

Gross Anatomical Study of the Urogenital System of the Indigenous Nigerian Male Donkey (*Equus africanus africanus*) in Comparison with the Stallion

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Abstract

Urogenital systems of two adult male donkeys were studied and the findings compared to that of the stallion. The right kidney, urinary bladder, ureters, testes, epididymis, ductus deferens, accessory genital organs, penis and urethra were found to be similar in many aspects especially their shapes, locations and relationship with associated structures. Dimensions and weights of the urinary and genital organs determined were much smaller and lighter than those of their matches in the stallion. The dimensions of the accessory genital organs were however, close to that of the stallion with the exception of the seminal vesicles which decreases. Certain key differences were also noticed such as the shape of the left kidney of the donkey is heart-shaped with flat dorsal surface and attachment of lateral ligaments of urinary bladder extends to the apex. In addition, the arcuate vessels of the kidneys were fewer; the columnae uretericae, urethral crest and mucosal folds of the bladder were not well pronounced. Despite the fact that both the donkey and the horse belong to the same species of animals, differences exist in the anatomy of their urogenital systems.

Keywords: Adult male donkey; Indigenous; Stallion; Nigeria; Urogenital systems

Introduction

The donkey (*Equus asinus*) belongs to the family equidae with the horse and Zebras. There is considerable difference in the types of breeds [1] with no official breed of the donkey [2]. There are over 40 million donkeys worldwide found in Asia, Africa and Latin America thriving mainly in arid and semi-arid areas and are valuable to farmers and traders, providing power and rural transport at low costs [3]. About 36% of this number is found in Africa [4].

The donkey with an estimated population of over 3 million in Nigeria weighing between 250 kg and 300 kg when in good body condition is found mostly in northern Nigeria. Donkeys are extensively used as a means of transportation and play a remarkable role in agricultural development and draught purposes [5,6]. They are used for tillage operations, weeding, processing of farm produce such as sugarcane crushing, water lifting etc [1]. Donkeys are also known for their exceptional survivability, longevity, low cost, hardiness, resistance to disease, docility, patience and low management requirements compared to other animals like the oxen [7,8].

Donkeys also thrive well on poor quality minimally supplemented feeds which made them popular in environments with critical feed shortages. They have been reported to survive better under drought conditions than any livestock species due to their small body size and low dry matter intake requirements minimizing their water and maintenance needs in arid and semi-arid areas [9].

In Nigeria, despite the potentials and virtues of the donkey, the animal have been virtually neglected by researchers, veterinarians, livestock assistants, entrepreneurs, government and livestock policy makers etc. Little attempt has been made to study any aspect of this equine [2]. Elsewhere, there has been lack of knowledge about their socio-economic status, husbandry and health needs [10]. Emphasis is now shifting on to the donkey in gross anatomy laboratories because of the cheap cost of the donkey compared to horses or cattle.

The anatomy of most domestic animals have been studied extensively elsewhere and found to be of different patterns [11]. In the

donkey, the situation is not so due to rare occurrence of the animal. Anatomy provides the basic information necessary for understanding and improving any livestock production. Understanding of the anatomy of the donkey will greatly enhance its management practices, welfare, viability, health status and production qualities making them abundant to carry out their multipurpose role of transportation and draught power. To the best of our knowledge, this is the first documented study on the anatomy of urogenital system of indigenous Nigerian donkey.

This study was undertaken in order to determine the gross morphology of the urogenital system of the adult male donkey and compare it with the horse so as to form part of the first-hand baseline information currently unavailable and further re-educate the farmers and veterinarians on the potentials of the donkey as an enduring animal that is facing extinction.

Materials and Methods

Two adult male donkeys (*Equus africanus africanus*) (Figure 1) aged 7 years each, belonging to the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria, Nigeria, were used for the purpose of this study. The donkeys weighing 260.0 ± 10.0 kg [Mean \pm SE] were sedated using acetyl promazine (acepromazine*) (0.2 mg/kg IM) and ultra-short acting anesthetic, thiopentone (thiopental*) (15 mg/kg IV) was used for humane killing of the donkeys. Thereafter, blood was drained through the jugular vein and the donkeys were studied fresh. The donkeys were embalmed with 10% formalin using embalming machine.

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The donkeys were placed on dorsal recumbency and a midline ventral skin incision extending from the thorax to pelvic region was made. At the abdominal and pelvic regions, the incision went down through the skin, linea alba and the peritoneum exposing the abdominal and pelvic organs. A saw was used to cut the ischiopubic symphysis, further exposing the sex organs and the urinary bladder.

