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SUMMARY

The African giant pouched rat, *Cricetomys gambianus* is a solitary rodent, distributed in savannah of Southern and Eastern Africa with socio-economical importance in landmines and tuberculosis detection. Despite of their importance, there are limited anatomical studies focusing on the reproductive organs of *C. gambianus*. This study was set to evaluate gross and histological features of the penis and prostate glands of *C. gambianus*. Ten sexually matured *C. gambianus* (1.0 ± 0.1 kg) were trapped from the wild and sacrificed using overdose of absolute halothane inhalation. After gross anatomical studies, penile and prostate samples were collected for histological studies. Gross evaluation revealed that, the penis of *C. gambianus* was caudo-ventrally oriented. Average length of measured anatomical parts were: anogenital distance (6.31 ± 0.89 cm); total penis length (6.66 ± 0.3 cm), root (2.0 ± 0.1 cm),shaft (3.77 ± 0.3 cm), and glans penis (0.89 ± 0.2 cm). The average length of the *os penis* was 1.8 ± 0.1 cm and its tip was visible through the urethral opening at the *glans penis*, while its base was attached to the shaft just after the collum penis groove. Microscopically, different parts of the penis showed variable histological composition and organization. Furthermore, the prostate gland consisted of dorsal, lateral and ventral lobes with small, moderate, and few short intraglandular epithelial foldings with acini lined by simple cuboidal to columnar epithelium.

Key words: Reproductive organs, Rodents, *Histology*, *Anatomy*, *Cricetomys gambianus*

INTRODUCTION

Morphology of the penis in mammals shows variations (Simson *et al.*, 1995) even between closely related individuals (Rocha-Barbosa *et al.*, 2013). The variations have been demonstrated more in rodents than other mammals (Atalar and Ceribasi 2006; Adebayo *et al.*, 2011), taking into considerations that rodents comprise of the largest order which forms more than half of all mammals (Atalar and Ceribasi, 2006). Anatomical studies of the penis and associated structures have evolved rapidly in many mammalian orders due to its clinical importance and usefulness in taxonomy (Bradley *et al.*, 1989; Simson *et al.*, 1995; Gultiken *et al.*, 2004; Yildiz *et al.*, 2010). Extensive studies have been performed in domestic animals and laboratory animals to show various features on the morphology of

the penises including grooves, ridges and spines (McLaughlin and Chiasson, 1979; Nickel *et al.*, 1981; Vilmann and Vilmann, 1983; Popesko *et al.*, 1990; Dinc *et al.*, 1996). In subterranean rodents, the penile surface morphology has also been reported to correlate with the pattern of ovulation (Van sandwyk and Bennett, 2005; Parag *et al.*, 2006; Bennett *et al.*, 2010; Faulkes *et al.*, 2010; Katandukila *et al.*, 2017), while that of Silvery mole rat demonstrated clearly the salient features of the *os penis* (Sylvie *et al.*, 2019).

The distance between the phallus and anus in male animals, the anogenital distance (AGD) has been reported to play a key role in reproductive success (Drickamer, 1996; Ophir and delBarco-Trillo, 2007).

Females are reported to prefer males with long AGD as a precopulatory cue (Ophir and delBarco-Trillo, 2007) and those with baculum as a postcopulatory sexual selection (Brindle and Opie, 2016). Moreover, the AGD has been reported to be important for sexual odour preference in African giant rat (Freeman *et al.*, 2018).

Apart from the penile tissues and its associated structures, the male reproductive system also consists of internal structures particularly the male accessory sex glands. The prostate is the largest accessory gland (Lee *et al.*, 2011) and is responsible for the secretion of a slightly alkaline fluid that forms part of the seminal fluid (Bhavsar and Verma, 2014). In rat, the prostate has three lobes, the dorsal, lateral and ventral lobes. The dorsal and lateral lobes are smaller than the ventral lobe and are adjacent to one another with morphologically similar acini, and are often considered together as the dorsolateral lobe since they are more difficult to separate by gross dissection (Jesik, *et al.*, 1982). The ventral prostate is the largest lobe and is most easily separated from the rest of the prostate. Prostatic acinar tissue is fundamentally similar in the dorsal,

lateral, and ventral lobes being tubuloalveolar and consists of epithelium-lined acini surrounded by a stromal matrix. Each prostatic acinus is surrounded by a single cell layer of smooth muscle (myoepithelium). The ventral prostate consists of two discrete lobes that are attached to the urethra by a layer of connective tissue and by a series of ducts lined with mainly cuboidal epithelium that drain into the urethra. Acini of the ventral lobes have a large degree of infolding, particularly of the peripheral acini, which are smaller and more convoluted (Jesik, *et al.*, 1982).

Despite a long tradition of research on the morphology of reproductive organs in mammals, there are still some knowledge gaps in relation to morphology of *C. gambianus* gross and histological features of the penis and the associated genital organs. The objective of this study was therefore to evaluate the gross and histological features of the penis, and prostate gland in *C. gambianus* in order to provide basic information for the purpose of uncovering the reproductive biology of this species.

MATERIAL AND METHODS

Study site and trapping of animals

This study received relevant institutional approval (Approval No. 2019-46-NA-2019-41), and was conducted in accordance with the Sokoine University of Agriculture research regulations and guidelines. A total of ten male, wild *C. gambianus* were trapped using Havahart live animal traps (Havahart, Woodstram Corp, Lititz, PA, USA). The trapping was done in abandoned animal houses, market places, as well as in maize farms at Modeko, MaFigurea and Vibandani areas in Morogoro municipality in Tanzania. Setting of traps was done at night time using ripe banana as bait. Trapped rats were collected on the following day morning, then transported to the laboratory for studies. Captured female rats and sub adult males with partial or undescended testes were freed at the trapping site.

