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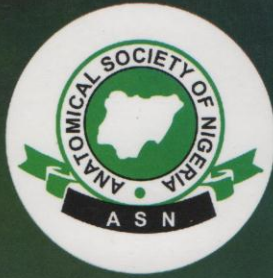
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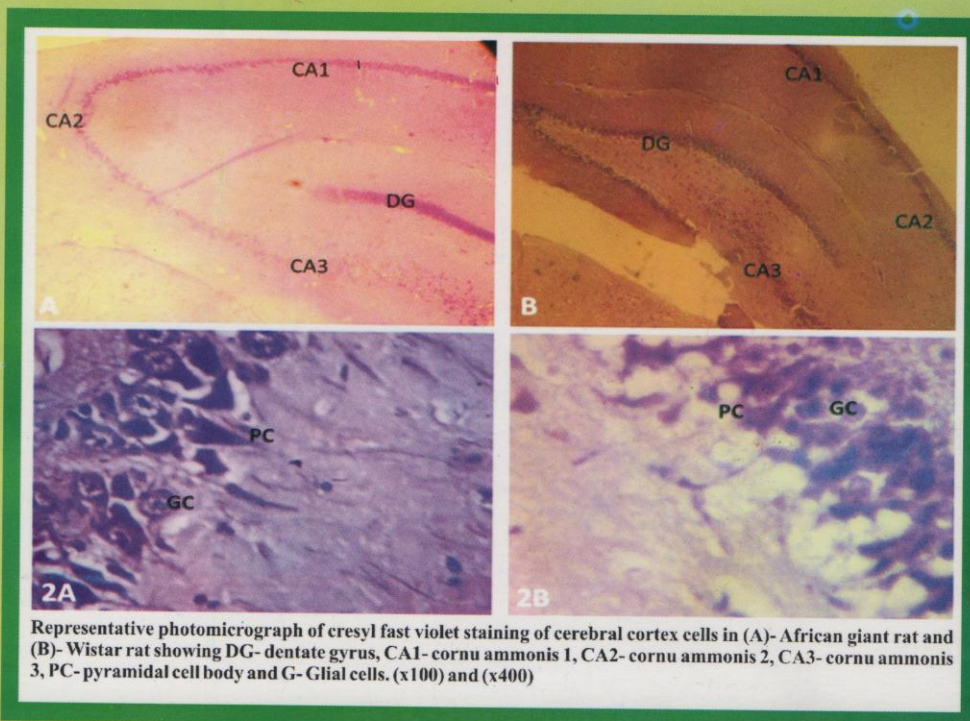
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Histoarchitectural Study of the Cerebrum and Cerebellum of Juvenile African Giant Rat (*Cricetomys gambianus* Waterhouse) And Wistar Rats (*Rattus norvegicus*) Brains

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ABSTRACT

African giant rats are used in some part of the world for the detection of landmines and tuberculosis from human sputum. However, in some parts of the world they are consumed as a source of protein. This study was designed to look into the histo-morphometry of the cerebrum and cerebellum in comparison with the Albino wistar rats that are mostly used as laboratory experimental animals. Eight African giant rats were captured from the wild comprising of four males and four females while the wistar rats were purchased from a local breeder at Ilorin, Kwara state. The animals were cardiacy perfused and their brains were removed for morphometric assessments and histological analysis. Result shows that the cerebral and cerebellar cortices are similar in the two animals. The cerebellar cortex has three layers (molecular, purkinje and granular) and a central core of white matter but were few differences in the population of the cells. The cerebral cortex of the two animals also has the six cell layers and the hippocampus area but there are more pyramidal cells in the hippocampal area of the African giant rat than that of the Wistar rats. In conclusion the properties of the cerebral and cerebellar cortex accounts for the behavioural pattern of the animals.

Keywords: African giant rat, Wistar rat, Cerebrum, Cerebellum, Histoarchitectural

INTRODUCTION

African giant rat (*Cricetomys gambianus* waterhouse) belongs to the family *Nesomyidae* and the order *rodentia*¹. They are one of the world largest nocturnal rodents, mainly omnivorous and mostly found in Tropical African. They are known to be good sniffers, and when trained they can be used to sniff tuberculosis from human sputum and in the detection landmines^{2,3}. However, in many African countries including Nigeria, they are considered as source of protein.

