted with the statistical package (Graph Pad Prison, Version 4.00, 2003). The weights and dimensions were expressed as mean and standard error of the mean (Mean + SEM). The differences between the male and female body and brain weights, the brain lengths and its components were analyzed using the independent simple "t" test. And $p< 0.05$ were considered significant.

RESULTS

Grossly, there was no observed difference in males and females brain structure. The olfactory bulbs were short, rounded and ventro-rostrally placed. They were visible on the dorsal view and not hidden under the frontal lobes. The cerebral cortex was observed to be the smooth type (lissencephalic) of brain with no sulci or gyri and the furrows seen on the surface were occupied by anterior and middle cerebral arteries. The cerebellum, 'little brain,' of grasscutter was observed to be irregularly globular in shape and located

on the dorsal aspect of the brain stem (the pons and the medulla-oblongata) in the cranio-caudal fossa. It formed the roof of the fourth ventricle.

The morphometric values of the body and brain weights of males and females are presented in Table I. The mean body weights for male and female were 543 + 97.96 g, and 1620 + 124.10 g respectively. The mean olfactory bulb weights were 0.57 + 0.05 g for males and 0.43 + 0.10 g for females while, the mean cerebral weights were 6.85 + 0.34 g and 6.58 + 0.09 g for males and females respectively.

There were significant differences ($p< 0.05$) in the body and olfactory bulbs weights. The mean brain lengths of male and female are shown in Table II. The mean brain lengths for male and female were 5.63 + 0.07 cm and 6.26 + 0.10 cm respectively. The mean cerebral, cerebellar and olfactory bulb lengths for males were 3.14 + 0.04 cm, 1.34 + 0.04 cm and 0.55 + 0.02 cm while those for the females were 3.80 + 0.32, 1.34 + 0.89 cm and 0.57 + 0.02 cm respectively. Significant differences ($p< 0.05$) existed in the whole brain length and cerebral lengths in favor of females.

Table I. Body and fixed brain weights of the males and females grasscutter.

Weight	Male (n=5)			Female (n=5)		
	Mean ± SEM	% BDW	% BRW	Mean± SEM	% BDW	% BRW
Body	543 ± 97.96*	100	-	1620 ± 124.1*	100	-
Whole brain	9.80 ± 0.50	1.80	100	10.27 ± 0.45	0.60	100
Olfactory bulb	0.57 ± 0.05	0.10	5.82	0.43 ± 0.10	0.03	4.19
Cerebrum	6.85 ± 0.34	1.26	69.90	6.58 ± 0.09	0.41	64.10
Cerebellum	1.18 ± 0.07	0.22	12	1.31 ± 0.08	0.08	12.76

*Values with significant difference; SEM, standard error of the mean; n= sample size; BDW, body weight; BRW, brain weight.

Table II. Fixed brain dimensions of males and females grasscutter.

Length (cm)	Male (n=5)		Female (n=5)	
	Mean ± SEM	%Brain weight	Mean ± SEM	% Brain weight
Whole brain	5.63 ± 0.07 *	100	6.26 ± 0.10*	100
Brain width	2.50 ± 0.08	-	2.51 ± 0.19	-
Brain height	1.22 ± 0.04	-	1.82 ± 0.17	-
Olfactory bulb	0.55 ± 0.02	9.77	0.57 ± 0.20	9.11
Cerebrum	3.14 ± 0.04*	55.77	3.80 ± 0.32*	60.70
Cerebellum	1.34 ± 0.04	23.80	1.34 ± 0.89	21.41

* Values with significant difference; SEM, standard error of the mean; n= sample size.

DISCUSSION

In the present study, the mean brain weight of the grasscutter was found to be 9.80 + 0.50 g for males and 10.27 ± 0.45 g for females. The mean olfactory bulb weights for males and females were 0.57 ± 0.05 g and 0.43 ± 0.10 g respectively. 1.18 ± 0.07 g and 1.31 ± 0.08 g were the cerebellar weights for males and females respectively. The mean brain lengths were observed to be 5.63 ± 0.07 cm for males and 6.26 ± 0.10 cm for females. The cerebral and cerebellar mean lengths of 3.14 ± 0.04 cm and 1.34 ± 0.04 cm for males, 6.26 ± 0.10 cm and 3.80 ± 0.32 cm for females were also observed. The results of this study showed that the olfactory bulb accounts for 6% the total brain length in males and 4% in females. Also, the cerebrum accounts for 70 % and 64 % the total brain weight and 62 % and 67 % the total brain lengths in males and females respectively. There were no observed significant differences in the weights of the whole brain, cerebrum and cerebellum. Likewise, significant differences in length were not found in olfactory bulb, cerebellum, brain height and width. However, significant differences ($p < 0.0001$ and 0.0259) was observed in the body and olfactory bulb weights and in the lengths of the whole brain and cerebrum ($p < 0.0005$ and 0.0001) for males and females.