Recording of measurements and preparation of tissues

The giant rats were weighed and thereafter sacrificed using overdose of absolute halothane inhalation (98.11%) for 3 minutes. Perineal region was then examined and the anogenital distance measured using vernier caliper (Supplementary Figure 1). The penis and prostate gland were then dissected out and examined for gross morphological features. The length of the penises was measured in three parts; *glans penis*, shaft and root using a vernier caliper. The *os penis* was then dissected from the penis and their lengths measured, recorded and subsequently immersion-fixed in 10% neutral buffered formalin for one week followed by immersion in 10% formic acid for five days to facilitate decalcification. The remained penile tissues and the prostate gland were fixed with 10% neutral buffered formalin and all tissues were then prepared

for light microscopic evaluation as previously described (Drury & Wallington 1967). Tissue sections cut at 5 μm thickness were dried in an oven at 36 °C for 72 hrs, stained with Ehrlich's haematoxylin, and counter-stained with eosin (Drury and Wallington, 1967) for normal architecture, and Verhoff-van Gieson stain for differentiation between elastic and collagen

fibers. Elastic fibers stain black while collagen fibers stain red (Belz G.G, 1995). All microscopic evaluation was done using Olympus BH-2 microscope fitted with camera for image capturing. The Mean and standard deviation (mean \pm SD) of each measured parameters was calculated using microsoft excel 2007.

RESULTS

Gross morphology and morphometrics of the penis

The average length of the anogenital distance was 6.3 ± 0.89 cm. (Table 1). The penis was caudo-ventrally oriented. The shaft first ran cranio-ventral approximately two third as it emerged from the ischiatic arch then formed a prominent flexure making the remaining one third together with the *glans penis* to turn caudoventral. The mean length of the penis was 6.66 ± 0.3 cm. The *glans penis* was very conspicuous due to its characteristic club-shape and brown coloration with a mean length of 0.89 ± 0.7 cm. The dorsal surface appeared flattened and slightly pointed end. The ventrolateral surface of the glans was folded to form grooves and ridges. A shallow collum penis that separates the shaft and glans was evident. The shaft appeared white in colour, cylindrical in shape with a prominent urethral groove at the ventral aspect with an average length of 3.77 ± 0.4 cm. (Figure. 1A and B).

The penis enclosed a bone, *os penis* which measured 1.86 ± 0.11 cm mean length. The bone extended from the distal part of the shaft just before the collum penis groove to the glans penis occupying its whole length. Externally it was visible through the urethral opening (Figure 1B). The *Os penis* was composed of a broad, brown, bony part which formed a base at the distal part of the shaft close to the collum penis. Extending from the base was the whitish soft cartilaginous shaft that occupied almost the same length of the *glans penis* and it slightly bent at the terminal end to form a craniodorsal pointed tip. The tip was clearly visible as a white structure projecting through the urethral opening (Figure. 1C).

Histological morphology of the penis

Two distinct parts of the *os penis* were observed; the rostral fibrocartilage shaft and the caudal hyaline cartilage base (Figure 2A). The shaft at the rostral part was composed of fibrocartilage, rich in dense irregularly oriented collagen fibers and chondrocytes in lacunae (Figure 2B). The root at the base was composed of hyaline cartilage that appeared to be calcified due to the presence of calcified materials and cartilage canals (Figure. 2D). The erectile tissues consisted of the *corpora cavernosa* penis surrounded by a delicate *tunica albuginea* which appeared as a weak layer of dense irregular connective tissues with staining characteristic of collagen fibers (Figure 3A and B) The *Tunica albuginea* in this species covered and completely separated the two *corpora cavernosa* by a septum (Figure 3C). The collagen fibers were arranged in outer longitudinal and inner circular manner with trabeculae projecting into the *corpora cavernosa* with relatively large blood spaces (Figure 3B). Numerous nerve fibers and blood vessels were observed in the *tunica albuginea* and in the septum. The cavernous bodies were predominantly composed of collagen fibers which stained red with Verhoff-van Gieson stain. (Figure. 3B and C). The *Tunica albuginea* that enclosed the *corpus spongiosum* was thinner compared to that enclosing the *corpora cavernosa*. The *corpus spongiosum* which surrounded the penile urethra was also rich in circularly arranged collagen fibers and large vascular sinuses Elastic fibers were virtually absent in both *corpora cavernosa* and *corpus spongiosum*(Figure 3D)

Table 1. Length (cm) of different parts of the penis and AGD of ten sexually matured African giant pouched rats

S/N	BWT (kg)	Length			Total length of penis	Length of <i>Os penis</i>	Anogenital distance (AGD)
		Glans	Shaft	Root			
1	1.12	0.94	3.7	1.9	6.54	1.82	5.8
2	1.05	0.98	4.01	2.02	7.01	1.88	6.7
3	1.22	0.8	3.72	2.1	6.62	2.16	6.5
4	1	0.82	3.91	1.95	6.68	1.79	7
5	0.98	0.96	3.94	2.02	6.92	1.9	4.0
6	0.9	0.86	4.1	1.99	6.95	1.85	6.4
7	1.11	0.93	4.06	1.95	6.94	1.8	6.2
8	1.01	0.8	3.12	1.89	5.81	1.78	6.9
9	1.2	0.9	4.11	2.2	7.21	1.85	6.6
10	1.1	0.92	3	1.94	5.86	1.84	7
Mean	1.06	0.89	3.77	1.99	6.66	1.86	6.31
SD	0.1	0.07	0.4	0.1	0.37	0.11	0.89