The wistar rats, (*Rattus norvegicus*) developed by the Wistar institute in 1906 for purposes of biological and medical researchers have offered to date the best functionally characterised model of mammalian system because similarity in their genetic sequences compared to humans⁴.

The average weight of African giant rats ranges between 750 g – 1200 g, while those of Wistar rats ranges between 180 – 350 gms at adulthood^{5,6}. The cerebrum and the cerebellum are component of the brain parts are responsible for most of the cognitive activities of the body. The cerebrum integrates psychological activities in the body amongst other various functions while the cerebellum functions in the maintenance of posture, balance and muscle and the coordination of voluntary motor activities⁷.

The study was designed to look into the histoarchitectural differences between the brains of the African giant rat and those of the Albino Wistar rats, a well-known laboratory animals that has been widely studied.

MATERIALS AND METHODS

Eight juvenile African giant rats (*Cricetomys gambianus* Waterhouse) consisting of four males and four females caught from the wild where purchased at a local market in Ilorin, Kwara state, Nigeria and the Wistar rats (*Rattus norvegicus*) were purchased from a local breeder at Ilorin, Kwara State. They were transported in an iron cage to the department of Human Anatomy laboratory, University of Ilorin, Ilorin, Kwara state, Nigeria.

The experiment was approved by the Animal Ethical Committee of University of Ilorin. The animals were allowed to acclimatise for a period of two weeks before the commencement of the experiment. The rats were euthanized with an overdose of intramuscular administration of ketamine after which their body weight was measured and the animals were perfused transcardially first with 0.9% of normal saline, followed by 4% paraformaldehyde solution. The brains were removed and weighed. The brain specimen were then processed for histological studies in paraffin embedded

wax, serial sections of about 3µm thickness were cut and stained with Haematoxylin and Eosin and Cresyl fast violet.

Data Analysis

The values of the weight of the brain and body were reported as mean ± SEM using statistical software SPSS version 16.

RESULTS

On general observation, the African giant rats were observed to be wild in behaviour, very active and agile. They were difficult to handle and extreme care is necessary to prevent them from attacking, which they do by bites and making of loud noises compared to the Wistar rat which were not as wild as they were.

The cerebrum of the African giant rats and Wister rats was smooth. The cerebellum of the African giant rat was seen to be encloses the brainstem and the Pons and appears relatively big when compared to the cerebellum of the albino Wistar rats.

The average mean weight of the male and female African giant was 748.72 ±54.66gm while the mean brain weight was 4.90 ± 0.10gm and 4.95 ± 0.05gm respectively for the male and female African giant rat respectively. There was no statistical significant difference between the two species (Table 2). The mean cerebrum/cerebellum ratio for the African giant rat were 4.35 and 4.93 while the cerebellum/cerebrum ratio were 0.0065 and 0.00585 for male and female respectively while for the Wister rats were 4.45 and 4.33; 0.23 and 0.205 for the male and female respectively (Table 3).

Table 1: Values showing the cerebrum-cerebellum/body weight, cerebrum/body weight, cerebellum/body weight, cerebrum/cerebellum and cerebellum/cerebrum weight

Animals	Sex	Cerebrum+ cerebellum/ bodyweight	Cerebrum/ bodyweight	Cerebellum/ body weight	Cerebrum/ cerebellum	Cerebellum/c cerebrum
AR1	M	0.0062	0.00477	0.0010	4.5	0.222
AR2	M	0.0053	0.0040	0.00096	4.22	0.237
AR3	F	0.00559	0.00436	0.00078	5.57	0.179
AR4	F	0.00557	0.0040	0.00091	4.38	0.229
WR1	M	0.016	0.013	0.0030	4.4	0.227
WR2	M	0.018	0.0146	0.0033	4.5	0.223
WR3	F	0.02	0.0161	0.0037	4.35	0.230
WR4	F	0.023	0.018	0.004	4.30	0.232

Table 2: Values of the mean weight of the animal, brain, cerebrum and cerebellum in African giant rats and Wistar rats

Weights	African giant rat			Wistar rats		
	M	F	Av mean	M	F	Av. Mean
Animal weight	---	845.28±33.56	815.00±3.18	119.00±1.00	95.50±4.50	107.25±7.04
total brain	4.9±0.1	4.95±0.05	4.93 ± 0.1g	2.05±0.15	2.06±0.06	2.0±0.067
Cerebrum	3.7±0.1	3.7±0.2	3.7±0.09	1.65±0.105	1.64±0.035	1.64±0.045
Cerebellum	0.85±0.05	0.75±0.05	0.8±0.04	0.37±0.02	0.38±0.01	0.37±0.01

