Bulgarian Journal of Veterinary Medicine, 2025, **28**, No 4, 660–668
ISSN 1311-1477; DOI: 10.15547/bjvm.2024-0100

Original article

RADIOGRAPHIC ANATOMY OF THE ABDOMEN OF ADULT GREATER CANE RATS (*THYRONOMYS SWINDERIANUS*)

R. T. SHOYOMBO-AMUSA[1], O. F. KEHINDE[2], I. O. OYENEKAN[1], O. T. ADENUBI[3] & R. A. AJADI[1]

[1]Department of Veterinary Surgery and Theriogenology, [2]Department of Veterinary Public Health & Preventive Medicine, [3]Department of Veterinary Pharmacology & Toxicology; Federal University of Agriculture, Abeokuta, Nigeria

Summary

Shoyombo-Amusa, R. T., O. F. Kehinde, I. O. Oyenekan, O. T. Adenubi & R. A. Ajadi, 2025. Radiographic anatomy of the abdomen of adult greater cane rats (*Thyronomys swinderianus*). *Bulg. J. Vet. Med.,* **28**, No 4, 660–668.

Greater cane rats (GCR) are wild rats in high demand for their meat. Domestication is slow due to a dearth of information on the rat's anatomy and physiology. This study described the radiographic anatomy of GCR abdominal structures. Five adult captive GCR were administered intra-peritoneal injections of xylazine (1 mg/kg) and ketamine (10 mg/kg) and radiographed in dorsoventral, ventro-dorsal, and lateral recumbency. Measurements of the abdominal organs were done relative to the length of the third lumbar vertebra (L_3) using the scales on the digital X-ray machine. Data obtained were analysed with descriptive statistics. Survey abdominal radiographs showed that the liver, stomach, caecum, and intestines were the only visualisable organs. The liver had relatively dense soft tissue opacity with craniocaudal length ranging between $1.4L_3$ and $1.6L_3$, while the ventrodorsal length ranged between $2.4L_3$–$5.2L_3$. The stomach was visualised as a radiolucent area representing the gastric antrum and located between T_9 and T_{13}. Stomach antral diameter ranged between $1.0L_3$ and $1.2L_3$. The intestines were radiographically located in the right half of the abdomen with gritty dense opacity. Craniocaudal measurement of the intestine ranged between $6.0L_3$ and $9.8L_3$, while latero-medial measurement ranged between $2.0L_3$ and $3.4L_3$. The caecum was observed on the right with craniocaudal length between $4.9L_3$ and $8.0L_3$. The kidneys, pancreas, and reproductive tract were not visualised on the survey abdominal radiographs. In conclusion, survey abdominal radiography in GCR provides useful anatomical details of abdominal structures for clinical disease diagnosis and management.

Key words: abdomen, cane rat, radiograph, survey

INTRODUCTION

Animal protein deficit in underdeveloped nations can be augmented through wildlife captive breeding (Adewumi *et al.,* 2021). Captive breeding of game species has been recommended as a solution to meet local demand for micro livestock. Greater cane rats (GCR) are one of the micro-livestock being explored for this purpose due to their potential for domestication. GCRs was reported with health-related advantages and better nutritional composition (Kilwanila *et al.,* 2023). The GCR is a hystricomorph rodent widely distributed in Africa (Babarinde *et al.,* 2023). It is closely related to porcupines, guinea pigs, and agouti, and is among the micro livestock used for meat (Mustapha *et al.,* 2020). GCRs are widely distributed in West Africa, and hunted for meat (Adewumi *et al.,* 2021). Increased socio-economic and scientific interest in this rat has led to increased research efforts in understanding the biology of the rats (Mustapha *et al.,* 2020).

Morphologically, the adult GCR has a thick body measuring 40–60 cm, with a tail measuring 20–25 cm and weight ranging from 2–4 kg in the females and 3–6 kg in males (Mpamikige & Makungu, 2023). The fur is a mixture of brown to red depending on the habitat (Mustapha *et al.,* 2020). The furs are easily pulled out which makes the animals difficult to handle after capture. GCR are quick runners and good swimmers with blunt snouts. They have excellent hearing and well-developed sense of smell (Kilwanila *et al.,* 2023).

Radiographic and sonographic examination are the most common imaging techniques used in rodents (Dorotea *et al.,* 2016; Mpakige & Makungu, 2023). Diagnostic imaging provides important anatomical details about different structures in rodents. It also assists with the clinical evaluation of musculoskeletal, respiratory, gastrointestinal, and urinary systems, thus helping treatment decisions and prognostic determination in this species (Debenhaum *et al.,* 2019). However, a dearth of relevant studies on the application of radiography in rodents in general, and greater cane rats in particular compared with other species has limited the application of this technique (Mpakige & Makungu, 2023). This study therefore described the survey radiographic features and measurements of major abdominal structures of the greater cane rats.