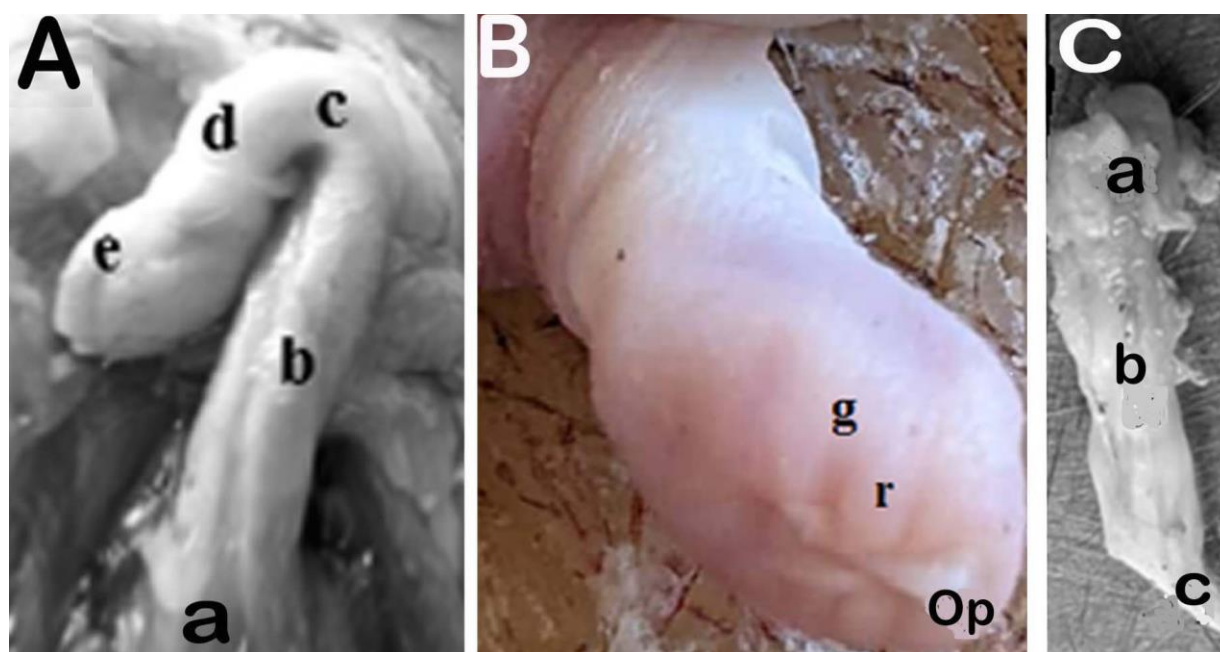


Figure 1. Gross morphology of the penis of the African giant pouched rat. A: Caudolateral view of the *in situ* dissected penis; a= root; b= 2/3 of the shaft ; c= flexure; d= 1/3 of the shaft and e= glans penis. B: Ventrolateral view of the glans penis. Note the grooves (g) and ridges (r) on the ventrolateral surfaces. Op= Tip of the *os penis* projecting through the urethral opening. C: *Os penis* of the African giant pouched rat; a= bony base, b=Cartilaginous shaft, c= Cartilaginous tip.

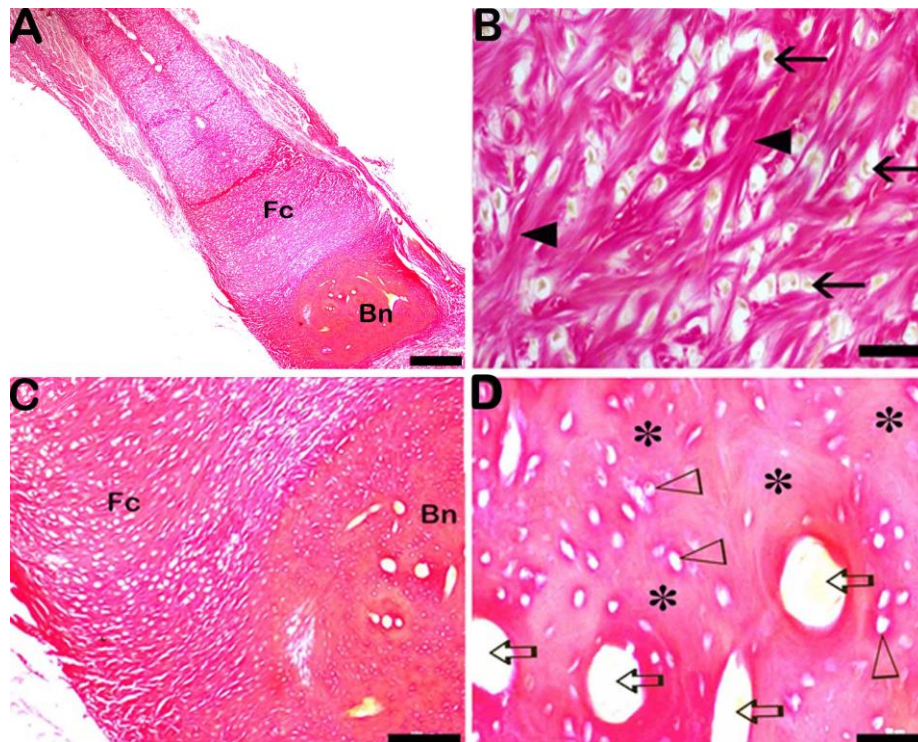


Figure 2. Microscopic structure of the *Os penis* the Africa giant pouched rat. A: Two distinct parts are visible; rostral fibrocartilage (Fc) and the caudal hyaline cartilage base (bn). B: Magnified fibrocartilage composed of dense irregular connective tissues rich in collagen fibers (arrow heads), and chondrocytes in lacunae (arrows). C: Junction between the fibrocartilage (Fc) and the hyaline cartilage (bn) parts of the os penis. D: Base part formed by hyaline cartilage. Note the chondrocytes in lacunae (Open arrow heads); cartilage canals (Open arrows) and cartilage matrix showing staining properties of the matrix that as it begins to calcify and appears devoid of chondrocytes in lacuna (Asterisks). Haematoxylin and Eosin (H&E) stain. Scale bar. A: 200 μ m, B and D: 50 μ m; C: 200 μ m;