Table 3: Values of the cerebellum/cerebrum ratio in males and females of the African giant and wistar rats

Animals	Sex	Cerebrum/Cerebellum	
		ratio	cerebellum-cerebrum ratio
African giant rat	M	4.35	0.00635
	F	4.93	0.00585
	M	4.45	0.23
Wistar rat	F	4.33	0.205

Histological analysis

The histological sections of the cerebellar and cerebral cortices shows that the cortices are of similar patterns in the two animals but there are differences in the abundance of granule cells in the cerebellum of the African giant rat as shown in Figure 1&2 and so are the pyramidal cells in the cerebral cortex when compared to the wistar rats as shown in figure 3 using the haematoxylin and eosin (H&E) and Cresyl fast violet stain.

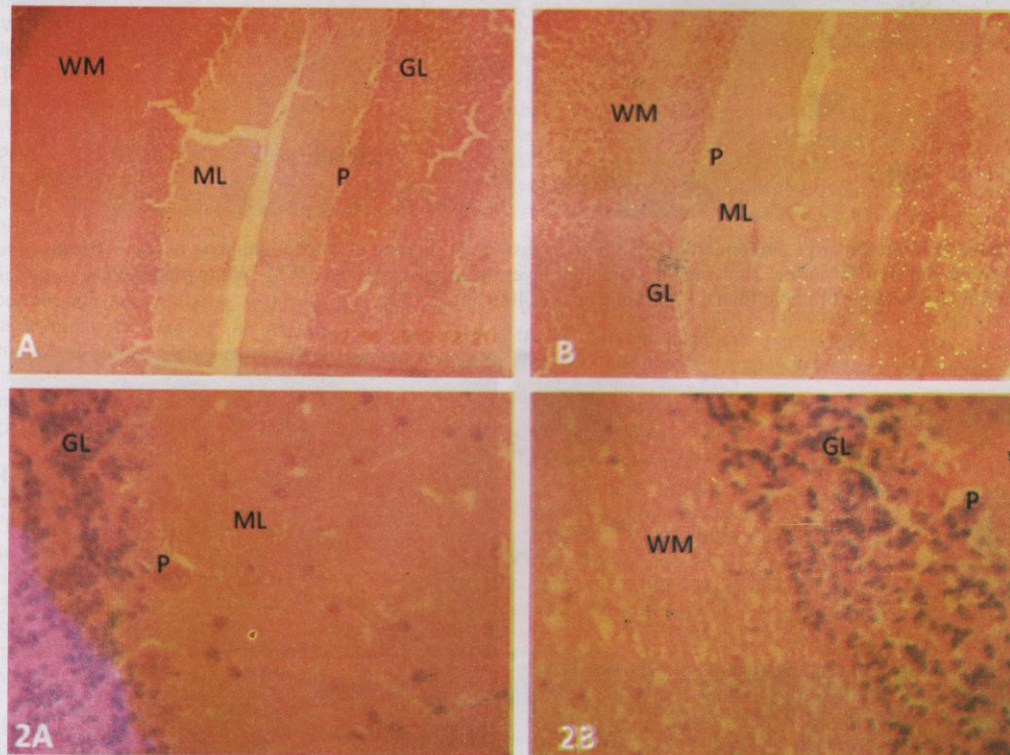


Figure 1: Representative photomicrograph of Heamatoxylin and Eosin staining of cerebellum in (A)- African giant rat and (B)- Wistar rat showing GL- Granular layer, WM- White matter, ML- molecular layer and P- Purkinje cell.(x40) and (x400)