From our observations, the olfactory bulb length had no sex difference, but it was larger in males than in females.

The females in turn, had longer brain and cerebral lengths than males.

The results of our findings were less than the 72 g, 30 g and 25 g figures reported for dog, cat and porcupine, but larger than the 7.6 g, 4 g, 2 g and 1 g for squirrel, guinea pig, laboratory rat and sparrow (Eric, 2006) respectively. Our findings were also slightly above that of the African giant rat, with brain weight and length of 4.88 ± 0.18 g and 4.33 ± 0.20 cm respectively (Nzalak, 2005). The mean cerebellar weights of the grasscutter were larger than those of the guinea pig, pigeon, mouse and bat (Sultan & Braitenberg, 1993). The ratio of brain to body weight has been reported to be 0.02 for man (Dyce *et al*., 1996) and 0.006 for the red Sokoto Sheep (Olopade & Onwuka, 2002). In our present research, the ratios of 0.01 for males and 0.006 for females were observed. The ratio for males was bigger than that for the females in grasscutter and sheep, but smaller than that of man. This suggests a relatively low brain weight in the sheep (Olopade & Onwuka) and in female grasscutter..

Russel (1979) stated that there exists a relationship between brain size and intelligence. Earlier in history of neuroscience, Broca (1861) was of the opinion that brain size reflected intelligence. It was Broca himself who laid the grounds work for the modern view that the brain is a heterogeneous collection of highly interconnected but functionally discrete system. Based on this, the grasscutter can be said to be less intelligent than the dog, cat, kangaroo and porcupine (Eric), but more intelligent than the squirrel, guinea pig, laboratory rat, sparrow and viper (Sultan & Braitenberg). Also, ranking the rodents like rat, mouse and African giant rat (Nzalak) base on their brain weights makes the grasscutter to be more intelligent than the rest.

Lack of significant differences observed in the brain height and width with different body weights between males and females suggests that full growth in these areas were achieved quickly in the grasscutter. This finding agreed with that documented for sheep by Onwuka *et al.* (2005).

This paper reports information that will serve as valuable tool in research especially in pharmacology. This is because pharmacological data in humans can be predicted using animals data (Kawakami, 1994). The data in this work will also be useful in neuropathology and in comparative neuroanatomical studies of rodents in Nigeria and other parts of the world.

CONCLUSION

The study establishes and reports an increased body weight in the females which was not directly proportional to the brain weight. The olfactory bulb in males is larger than that of the females suggesting better olfaction in males' grasscutter. And that the female brain is longer than that of the male counter part.

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RESUMEN: Este estudio se llevó a cabo para registrar los parámetros morfométricos del cerebro de grasscutters machos y hembras. Diez grasscutters sanos (5 machos y 5 hembras) fueron utilizados en este estudio. La media de peso del cerebro fueron 9,80 ± 0,50 g y 10,27 ± 0,45 g para los machos y hembras respectivamente. El peso medio del bulbo olfatorio fue 0,57 ± 0,05 g para los machos y 0,43 ± 0,10 g para las hembras. La longitud media del cerebro y del cerebelo fue de 3,14 ± 0,04 y 1,34 cm ± 0,04 cm para los machos, y 6,26 ± 0,10 cm y 3,80 ± 0,32 cm para las hembras, en las muestras observadas. El cerebro, cerebelo y el bulbo olfatorio representaron un 70%, 12% y el 6% del peso total del cerebro en machos y 64%, 13% y 4% en las hembras, respectivamente. La media de las longitudes del cerebro fueron 5,63 ± 0,0 y 6,26 cm ± 0,1 cm para los machos y hembras respectivamente. Hubo diferencias significativas en el peso del cuerpo y el bulbo olfatorio, y también en la longitud total del cerebro de machos y hembras. En nuestra actual investigación, los índices de 0,01 para los machos y de 0,006 para las hembras fueron observados. Esto sugiere un peso relativamente bajo en el cerebro de rumiantes. El bulbo olfatorio en los machos es mayor que en las hembras. A su vez, las hembras presentan una dimensión cerebral mayor que los machos. El cerebelo no tuvo variación según el sexo tanto en peso como en longitud.