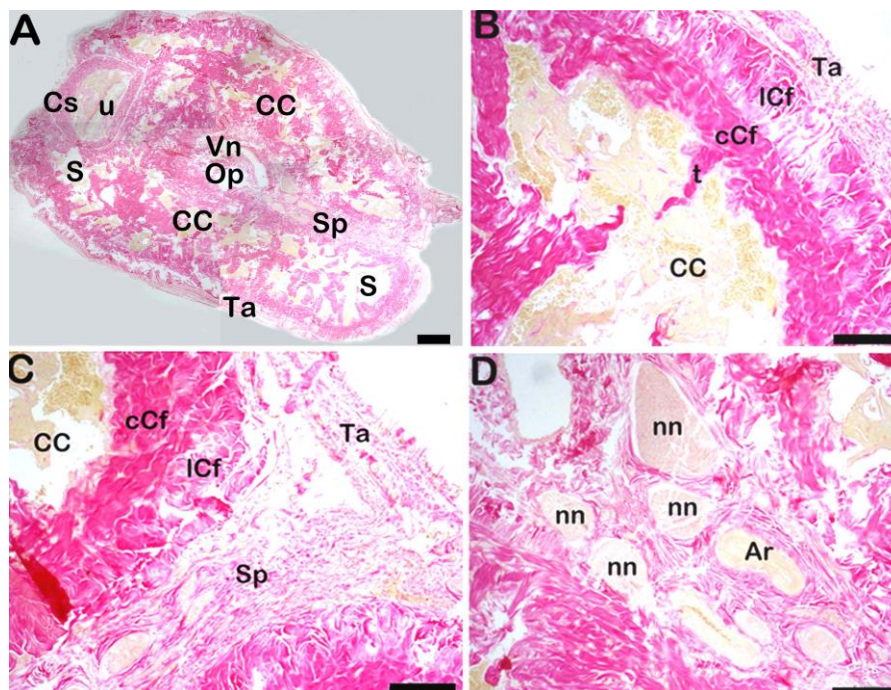


Figure 3. Histological organization of the penis of the African giant pouched rat. A: General overview of the penile tissue bound by a weak *tunica albuginea* (Ta) that send trabeculae (Sp) to separate the *corpus carnosum* (CC) into two parts with blood sinuses (S). Note the presence of vein (Vn) and the area where the *Os penis* (removed) was localized (Op). Note the presence of

corpus spongiosum (Cs) that surround the urethra (U). B: *Corpus carvenosum* (CC) bound by *tunica albuginea* (Ta) with collagen fibers arranged in outer longitudinal (ICf) and inner circular (cCf) manner with trabeculae (t) projecting into the *corpus carvenosum* (CC). C and D: Septum (Sp) of *tunica albuginea* (Ta) in which arteries (Ar) and nerve fibers (nn) are found. Images taken from Verhoff-van gieson stained tissue, and scale bar. A: 500 μm ; B, C and D: 200 μm . Collagen stained red, other tissues stained yellow (CC, Ar, and nn)

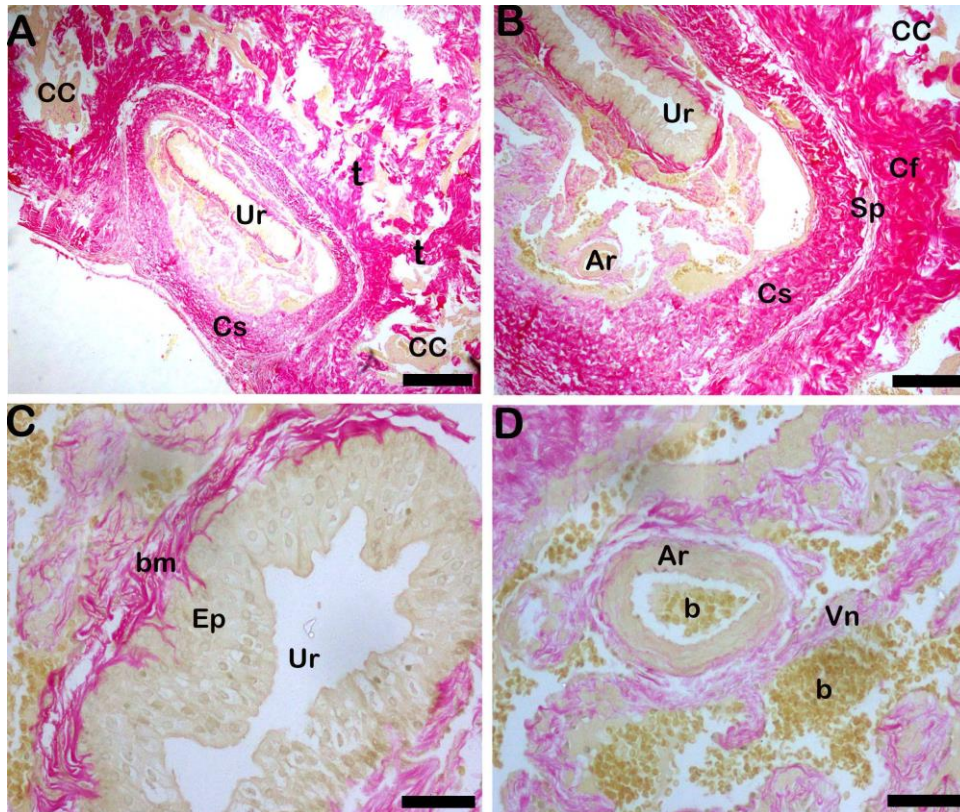


Figure 4. *Corpus spongiosum* showing various anatomical structures. A and B: *Corpus spongiosum* (Cs) surrounding the urethra (Ur). Note the *corpus carvenosum* (CC), dorsal artery (Ar), septum of the *tunica albuginea* made up of collagen fibers (Cf) and trabeculae (t). C: Urethra (Ur) with transitional epithelium (Ep) resting on basement membrane (bm). D: Erectile tissues with blood (b), artery (Ar) and veins (Vn). Verhoff-van gieson stain stained tissue, scale bar. A: 500 μm ; B: 200 μm , C and D: 50 μm . Collagen stained red, other tissues stained yellow (CC, C, Ur, Ep, and b)