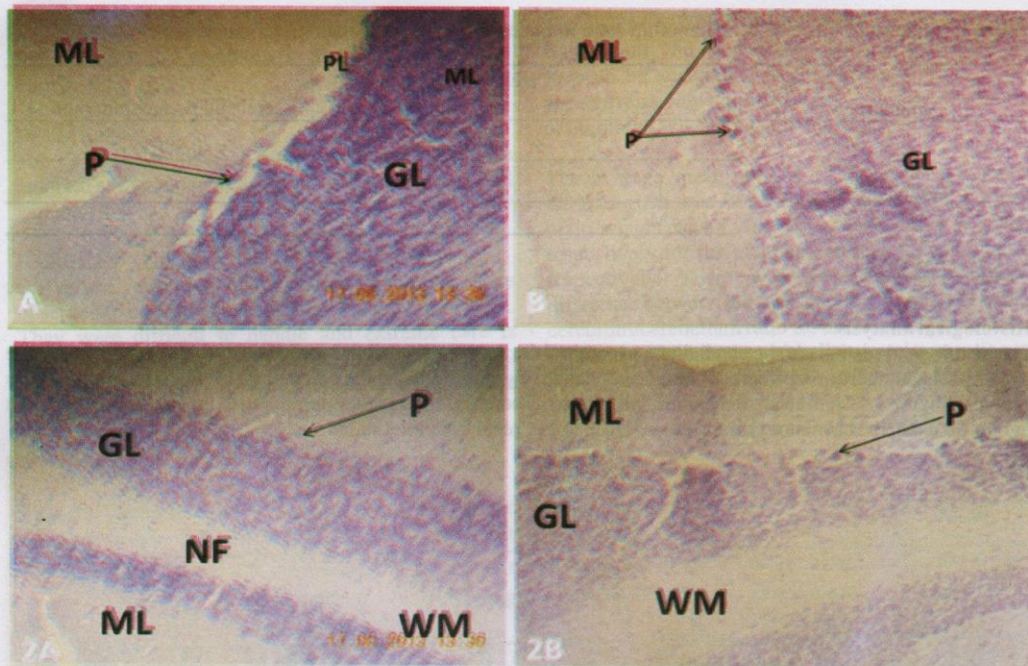


Figure 2: Representative photomicrograph of Cresyl fast violet staining of cerebellum layer in (A)- African giant rat and (B)- Wistar rat showing GL- Granular layer, ML-molecular layer WM- White matter, PL- Purkinje, NF- tracts of nerve fibers, P-purkinje cells (x400) and (x100).

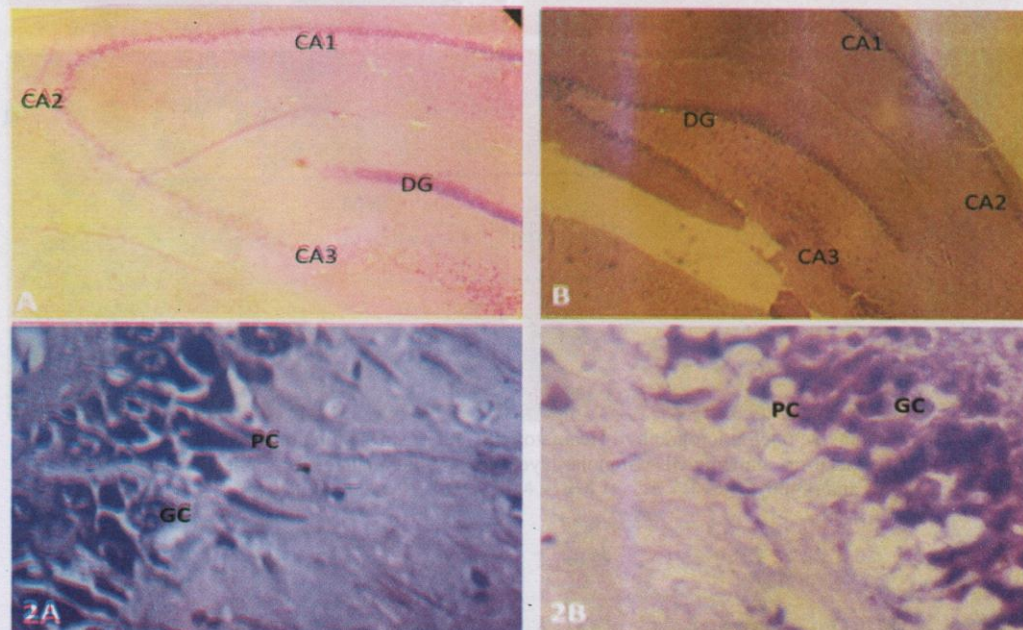


Figure 3: Representative photomicrograph of cresyl fast violet staining of cerebral cortex cells in (A)- African giant rat and (B)- Wistar rat showing DG- dentate gyrus, CA1- cornu ammonis 1, CA2- cornu ammonis 2, CA3- cornu ammonis 3, PC- pyramidal cell body and G- Glial cells. (x100) and (x400)