The gross anatomy of both urinary and genital systems were studied insitu and separately. The dissection was carried out using a postmortem kit while measurements and weights of various organs and structures studied were done using a measuring tape and weighing balance respectively. Photographs of relevant organs were taken using a Canon still camera (EOS-1 system).

Results

Urinary system

The Kidneys: Both kidneys were located ventral to the lumbar vertebrae, the anterior parts were within the region of the last two ribs. The right kidney was located ventral to the 17th and 18th ribs and transverse processes of the first lumbar vertebra (Figure 2). It resembles the heart on a playing card or equilateral triangle with rounded-off angles (Figures 2 and 3), the ventral surface was slightly concave and related to the cecum, liver and pancreas (Figure 4), while the medial border was convex and in relation to the right adrenal gland, abdominal aorta, posterior vena cava and right ureter (Figure 2). The cranial pole was observed to be convex while caudal pole was nearly straight (Figure

2). The right kidney weighted about 271.5 ± 1.50 g and measured 11.5 ± 0.50 cm in length, 10.0 ± 1.00 cm wide and 5.3 ± 0.25 cm in thickness (Table 1).

The left kidney of the donkeys was found to be heart-shaped (Figure 5) and located ventral to the 18th rib and first two lumbar transverse processes (Figure 6). The dorsal surface was flat while the ventral surface was irregular and markedly convex (Figure 5). The medial border was thick and related to the abdominal aorta, left ureter and left adrenal gland (Figure 6). Caudal pole was larger than cranial pole. The weight of the left kidney was about 242.0 ± 1.00 g and measured 12.7 ± 1.49 cm long, 7.5 ± 1.00 cm wide and 5.5 ± 1.20 cm thick (Table 1).

The medial borders of each of the kidneys presented in the middle, a hilus of 3 cm long where all renal vessels, nerves and ureters enter and leave the parenchyma of the kidney (Figure 7).

The ureters: The ureters were paired starting from the hilus of the kidney extending to the entrance on the dorsal wall of the urinary bladder near the neck (Figures 8, 9 and 12). The right and left ureters measured about 37.0 ± 2.00 cm and 39.8 ± 2.75 cm in length and 3.0 ± 1.00 mm and 2.0 ± 0.50 mm in diameter respectively (Table 1).

The Urinary bladder: The partially filled urinary bladder was found to consist of a narrow part, the neck, rounded body and a rounded blind end, the apex (Figures 10 and 11). The urinary bladder is oval to spherical in shape and extends a little cranial to the brim of the pelvis

Organ	No.	Length (cm)	Width (cm)	Thickness (cm)	Diameter (mm)	Weight (g)
Kidneys	2					
Right		11.5 ± 0.50	10.0 ± 1.00	5.3 ± 0.25	-	271.5 ± 1.50
Left		12.7 ± 1.49	7.5 ± 1.00	5.5 ± 1.20	-	242.0 ± 1.00
Ureters	2					
Right		37.0 ± 2.00	-	-	3.0 ± 1.00	-
Left		39.8 ± 2.75	-	-	2.0 ± 0.50	-
Urinary bladder	1	17.8 ± 1.75	6.3 ± 0.40	-	-	-
Urethra	1	40.3 ± 2.25	-	-	3.1 ± 0.50	-
Testes	2					
Right		8.0 ± 0.70	4.0 ± 0.10	3.3 ± 0.40	-	123.0 ± 4.00
Left		9.4 ± 0.45	4.4 ± 0.40	2.9 ± 0.20	-	136.0 ± 3.00
Epididymes	2	6.5 ± 0.30	1.6 ± 0.20	-	-	-
Ductus deferens	2	44.1 ± 2.75	-	-	4.2 ± 0.6	-
Ampullae	2	13.3 ± 0.40	-	-	1.4 ± 0.30 cm	-
Seminal vesicles	2	5.4 ± 0.40	2.2 ± 0.33	-	-	-
Prostate	2	4.1 ± 0.27	1.9 ± 0.20	-	-	-
Bulbourethral gland	2	4.4 ± 0.25	2.5 ± 0.25	-	-	-
Penis	1	36.3 ± 1.20	-	-	5.0 ± 0.40 cm	-

Table 1: Measurements and weights of the urogenital organs of the donkey (*Equus africanus africanus*)



Figure 1: One of the donkeys studied (*Equus africanus africanus*)