Histomorphology of the prostate gland

The prostate gland consisted of three lobes; dorsal, lateral and ventral. Cranial and adjacent to the dorsal lobe appeared the ampullary gland (Figure. 5A). The dorsal lobe composed of acini which were large closely packed and lined by low to tall cuboidal epithelium with centrally located nucleus and supranuclear clear areas. The acini were small with reduced infolding of the epithelium and were loosely distributed within the stroma (Figure. 5B). The ampullary gland was composed of thin epithelium, lined by low cuboidal cells with

basally located nuclei and the acini were found to contain yellowish secretions with characteristic of vacuolation (Figure. 5A). On the other hand, the lateral lobe was composed of closely packed acini lined by cuboidal or columnar epithelium with centrally located nucleus and supranuclear clear areas. Epithelium showed moderate areas of intraglandular infoldings (Figure. 5C). Ventral lobe was lined mainly by cuboidal epithelium with central nuclei. Epithelium showed large degree of infoldings particularly of the peripheral acini (Figure. 5D). The acini in all lobes

were filled with secretions. The collecting ducts of the lobes drained independently into the proximal urethra. The ducts were

surrounded by a thick band of smooth muscle (Figure. 6 and 7).

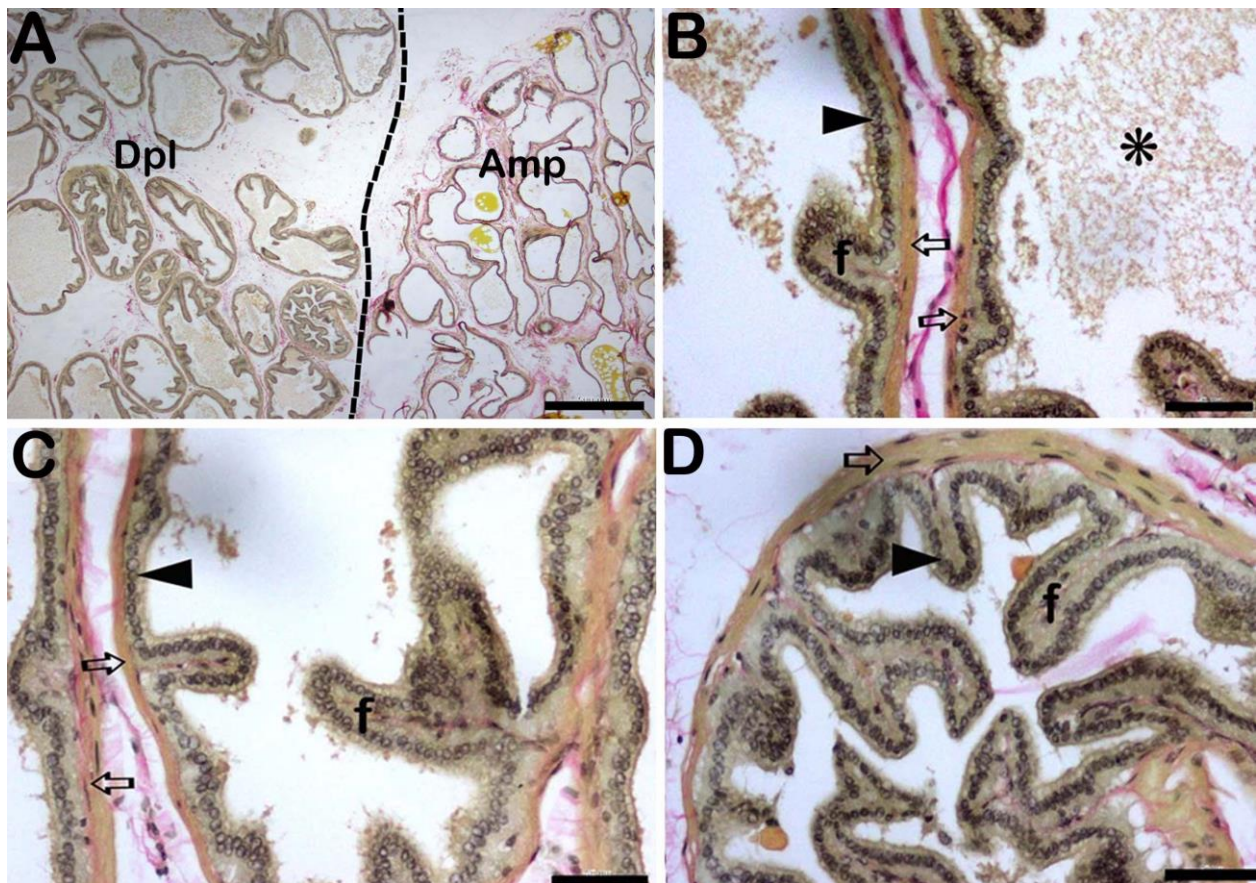


Figure 5. Micrograph showing the histological organization of the prostate gland and its relation with the ampullary gland. A: General overview of dorsal lobe (Dpl) and the ampullary gland (Amp) located cranial and adjacent to the dorsal lobe. B: The dorsal lobe composed of acini which are large closely packed and are lined by low to tall cuboidal epithelium (arrow heads) with centrally located nucleus and also supranuclear clear areas. Epithelium shows moderate areas of epithelial infolding (f). The acini have less infoldings than either the lateral or ventral lobes. Secretions (Asterisks) also found in the acini which are also surrounded by single cell layer of smooth muscle (open arrows) (myoepithelium). C: The lateral lobe is composed of acini which is lined by cuboidal or columnar epithelium (arrow heads) with centrally located nucleus and show supranuclear clear areas. Epithelium (arrow heads) shows moderate infoldings (f). D: The Ventral lobe is lined by mainly cuboidal epithelium with central nuclei displaying a higher degree of infoldings (f), particularly of the peripheral acini. Acini of the lobes are surrounded by single cell layer of smooth muscle (open arrows) (myoepithelium). Verhoff-van gieson stain. Scale bar. A: 500 μ m; B, C and D: 50 μ m. Collagen stained red, elastic fibers and nuclei stain blue-black, other tissues stained yellow.