DISCUSSION

The activities of the entire body system is largely dependent on the functions of cerebrum and cerebellum, since they contain neuronal cells that have the ability to convey and relay such vital information from these two aspects of the brain to entire body systems in all mammals⁷. Comparatively, the body weights of the two animals are different; some observation was seen in their brain sizes as shown in the table. These findings was in agreement with the earlier study of Nzalak et al, 2005 and 2008 that report African giant rats brain were much bigger compared to that of the Wistar rats^{5,8}. The sensory and motor activities of the neurons are relatively proportionate to the size of the cerebellum⁹ and this could be an explanation for the choice of African giant rats in the so many fields of works such as sniffing and mines detection because of the large size of their cerebellum compared to those of Wistar rats. However, the cerebellum – cerebrum ratio in the two animal species are not significantly different. Thus, observation may be due to them belonging to same phallogeny and class. The reason for the brain – weights ratio differences in the two animal species were poorly understood and a challenge for further studies. The olfactory lobes of the African giant rats were much bigger than that of the Wistar rats. The size of the olfactory bulb may be related to the ability of the part utilization in mine detection and various sneefing activities which they are seen deployed. These findings corroborate those of Poling et al, 2011 that state that the large olfactory lobe of the African giant rats may contribute to their well-developed sense of smell, thus, facilitating their use in tuberculosis detection and landmines³. The ability has more made the African giant rats to often be referred to as “good sniffers”¹⁰.

Histology of the Cerebellar Cortex in African giant rats and Wistar rats

The cerebellar cortex of the African giant rat and Wistar rat was seen to have three cell layers comprising of different neuronal cell types. The cortex is surrounded by a centrally located white matter. The cell layers in the cortex are the molecular layer, granular layer and the middle purkinje layer. This is similar to the findings in most other animals and human¹¹ in their cerebellum.

The outer molecular layer in the two animals are seen to have basically two types of cells which are the basket and stellate cells as previously documented⁷, and this cells in these study were described as inhibitory interneurons. The middle purkinje layer is a single layer consisting of the cell body of the purkinje cell and their dendrites projecting into the molecular or granular layer. They are the largest neurone in the brain with presence of spines on the dendrites¹². The third layer of the cerebellar cortex in the two animals is the outer granular layer comprising of dense packed granule cells, and the cells are densely populated. However, the granular layer of the African giant rats is more densely packed with the granule cells compared to that of Wistar

rats. This may explain why the African giant rats are more coordinated in movement and other activities compared to the Wistar rats. The densely packed granule cells seen in these animals may have direct relationship to the environment they live and other conditions that may enhance neurogenic activities in the brain. Molton, 1974 concludes that relatively diverse and enhanced environment may influence the population of the granule cells in the cerebella cortex¹³.

Histology of the Cerebral cortex in African giant rats and Wistar rats

The cerebral cortexes of the African giant rat and Wistar rat comprise of six cortical layers and are similar in the general outlook. These findings was consistence with the reports of Standring et al, 2008, Riling, 2006 and Ibegbu et al., 2014 where they found the cerebral cortices of mammals ranges between 4 – 6 layers^{7,14,16}. However, the pyramidal layers in the cerebral cortex of the African giant rats were larger and closely packed. These observations may account for the complex behaviour of the African giant rats. This was supported by the findings of Stick, 2003. There were similarities in the outlines of the two animals' hippocampus with similarities in the general outline of the cornus ammonis 1 – 3 and the dentate gyrus. Though, the hippocampus was thought to be involved in emotions and memory as a part of the limbic system¹⁵, the cells are more closely packed in the African giant rats compared to those of the Wistar rats. The presence of these complex dentate gyri in the African giant rats partly explains why it is transduce and used in complex activities that are noticed in the African giant rats

CONCLUSION

The study concludes that though there are variations in the sizes of the Cerebrum and the Cerebellum between the African giant rats and Wistar rats, these variations in size have no effects on the histoarchitectural complexity of the organs. However, the complexity of the cells found in the different animals explains the while the animals behavioural activities are different.

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