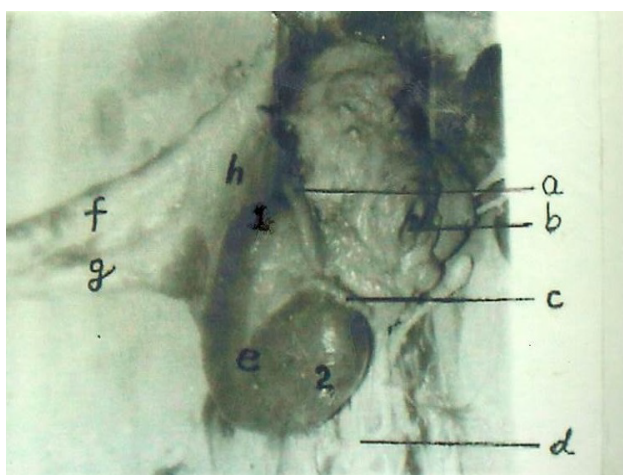


Figure 2: Right kidney and adrenal gland of the donkey insitu (ventral view) a- Right adrenal, b- Severed abdominal aorta, c-Right ureter, d- Posterior vena cava, e – Right kidney, f- 17th rib, g- 18th rib, h- Crus of diaphragm (severed), 1- Cranial pole (convex), 2- Caudal pole (nearly straight)



Figure 3: Right kidney of the donkey (ventral surface) a- Right renal artery (severed), b- Right ureter, c- Right kidney, with a slightly concave ventral surface

because of its contents (Figure 10).

The dorsal surface is in relation to the prostate, seminal vesicles, ampullae and rectum (Figures 9-11, 13 and 15). The ventral surface lies on the ventral floor of the pelvic cavity (Figure 10). About 0.9 litres and 1.1 litres of urine was removed from the bladders. The organ measured 17.8 ± 1.75 cm in length and 6.3 ± 0.40 cm in width (widest portion).

The urinary bladder of the donkeys is supported by three ligaments; the middle ligament extending from the ventral surface of the bladder onto the floor of the pelvis (Figures 10 and 11), the lateral ligaments stretched from the lateral wall and apex of the bladder to the lateral wall of the pelvis and the third ligament called the round ligament which is firm and located at the free edges of the lateral ligaments (Figures 10 and 11).

Ureters of the donkeys penetrate the bladder at about 1.5 ± 0.2 cm apart and continue in submucosa to form the columnae uretericae which is not well pronounced (Figure 12). The urethral crest in this study was found to be an extension of a mucosal fold from the ureteral opening to colliculus seminalis forming the first part of the urethra, the urethral crest is not prominent. The mucosal coat of the bladder of the donkeys was light coloured with few mucosal folds (Figure 12).

Genital system

The scrotum: The scrotum of the donkeys has a sparsely hairy and patchy coloured (grey and black) thin skin with patches of grey and dark colour. It was found to be asymmetrical and divided by the external median raphae (Figure 13).

The testes: The testicles of the donkeys are paired, globular organs located in the inguinal region and enclosed in the thin scrotum (Figure 13). They are oval (Figure 9 and 14) and weighed 136.0 ± 3.00 g and 123.0 ± 4.00 g for the left and right testes respectively. The size of the left testis was 9.4 ± 0.45 cm long, 4.4 ± 0.40 cm wide and 2.9 ± 0.20 cm thick while the right testis was 8.0 ± 0.70 cm in length, 4.0 ± 0.10 cm in width and 3.3 ± 0.40 cm thick (Table 1). The testis from the study conducted was found to consist of extremities capitata, extremities caudata, epididymal border and free border (Figure 14).

Epididymis: The epididymis has an enlarged cranial end, the head containing coiled tubules, a narrow part, the body lying on the dorsolateral surface of the testis, and the tail, which is enlarged and markedly coiled (Figure 14). The tail of the epididymis was found to continue with the ductus deferens. Ligaments of the tail of the epididymis were found to continue with the tunica vaginalis while the proper ligament of the testes attached the tail to extremities caudata of the testis (Figure 14). The body of the epididymis measured 6.5 ± 0.30 cm long and 1.6 ± 0.20 cm wide (Table 1).

Ductus deferens: The ductes deferens of the donkeys measured 44.1 ± 2.75 cm long from its origin to colliculus seminalis and the diameter measured almost 4.2 ± 0.6 mm. Terminal part of the ductus deferens was enlarged forming the ampulla which is cylindrical (Figures 11 and 15). The ampulla measured 13.3 ± 0.40 cm long and 1.4 ± 0.30 cm in diameter (Table 1). Beyond the ampulla, the duct reduced in diameter and opened with the excretory duct of seminal vesicles on the colliculus seminalis of the urethra forming a common opening called ejaculatory orifice (Figure 12).