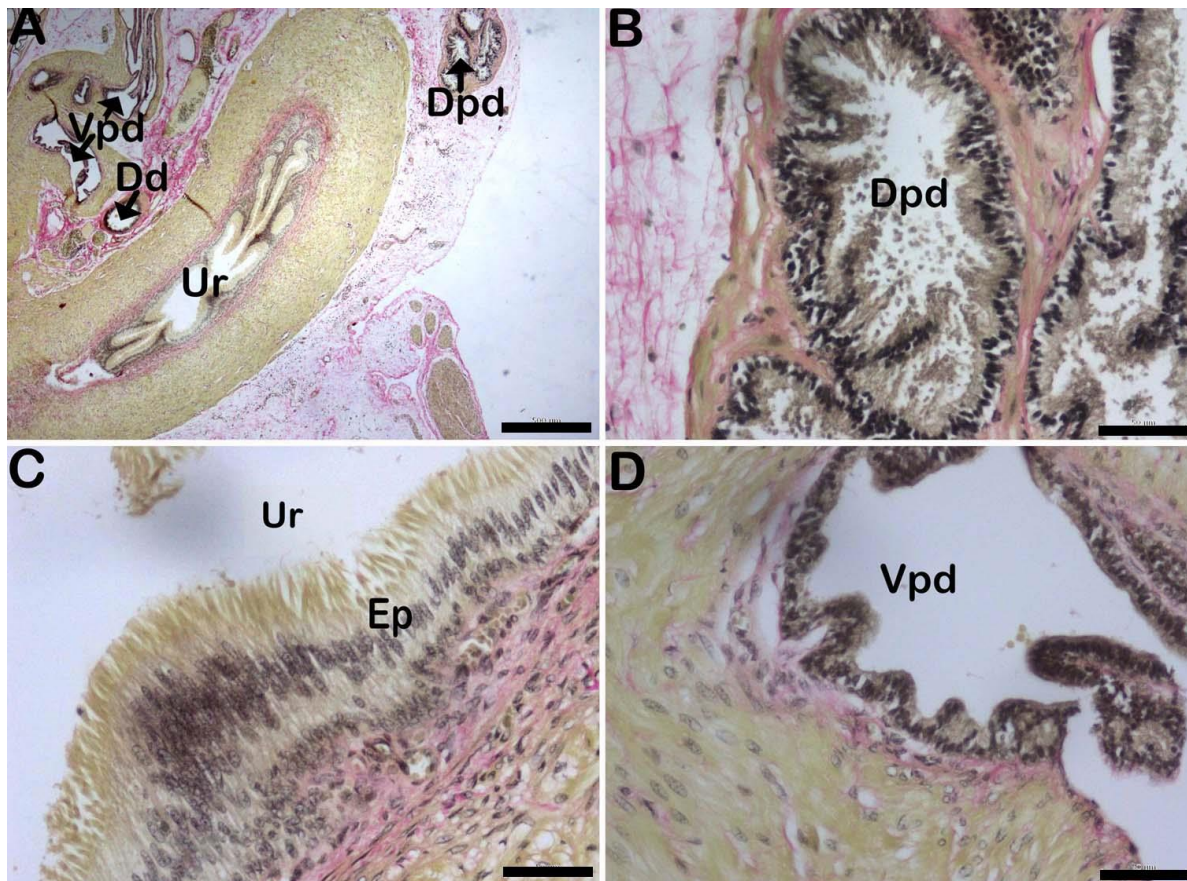


Figure 6. Histology of the prostatic duct system with deferent duct of the African giant rat. A: Prostate lobes with branching dorsal prostatic ducts (Dpd) and ventral prostatic ducts (Vpd) that drain independently into the urethra (Ur). Note the position of deferent ducts (Dd) ventral to the urethra. Detailed structure of the ducts is displayed at higher magnifications, B: Dorsal prostatic duct (Dpd) with infoldings of the epithelial lining C: Urethra with stratified epithelium (Ep). D: Ventral prostatic duct (Vpd) with less infoldings of the epithelial lining. Verhoff-van gieson stain. Scale bar. A: 500 μ m; B, C and D: 50 μ m. Collagen stained red, elastic fibers and nuclei stain blue-black, other tissues stained yellow.