MATERIALS AND METHODS

Animals

Five captive-bred adult GCRs comprising 3 females and 2 males with weights ranging from 2.8 to 3.1 kg originating from Favour Farm, Eleweran, Abeokuta, Ogun State, Nigeria, were used. The rats were kept singly in metal cages in an enclosed area on the farm before and during the study. The health status of the rats were assessed based on general body evaluation. The rats were provided grasses and concentrates, along with clean water. Before the commencement of the radiographic examination, the GCRs were determined to be apparently healthy based on the findings of physical examination and results of complete blood counts. Ethical approval (FUNAAB/COLVET/CREC/2022/07/03) for the study was obtained from COLVET Research and Ethics Committee (CREC), Federal University of Agriculture, Abeokuta.

Radiographic examination

Radiographic examination was done as described by Dorotea *et al.* (2016). The GCRs were not fasted before the radiographic examinations. The rats were administered 1mg/kg of 2% xylazine hydrochloride (Xylazin®, Kepro Ltd, Holland) and 10 mg/kg of 5% ketamine (Ketamine®, Kepro Ltd, Holland) intraperitoneally to facilitate proper restraint and positioning of the rats. Following the loss of the righting reflex, the rats were positioned for abdominal radiography. Radiographs were obtained with a digital X-ray (CR) machine (Brivio XR 115, GE Health Care Services, General Electric Company, India). The exposure parameters used were 10 mAs and 56 kVp. Radiographs were saved using Digital Imaging and Communication in Medicine (DICOM) software. Right and left lateral (L), dorsoventral (DV), and ventrodorsal (VD) whole-body survey radiographs were obtained. The GCRs were positioned on the cassette in lateral recumbency with the fore and hind limbs extended to reduce superimposition of the thorax and abdomen. For DV projections, each GCR was positioned on the cassette in ventral recumbency. The hind limbs were symmetrically extended caudally and forelimbs cranially. The head was placed in a dorsoventral position. The radiographs were reviewed and subjectively evaluated as described by Dorotea *et al.* (2016). Measurements were made on the DV and RL view for the rats a using digital caliper. Visualisable organs in the abdominal cavity were measured in relation to the length of the third lumbar vertebra (L_3).

The craniocaudal length of the liver was defined as the maximum distance occupied by the liver from the diaphragm to the caudal border on a ventrodorsal abdominal radiograph, while its ventrodorsal length was defined as the maximum distance covered by the liver from the dorsal to the ventral border on a lateromedial abdominal radiograph. The craniocaudal measurement of the intestine of the cane rats was measured as the maximum distance occupied by the small intestine from the cranial to the caudal border on a ventrodorsal abdominal radiograph, while the lateromedial measurement was defined as the maximum distance covered by the small intestine from the dorsal to the ventral border on a lateromedial abdominal radiograph. In addition, the craniocaudal length of the caecum was measured as the maximum distance occupied by the caecum from the cranial to the caudal border on a ventrodorsal abdominal radiograph, while the lateromedial measurement was defined as the maximum distance covered by the small intestine from the dorsal to the ventral border on a lateromedial abdominal radiograph.

Statistical analysis

The ranges of each of the parameters was determined for each radiographic measurement and presented in tables.

RESULTS

The ventrodorsal and lateral abdominal radiographs (Fig. 1 and 2) of the GCR showed that the liver, stomach antrum, caecum, and intestines were visualised radiographically. The spleen, kidneys, adrenal gland, urinary bladder, and genital tracts were not visualised on the survey radiograph. The liver occupied the majority of the cranial third of the abdominal cavity immediately caudal to the cardiac silhouette, surrounded by the intestine, stomach, and caecum. It was relatively dense with somewhat soft tissue opacity and located between thoracic vertebrae T_9 and T_{13}. The craniocaudal length of the liver ranged between $1.3L_3$ and $1.6L_3$, while the ventrodorsal length – between $2.4L_3$ and $3.2L_3$ (Table 1).

The stomach of the GCR appeared as a radiolucent, oval-shaped area which represented the stomach antrum. It was located between the 9^{th} and 13^{th} thoracic vertebrae and surrounded by the more radiodense liver cranially and laterally, while

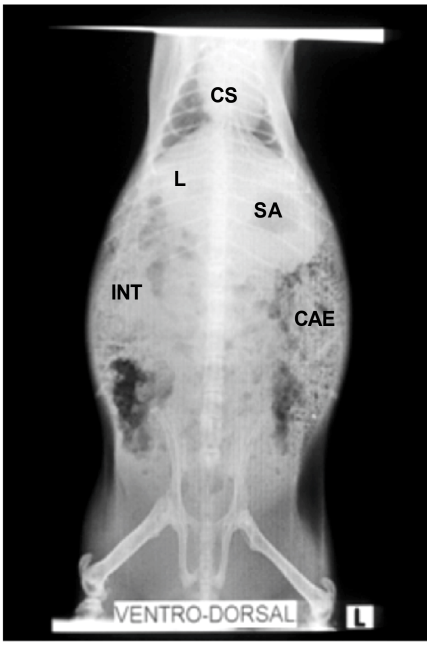

Fig. 1. Ventrodorsal abdominal radiograph of greater cane rats showing the cardiac silhouette (CS), liver (L), stomach antrum (SA), caecum (CAE) and the intestine (INT).