Seminal vesicles: The seminal vesicles were paired, pear-shaped and consisted of fundus which was rounded blind end, body and a constricted neck (Figure 15). They were located ventral to the rectum and lateral to the neck of the bladder and ampullae (Figure 15). Each gland measured 5.4 ± 0.40 cm long and 2.2 ± 0.33 cm in width at its widest portion (Table 1). The excretory duct of the seminal vesicle

in this study opens as ejaculatory orifice on colliculus seminalis in common with the ductus deferens.

Prostate: Prostate gland consisted of two lateral lobes, each somewhat triangular with a concave dorsal surface. The gland is related caudally with the urethralis muscle (Figure 15). Its length is 4.1 ± 0.27 cm and width 1.9 ± 0.20 cm (Table 1).

Bulbourethral gland: This gland is paired and oval in the donkeys and depressed dorsoventrally (Figure 15). Bulbourethral gland was found to measure 4.4 ± 0.25 cm long and 2.5 ± 0.25 cm wide.

External genitalia

Penis: The penis of the adult male donkey comprised of root, body and glans penis (Figure 16). It is a musculocavernous organ measuring 36.3 ± 1.20 cm long and 5.0 ± 0.40 cm in diameter when relaxed (Table 1). The body is flattened laterally for most part but becomes rounded and smaller cranially (Figure 16). The penis consisted of two erectile bodies, the corpora cavernosa and corpus spongiosum. The corpus cavernosum is the dominant structure and extends cranially to the glans penis through the urethra (Figures 17 and 18). A whitish fibrous and thick material, tunica albuginea covers the corpus cavernosum (Figure 17). Trabeculae in the donkey traverse the interior of the corpus cavernosum and the corpus spongiosum enclosing the urethra (Figure 17).

The penis of the donkey consisted of the following muscles: Bulbospongiosus covering the entire length of the penis and found to be ventral to the urethra; corpus cavernosum; corpus spongiosum; and retractor penis muscle which was ventral to bulbospongiosus (Figures 17 and 18).

Glans penis: The glans of the donkey was convex cranially and consisted of soft tissue, corpus spongiosum glandis which was covered by an elastic skin. At the middle of the glans is a constriction called collum glandis which extends to form corona glandis. Fossa glandis was found in the mid cranial part of the glans for the opening of external urethral orifice (Figure 16).

Prepuce: This has two folds of skin containing the penis when at rest (Figure 16). The sheath was made up of external and internal parts. The external part extends to form the preputial orifice. The outer skin takes a characteristic feature of the scrotum and the internal layer was found to be hairless.

Male urethra: The male urethra of the donkeys measured about 40.3 ± 2.25 cm long from the bladder to the external urethra orifice at the tip of the glans penis and 3.1 ± 0.50 mm in diameter (Table 1). The pelvic part of the urethra is associated with the accessory genital organs, with the excretory duct of the accessory sex organs entering this part. The spongy part is surrounded by corpus spongiosum and is dorsal to bulbospongiosus muscle and ventral to corpus cavernosum (Figures 17 and 18).

Discussion and Conclusion

The results of this study showed similarities in the anatomy of the male urogenital system of the donkey and that of the stallion. However, certain salient differences were observed. The shape of the left kidney of the donkey (Figure 5) differs from that of the horse which is nearly bean-shaped [11] with a convex dorsal surface [11,12]. There are some similarities between the left kidneys of the donkey and the horse in terms of positioning, relationship with associated structures, poles and borders.

The right kidney of the donkey displays a great similarity to that

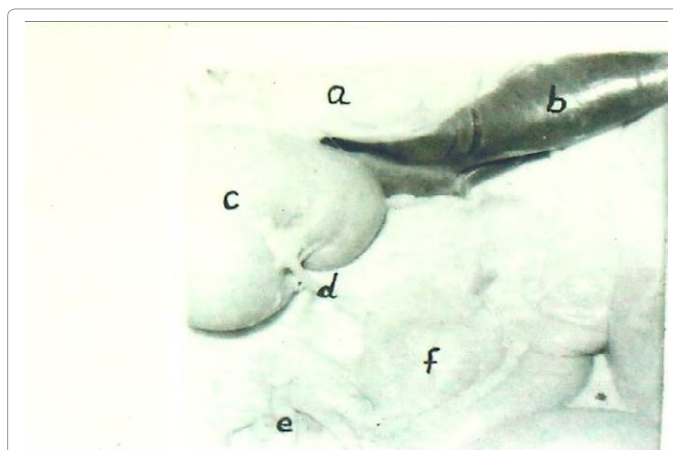


Figure 4: Right kidney of the donkey insitu (Ventral aspect, kidney tilted laterally)

a- Pancreas, b- Liver, c- Right kidney, d- Right ureter, e- Abdominal aorta, f- Cecum

