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Preliminary Anatomical Assessment of the Eye of the African Giant Rat (*Cricetomys gambianus*)

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ABSTRACT

Eleven African giant rats were caught, bilaterally enucleated and the globes were routinely processed for light microscopy. Eye weight, vertical and horizontal corneal diameters, as well as vertical, horizontal and axial eye diameters were obtained from each globe. Observed external macroscopic ocular features were typical of mammalian eyes comprising cornea, sclera and attached extraocular muscles. The eye dimensions were however generally smaller than those of humans. The large mean corneal diameter to mean eye diameter ratio of 0.86 as well as the scanty retinal ganglion cells observed are associated with morphological adaptations for nocturnal vision. Pigments observed in the retinal epithelium suggests absence of *tapetum lucidum*, indicating a sub-optimal nocturnal visual capability. This study has provided scientific documentation of some ocular morphological characteristics of the giant rat and has shown that the eye of this species will be anatomically unsuitable for xenotransplantation in humans.

Key words: Corneal diameter, *Cricetomys gambianus*, Ocular morphology, *Tapetum lucidum,* Xenotransplantation.

The African giant rat, *Cricetomys gambianus*, is a nocturnal, omnivorous and fossorial rodent (Igbokwe *et al.*, 2015) of the family muridae. It is usually hunted for its widely accepted meat and has been noted as Africa's second most hunted micro-livestock (Olude *et al.*, 2013), thus serving as a source of income generation to man (Saikia and Saud, 2017) and a potent threat to the existence of the species (Aslan *et al.*, 2018). Agricultural farming of the rodent on a large scale has however been largely unsuccessful (Akinloye and Oke, 2012). The rodents are reportedly easy to tame and have been trained to detect land mines (Cooper, 2008) and diagnose pulmonary tuberculosis in human sputum samples (Mgode *et al.*, 2012). They serve as exotic pets in Britain (Cooper, 2008). Though the rats are thought to have poor visual capability (Igbokwe *et al.*, 2017), information on their ocular characteristics is scarce.

The potential of the use of the eye of the African giant rat for treatment of human ophthalmic diseases has however, not been explored. Knowledge of the ocular morphological characteristics of this rat will aid understanding of its behaviour and recognition of its ocular pathology as well as determination of its xenotransplantation potentials in humans. This study is therefore a preliminary investigation of the anatomical aspects of the visual characteristics of the African giant rat.

The study was conducted according to specified guidelines for animal care and use in research in the University of Nigeria, Nsukka.

Eleven African giant rats comprising 7 males and 4 females were used for the study. They had a mean weight of 686.09 ± 253.65 g and were caught from the wild in Mbu, Isi-Uzo Local Government Area, Enugu State, Nigeria. The rats were sedated using intramuscular injection of 7 mg/kg of Xylazine hydrochloride following which the horizontal and vertical corneal diameters of each eye were taken using Vernier calliper. Bilateral enucleation (Hall, 2008) was done following euthanasia using intramuscular injection of 120 mg/kg of ketamine hydrochloride. The axial, horizontal and vertical eye diameters as well as the eye weight were obtained from each globe. The axial diameter was taken as the distance from the anterior pole to the posterior pole of the eye; the horizontal diameter was taken as the distance from the lateral to the medial aspects of the eye; while the vertical diameter was the distance from the dorsal to the ventral aspects of the eye. The globes were fixed for 18 hours in Davidson's fixative (Agrawal *et al*., 2007) and post-fixed in 10% neutral buffered formalin. The globe samples were thereafter dehydrated in increasing graded concentrations of ethanol and processed routinely for light microscopy. Numerical data obtained were presented as mean ± standard deviation.