PALABRAS CLAVE: Cerebro; Dimorfismo sexual; Machos y hembras; Grasscutter.

REFERENCES

Asibey, E. O. A. Wildlife as a source of protein in Africa South of the Sahara. *Biological conversation, 6*:32-9, 1974.

Asibey, E. O. A. & Eyeson, A. A. Additional information on the importance of wild animals and food source in Africa South of the Sahara. *Bongo Journal of Ghana Wildlife*

Society. 1(2):13, 1973.

Asibey, E.O. A & Addo, P. G. *The grasscutter, a promising animal meat production in Ghana.* African Perspectives, Practices and policies supporting Scandinavian Seminar College, Denmark, in association with Weaver press, Harare, Zimbabwe. www.cdr.dk/sscafrica/asddad-gh.htm, 2000.

Baptist, R. & Mensah, G. A. The Cane rat farm Animal of the future in Benin and West Africa. *World Animal Review, 60*:2-6, 1986.

Broca, P. Surle volume at all forme du cerveau suivalent less individus et suivant less races. *Bull. Soc. Anthrop., 2*:139-207, 301-321, 1861.

Clottey, St. J. A. Relation of physical body composition to meat yield in the grasscutter (*Thryonomys swinderianus*, Temminck). *Ghana Journal of science, 21*:1-7, 1981.

Den Hartog, A. P. & De Vos, A. The use of rodents as food in tropical Africa. *FAO Nutrition Newsletter, 11*:1-4, 1973.

Dyce, K. M.; Sack, W. O. & Wensing, C. J. L. *Text Book of Veterinary Anatomy*. 2nd edition. Philadelphia, W. B. Sauders Company, 1996.

Eben, A. B. Grasscutter: Importance, Habitat, Characteristics, feed and Feeding, Breeding and Diseases. Kumasi,Ghana, Programme organized by Centre for Biodiversity Utilization and Development (CBUD), 2004. pp.1-6.

Eric, H. C. *Brain facts and figures. In*: Neurosciences for Kids. Washington, University of Washington, 2006. pp.1-8.

Fletcher, T. F. *Brain Gross Anatomy from the lab manual for CVM 6120 In*:Veterinary Neurology. University of Minnesota, College of Veterinary Medicine, 2006. pp.1-25.

Harper, J. W. & Maser, J. D. A. Microscopic study of the brain of Bison, the American Plain Buffalo. *Anat. Rec., 18*:187-202, 1975.

Kawakami, J. Prediction of the brain delivery of ofloxacin, Anew quinoline in humans from animal data. *J. Pharmacokinet. Biopharm., 22(3)*:207-27, 1994.

National Research Council. *Micro-livestock: Little known (grasscutter) animals with promising economic future.* Xvii x 449 (Viet Meyer Noel Ed.). Washington, National Academy Press, 1991.

Nzalak, J. O. Morphologic Studies of the Cerebellum and Forebrain of the African giant rat (*Cricetomys gabianus*). *Trop. Vet., 23:(3-4)*:87-92, 2005.

Olopade, J. O. & Onwuka, S. K. Preliminary Morphometric Investigation of the brain of Red Sokoto (maradi) goat. *Trop. Vet., 20(2)*:80-4, 2002.

Onwuka, S. K.; Olopade, J. O.; Balogun, B. A. & Oke, B. O. Morphometric Investigation of the brain of West African Dwarf sheep in Nigeria. *Int. J. Morphol., 23(2)*:99-104, 2005.

Russel, M. S. *The brain size and intelligence: comparative perspective in brain behavior and evolution* (Oakly and Plotkin ed.). London, Associated Book Publishers, 1979. pp.127-53.

Sultan, F. & Braitenberg, V. Shapes and sizes of different mammalian cerebellum. A Study in Quantitative Comparative Neuroanatomy. *J. Hirn forsch, 34*:79-92, 1993.

Yeboah, S. & Adamu, E. K. The Cane Rat. *Biologist, 42(2)*:86-7, 1995.

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