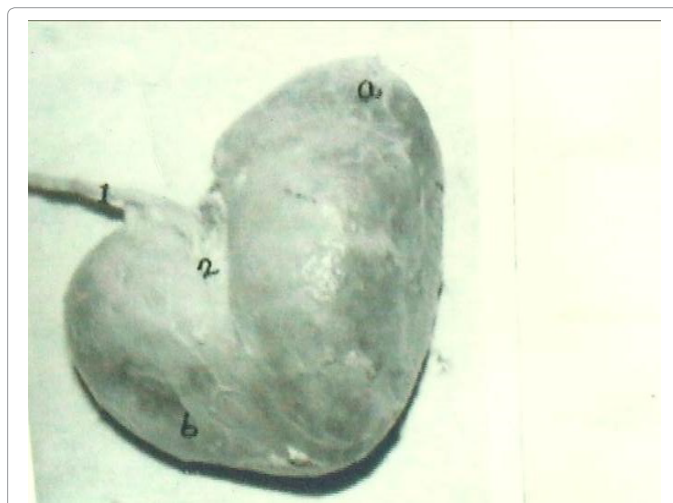


Figure 5: Ventral surface of the left kidney of the donkey

a- Cranial pole, b- Caudal pole, larger than cranial, 1-Left ureter, 2- Hilus

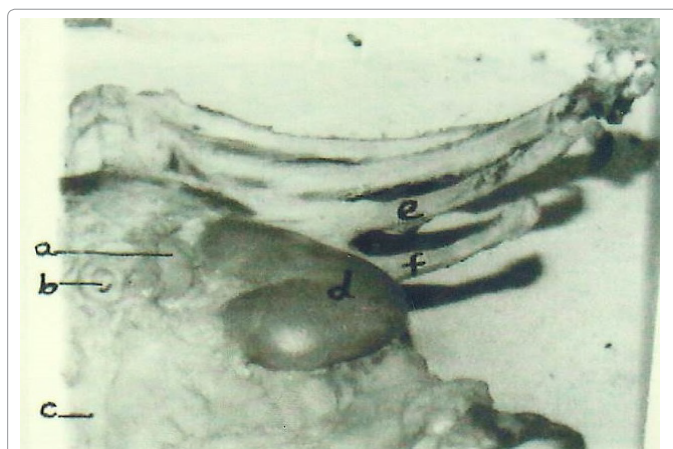


Figure 6: Left kidney and adrenal gland of the donkey insitu (Ventral aspect, kidney tilted laterally)

a- Left adrenal, b- Severed abdominal aorta, c- Left ureter, d- Left kidney, e- 17th rib, f- 18th rib

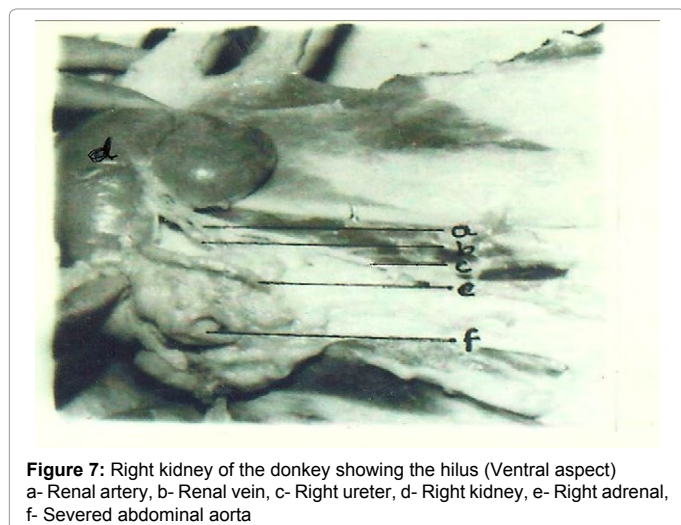


Figure 7: Right kidney of the donkey showing the hilus (Ventral aspect)
a- Renal artery, b- Renal vein, c- Right ureter, d- Right kidney, e- Right adrenal, f- Severed abdominal aorta