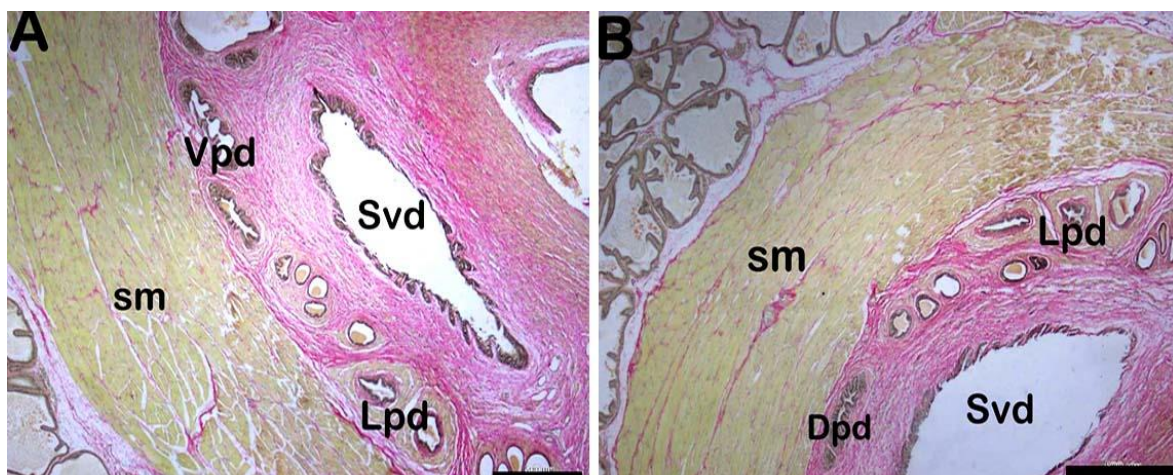


Figure 7. Histology of the prostatic duct system with seminal vesicle duct of the African giant rat. A and B show seminal vesicle ducts (Svd) and the prostatic duct systems [lateral prostatic ducts (Lpd), ventral prostatic ducts (vpd) and dorsal prostatic ducts (Dpd)] bound together by thick layer of smooth muscles (sm). The seminal vesicle in rodent is located dorsolateral to urinary bladder and attach to dorsal lobe of the prostate. Verhoff-van gieson stain. Scale bar. A and B : 500 μ m. Collagen stained red, elastic fibers and nuclei stain blue-black, other tissues stained yellow.

DISCUSSION

Results obtained on external genitalia measurements and morphology showed that the penis of the African giant rat follow the same morphological architecture of other rodents studied so far with slight variation in some anatomical features. The average anogenital distance of 6.31cm observed in this study is similar to that found in other studies (Freeman *et al.*, 2018) in which it was 6.4 cm. The gross morphology of the penis of *C. gambianus* was found to follow the general characteristics of the penises from previously studied rodents; Penises of the rat (Green, 1963), mouse (Cook, 1965), porcupine (Atalar and Ceribasi, 2006), greater cane rat (Adebayo *et al.*, 2011) which are all caudoventral directed. From the ischiatic arch the penis of the African giant pouched rat runs cranioventral approximately two third of the total length, then it forms a prominent flexure which results into the rest of the shaft and *glans penis* to turn caudoventrally.

The same feature was reported in some domestic animals such as the cat (Nickel *et al.*, 1982) and in laboratory animals such as the guinea pigs and rabbits (Popesko *et al.*, 1990). Characteristically, the *glans penis* in *C. gambianus* was found to be brown in colour and expanded to form the bulbous, club-shaped terminal end that differentiate it from the shaft. Colour difference between shaft and *glans penis* was also reported in porcupine (Atalar and Ceribasi, 2006) whereby the shaft is white while the *glans penis* is black. In contrary, both the shaft and the *glans penis* of the greater cane rat are reported to be white and thus the *glans penis* can only be differentiated from the shaft by its club shape (Adebayo *et al.*, 2011). The ventrolateral surfaces of the *glans penis* in the African giant pouched rat are ornamented by grooves and ridges. These features have been reported to cause mechanical stimulation in some animal species during coitus (Parag *et al.*, 2006).

The shaft and the *glans penis* in *C. gambianus* are separated by shallow *collum penis* groove as reported in other species (Atalar and Ceribasi 2006). The average total length of the penis in *C. gambianus* is 6.66 cm with the shaft being three times

longer than the glans (see Table 1). This size is slightly larger compared to some other rodents studied so far such as of the greater cane rat; 5.46 cm (Adebayo *et al.*, 2011) and porcupine; 5 cm (Atalar and Ceribasi, 2006). The flexure of the shaft that makes the penis to change its direction from cranial to caudal was also reported in other mammals such as cats (Nickel *et al.*, 1982), rabbit (Popesko *et al.*, 1990), porcupine (Atalar and Ceribasi, 2006) and greater can rat (Adebayo *et al.*, 2011).

The *os penis* in *C. gambianus* was found to be 1.8 cm long, having a base, shaft and a tip. This bone is slightly longer in this species than in some other reported rodents such as greater cane rat; 1.26 cm (Adebayo *et al.*, 2011). The base of the *os penis* was hard, made up of bony part at the base while the shaft and glans were soft and cartilaginous in composition. This observation is in line with the previously reported *os penises* from; dog (Nikel *et al.*, 1981), porcupine (Atalar and Ceribasi, 2006) and greater cane rat (Adebayo *et al.*, 2011). However the *os penis* of a dog extends from the shaft while that of *C. gambianus* occupied mainly the *glans penis* and a small portion of the shaft. In other rodents studied so far, the *os penis* occupies only the glans penis; (Vilmann and Vilmann, 1983; Yamamoto, 1987; Atalar and Ceribasi, 2006;).

Histologically the *os penis* of *C. gambianus* was found to have two major parts; a bony part at the base which was formed by ossifying hyaline cartilage and a fibrocartilaginous part at the shaft and tip formed by chondrocytes in lacunae and dense irregular collagen fibers. The hyaline cartilage at the base was observed to have several cartilage canals and calcified matrix devoid of chondrocytes. This is the main feature of endochondral bone formation (Banks *et al.*, 1986). Cartilage canals are known to contain small blood vessels which are embedded in the canal matrix providing nutrients to the cartilage and also ossification centre in long bones and ossification nucleus in short bones (Ganey *et al.*, 1995; Shapiro 1998; Blumer *et al.*, 2004a; Blumer *et al.*, 2004b). This trend of

cartilage ossification in *os penis* has been demonstrated previously by several authors; (Nikel *et al.*, 1981; Vilmann and Vilmann, 1982; Yamamoto, 1987; Adebayo, 2011) In this study, the *os penis* of *C. gambianus* was found to have a urethral groove on the ventral aspect which is deeper at the base and shallower at the shaft. Similar findings were observed in the greater cane rat (Adebayo *et al.*, 2011). The penis of *C. gambianus* showed the general tissue arrangement described by Banks *et al.*, 1986 and Tanyolac, 1993 in which the urethra is surrounded by *corpus spongiosum* followed by two *corpora cavernosa* separated by a septum from *Tunica albuginea* then penis epidermis and externally covered by the *lamina interna* of *preputium*.