The external macroscopic features of the eye were typical of mammalian eyes comprising a transparent cornea and whitish sclera with its attached extraocular muscles. The eyes had a mean weight of about 0.16 ± 0.05 g and vertical, horizontal and axial eye diameters of 0.65 ± 0.06

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cm, 0.65 ± 0.05 cm and 0.64 ± 0.10 cm respectively. The vertical corneal diameter was 0.55 ± 0.05 cm while the horizontal corneal diameter was 0.57 ± 0.06 cm. The large mean corneal diameter to mean eye diameter ratio of 0.86 was typical of nocturnal mammals (Hall *et al.*, 2012; Kirk, 2004) and is known to permit sufficient amount of light rays into the eye for adequate night vision. The eyes were generally smaller than those of humans and African grasscutter with axial eye diameters of 2.44 ± 0.10 cm (Augusteyn *et al*., 2012) and 0.92 ± 0.08 cm (Peter-Ajuzie *et al.*, 2019) respectively.

Histologically, the eyes were similar to those of most mammals. The cornea was made up of a regular dense connective tissue lined internally and externally by epithelium (Fig 1) while the sclera was an irregular dense connective tissue without epithelial lining. The choroid (Fig 2), ciliary body and iris were pigmented tissues. Their pigments determined the boundaries of the light rays within the globe. The retina was multi-layered comprising a pigmented epithelium, outer and inner segments of the photoreceptor layer, outer nuclear layer, outer plexiform layer, inner nuclear layer, inner plexiform layer and a layer of axons and ganglion

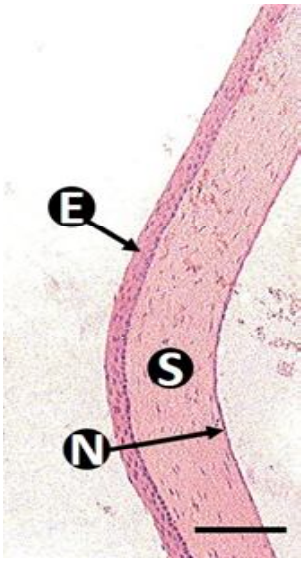

Fig 1: Histological section of the cornea of *Cricetomys gambianus* showing the corneal epithelium (E), stroma (S) and endothelium (N). (Haematoxylin and eosin stain. Scale bar - 50 µm).

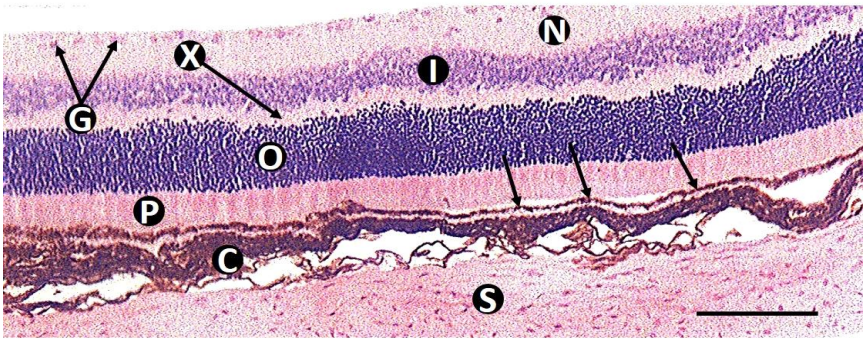

Fig 2: Histological section of the eye tunics of *Cricetomys gambianus* showing sclera (S), choroid (C) and parts of the retina including the photoreceptor layer (P), outer nuclear layer (O), outer plexiform layer (X), inner nuclear layer (I), inner plexiform layer, ganglion cells (G) and retinal epithelium (free arrows). (Haematoxylin and eosin stain. Scale bar - 100 µm).

cells (Fig 2). The scanty retinal ganglion cells observed is associated with nocturnality and has been reported for most nocturnal animals (Hall, 2008; Peter-Ajuzie *et al*., 2019). The *tapetum lucidum*, which greatly enhances nocturnal vision (Ollivier *et al*., 2004), however was absent in the giant rat as suggested by the retinal epithelium adjacent to the choroid which was pigmented throughout its length. This lack of *tapetum lucidum* indicates that the nocturnal capability of the animal is not optimal and might be responsible for the ease with which the rodents are caught in the wild by hunters at night.

CONCLUSION

This study has provided scientific documentation of some ocular morphological characteristics of the giant rat and has shown that the eye of this species will be anatomically unsuitable for xenotransplantation in humans.

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