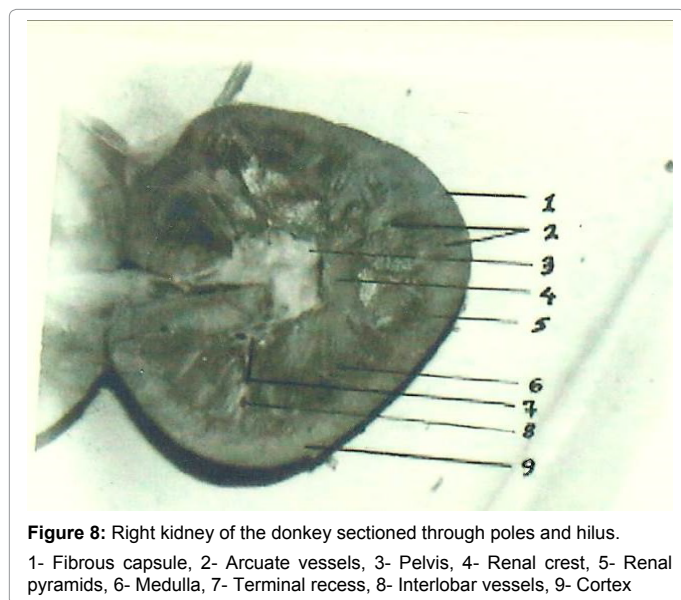


Figure 8: Right kidney of the donkey sectioned through poles and hilus.
1- Fibrous capsule, 2- Arcuate vessels, 3- Pelvis, 4- Renal crest, 5- Renal pyramids, 6- Medulla, 7- Terminal recess, 8- Interlobar vessels, 9- Cortex

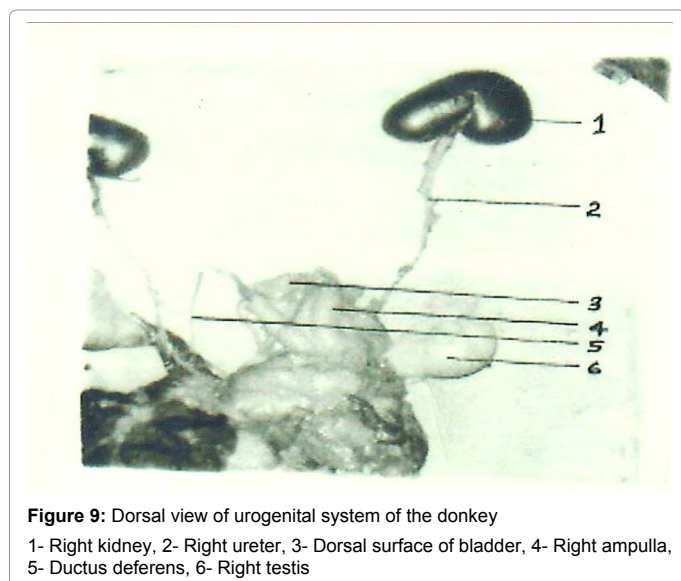


Figure 9: Dorsal view of urogenital system of the donkey
1- Right kidney, 2- Right ureter, 3- Dorsal surface of bladder, 4- Right ampulla, 5- Ductus deferens, 6- Right testis

of the horse in most aspects which agrees with the observations by Sisson et al. [11] and Nickel et al. [12] who did their study in the horse. The kidneys of the donkeys were smaller in size and weighed about one third that of the horse. The right kidney was found to be heavier than the left (Table 1) as reported in the horse. Longitudinal section of the kidney in this study showed a grayish coloured cortex (Figure 8) as opposed to brown coloured cortex of the kidney of the horse [11]. Also, the arcuate vessels are fewer and folds of mucosa of the bladder (Figures 8 and 12) were not as pronounced as in the horse [12].

The ureters in this study were found to be similar with the stallion but the length and diameter were half those of the stallion. The urinary bladder as regards position, associated structures, shape and form when full and empty were consistent with that of the stallion. However, the attachment of the round and lateral ligaments extend from the lateral aspect of the bladder up to the apex in the donkey (Figures 10 and 11) while in the stallion the attachment of the ligaments are only on the lateral aspect of the bladder [11].

The anatomy of the scrotum and prepuce of the donkey and the stallion were similar [13]. Investigation by Arthur et al. [14] on the location of the testes of the stallion agrees with what was observed in this study. In addition, the number, shape and parts of the testes in the donkey were consistent with that of the stallion. However, the testes and epididymis of the donkey were smaller and lighter, weighed about half those of the stallion. A difference was noticed in the weight of the testicles of the donkeys studied, with the left testis being heavier. Jacob [15] reported that with advancing age, there was an increase in testes weight and tubular diameter in stallions. This was not determined in the donkeys in this study.