The *tunica albuginea* that surrounded the penis completely divided the two *corpora cavernosa* penis. These findings concurred with the observations of Wrobel and Bergmann (2006) on the penis of a dog and also Adebayo *et al.*, (2011) on the greater cane rat. According to the architecture of the *corpora cavernosa*, the penis of mammals is classified into fibroelastic and musculocavernous types. The fibroelastic type has small and confined blood sinuses divided by tough fibroelastic tissues. This type of penis appears in ruminants and boars (Hafez & Hafez 2004; Dyce *et al.*, 2010). In the musculocavernous type, blood spaces are relatively larger with more muscular tissue between the blood sinuses. This is common in stallions and dogs (Hafez & Hafez 2004, Dyce *et al.*, 2010). Based on this criterion the penis of *C. gambianus* hangs between the two types.

Another way of classifying mammalian penis histologically is by assessing the degree of development of the *tunica albuginea* in which two types of penises exists: the fibrous type with well developed *tunica albuginea* and the vascular type with imperceptible *tunica albuginea* (Banks, 1986). Since the *tunica albuginea* in the African giant pouched rat is poorly developed, the penis in this species best fits into the vascular type. Wrobel and Bergmann (2006) classified mammalian penises into three types based on what

predominates the *corpora cavernosa* between the erectile and connective tissues. Vascular type which is common in stallion and man have more erectile tissues while bull and boar have a fibroelastic type predominated by connective tissues. The penises of dog and cat are classified as intermediate type between vascular and fibroelastic types. Under this classification the penis of *C. gambianus* do not fit into the fibroelastic nor the vascular type thus be included in the intermediate type. Combining the criteria for classification of the penis in mammals, the penis of *C. gambianus* resemble more with the penis of the carnivores than that of bovidae, equidae or suidae and this observation is in line with Atalar and Ceribasi (2006) who reported that penises of most rodents resemble those of dogs and cats.

The prostatic tissue of *C. gambianus* is tubuloalveolar and consists of acini surrounded by a stromal matrix as in other rodents. Three lobes of prostate were identified based on their relative relation with the urethra. The lobes were connected to the urethra by loose connective tissue and a series of ducts. Each prostatic acinus was surrounded by a single cell layer of smooth muscle (myoepithelium). In general the histological appearance of the epithelium resembles other rodents with slight difference in the position of the nucleus and shape of epithelial cells. The dorsal lobe showed cuboidal shape with basally located nuclei as shown in rat (Jesik, *et al.*, 1982). In contrast the lateral and the ventral lobes possessed centrally located nuclei in *C. gambianus*. Acini of the ventral lobes showed infolding, especially of the peripheral acini, which appeared smaller and more convoluted than the centrally located acini.

In conclusion, the penis of an adult *C. gambianus* is approximately 7 cm long, caudoventally directed with *os penis* inside. The penile erectile tissues are collagen fibers which form a weak *tunica albuginea*. Elastic fibers were not observed in the penis of *C. gambianus*. These features suggest that the penis of the *C. gambianus* resembles more with that of dog and cat than other domestic mammals. However, it posses

many features of the penises found in other rodents with slightly deviation in some characteristics. The prostate gland showed similar features reported in other rodents except minor differences on the epithelial lining.

The current study provides an insight on the anatomy of the penis and associated structures and broaden the understanding on the reproductive biology of this species.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

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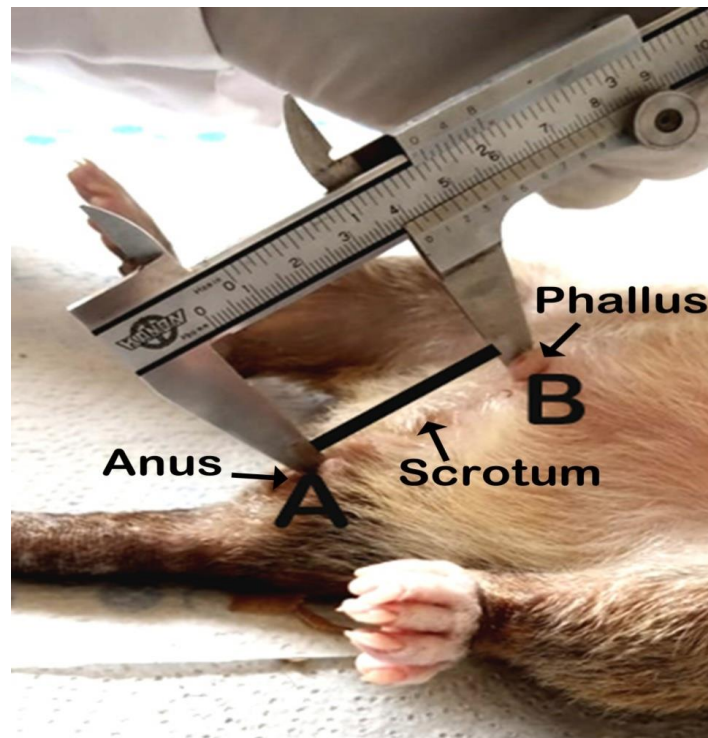
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Supplementary information



Suplemntary Figure 1: Genital measurements of the sacrificed African giant pouched rat. The distance from the anus (point A) to the base of the penis (point B) was measured using a vernier caliper after laying the rat on dorsal recumbence