The division of the stallion's epididymis as reported by Hafez [16] fits the description of the epididymis of the donkeys studied (Figure 14). The sizes of the prostate and bulbourethral gland of the donkeys were rather a peculiar finding. The organs were much closer to those of the stallion relative to the size of other organs and structures. Although not specifically determined, their common physiological roles may be responsible for their sizes being closer to the stallion. Therefore, further studies may provide further explanation.

The common opening, ejaculatory orifice, formed from the combination of the ductus deferens and excretory ducts of seminal vesicles observed in the donkey (Figure 12) was similar to report made in the stallion by Dyce et al. [13].

The shape of the seminal vesicles in this study agrees with the findings in the stallion by Nickel et al. [12] and Dyce et al. [13]. A similar observation was made by Hafez [16] who reported the gland as somewhat a piriform sac. The relationship of the long axes of the seminal vesicles in this study to the ductus deferens and ampullae (Figure 15) conforms to that of the stallion as observed by Sisson et al. [11]. Also, the finding in the stallion by Arthur et al. [14] that the gland is lateral to the ampullae holds in the donkey. From the results obtained, the seminal vesicles of the donkeys were smaller than that of the stallion. This may be attributed to the smaller size of the donkey. The position, number and parts of the seminal vesicles are the same with the description of that of the stallion [12,14,16].

The shapes of the prostate and bulbourethral gland in the stallion as reported by Sisson et al. [11] and that of the donkey found in this study (Figure 15) were the same. However, Nickel et al. [12] described the prostate gland as club-shaped in the stallion and Arthur et al. [14] indicated that it is rounded in the bull, ram and stallion.

Although the anatomy of the external genitalia of the male donkey in this study is in agreement with that of the stallion [11,13,14], the



Figure 10: Pelvic inlet and caudal part of abdominal wall of the donkey on dorsal recumbency viewed from anterior

a- Ductus deferens, b- Middle ligament of bladder, c- Apex of bladder, d- Ampulla, e- Genital fold, f- Round ligament of bladder, g- Lateral ligament of bladder, h- Rectum



Figure 13: Scrotum of the donkey

1, Scrotum, 2- Median raphe



Figure 11: Dorsal surface of the bladder of the donkey with associated structures

1- Ductus deferens, 2- Round ligament of bladder, 3- Lateral ligament of bladder, 4- Right ureter, 5- Ampulla, 6- Urinary bladder, a- Apex of bladder, b- Body of bladder, c- Neck of bladder



Figure 14: Left testis and epididymis of the donkey (Lateral view)

a, Left testis, b- Head of epididymis, b'- Body of epididymis, b''- Tail of epididymis, c- Severed ligament of tail of epididymis, d- Proper ligament of testis, e- Severed ductus deferens, f- Cremaster muscle, 1- Extremities capitata, 2- free border of testis, 3- Extremities caudata, 4- Epididymis border of testis.

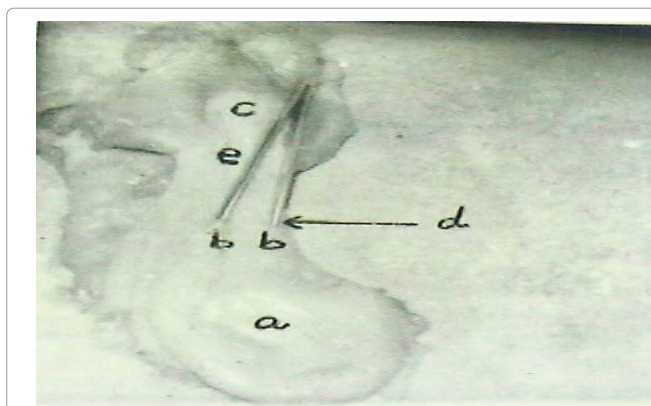


Figure 12: Bladder of the donkey opened longitudinally.

a- Folds of mucous membrane, b- Columnae uretericae, c- Colliculus seminalis (ejaculatory orifice), d- Ureteral opening, e- Urethral crest

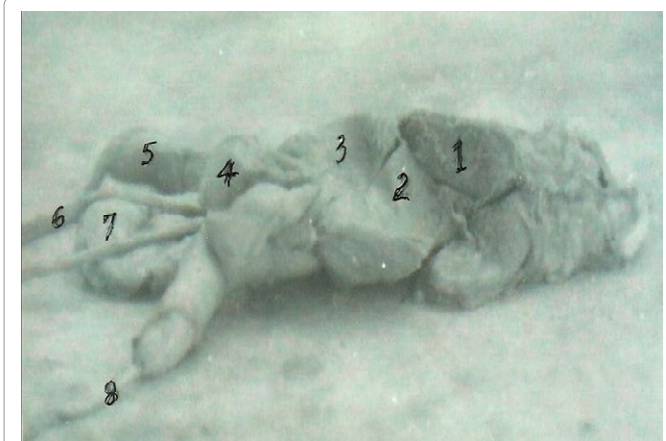


Figure 15: Accessory genital organs and bladder of the donkey (Dorsal view)

1- Bulbourethral gland, 2- Urethralis muscle, 3- Right prostate gland, 4- Right seminal vesicle, 5- Ampulla, 6- Ureter, 7- Bladder, 8- Ductus deferens

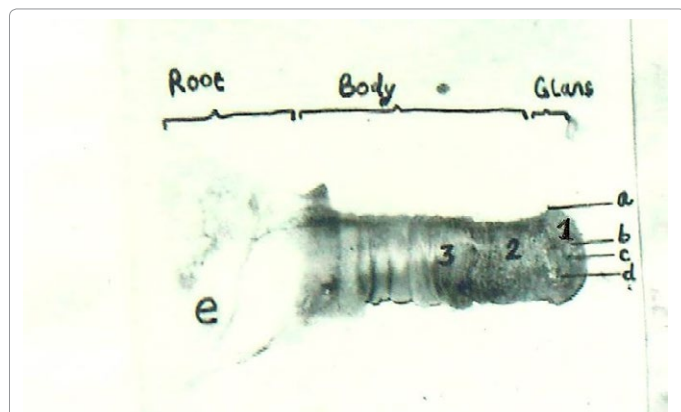


Figure 16: Penis of the donkey (Ventral view)

1- Glans penis, 2- Free part of penis, 3- Plica prepuccialis, a- Corona glandis, b- External urethral orifice, c- Fossa glandis, d- Collum glandis, e- Prepuce

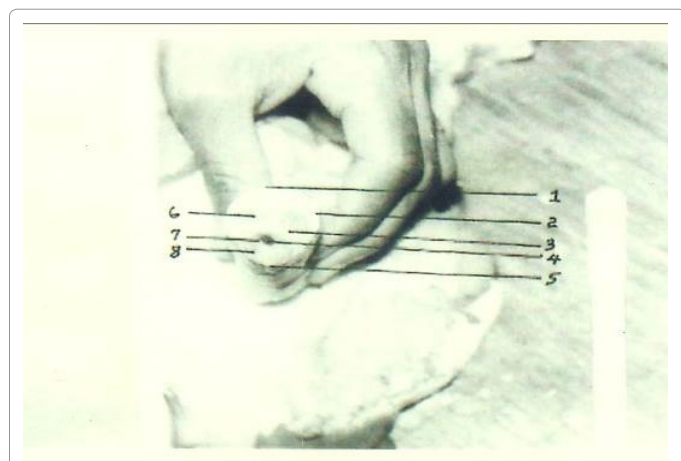


Figure 17: Cross section of body of penis of the donkey

1- Dorsum penis 2- Tunica albuginea, 3- Trabeculae, 4- Urethra, 5- Retractor penis muscle, 6- Corpus cavernosum penis, 7- Corpus spongiosum penis, 8- Bulbospongiosus muscle



Figure 18: Penis of the donkey cut longitudinally

1- Bulbospongiosus muscle, 2- Corpus spongiosus, 3- Corpus cavernosum

length and diameter of the penis and male urethra of the donkey were found to be almost half those in the stallion. In addition, the corona glandis and collum glandis are not as prominent as shown in the stallion.

It could be inferred from this study that some differences exist in the anatomy of the urogenital system of the male donkey and the horse despite the fact that they belong to the same species of animals. Most of the differences were in the sizes and weights and in few instances, the shape and some anatomy of the internal organs. This study therefore, hopes to serve as a yardstick towards a thorough understanding of the anatomy of the donkey, provide a foundation for further studies in areas of comparative anatomy and provide a literature on the anatomy of the indigenous donkeys in Nigeria in order to sustain this important and hardy animal to perform better so as to support the rural communities. The donkey can also replace horses in gross anatomical studies because of its affordability.

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