the caecum was visualised caudal to the stomach antrum. The stomach antral diameter ranged between $1.0L_3$ and $1.8L_3$ (Table 2). The small intestine was radiographically located within the right half of the abdomen. It ran from the last two thoracic vertebrae through the entire part of the lateral aspect of the abdominal cavity. Radiographically, the intestine had gritty dense opacity with some radiolucent tubular structure. The craniocaudal dimension of the intestine of the cane rats measured between $6.0L_3$ and $7.8L_3$, while the lateromedial measurement ranged from $2.0L_3$ to $3.4L_3$ (Table 3).

The caecum of the cane rats occupied the majority of the left half of the abdomen, extending from the left lateral part of the last two thoracic vertebras through the lumbar vertebra and appeared ventral to the intestine on the lateral abdominal radiograph. The radiographic opacity of the caecum was consistent with that of the intestine. The craniocaudal length of the caecum ranged between $5.0L_3$ and $8.0L_3$,

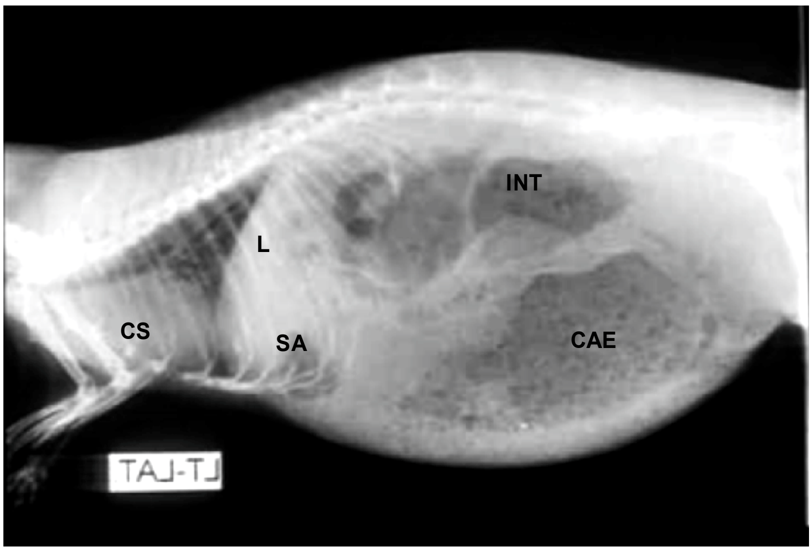

Fig. 2. Left lateral abdominal radiograph of greater cane rats showing the cardiac silhouette (CS), liver (L), stomach antrum (SA), caecum (CAE) and the intestine (INT).

Table 1. Craniocaudal and dorsoventral lengths of the liver of greater cane rats

Rats	Location	Craniocaudal length	Ventrodorsal length
1	$T_9 - T_{12}$	$1.6L_3$	$2.8L_3$
2	$T_9 - T_{12}$	$1.6L_3$	$3.2L_3$
3	$T_9 - T_{12}$	$1.3L_3$	$3.1L_3$
4	$T_9 - T_{13}$	$1.4L_3$	$3.0L_3$
5	$T_9 - T_{13}$	$1.6L_3$	$2.4L_3$
Range	$T_9 - T_{13}$	$1.3L_3 - 1.6L_3$	$2.4L_3 - 3.oL_3$

T: thoracic vertebra; L: lumbar vertebra.

while the lateromedial dimension ranged between 2.0 L_3 and $3.2L_3$ (Table 4). The kidneys, pancreas, spleen, ovaries, and reproductive tracts were not visualised.

Table 2. Radiographic location of the stomach and antral diameter in greater cane rats

Rats	Location	Stomach antral diameter
1	$T_9 - T_{13}$	$1.8L_3$
2	$T_{10} - T_{13}$	$1.4L_3$
3	$T_9 - T_{13}$	$1.5L_3$
4	$T_{10} - T_{12}$	$1.1L_3$
5	$T_9 - T_{13}$	$1.0L_3$
Range	$T_9 - T_{13}$	$1.0L_3 - 1.8L_3$

DISCUSSION

This study describes the survey radiographic anatomy of abdominal structures of greater cane rats. It also determined morphometric measurements of selected abdominal structures of the rats. The study revealed that observable abdominal structures on survey abdominal radiographs included the liver, stomach, caecum, and intestine. The kidneys, adrenal glands, spleen, pancreas, and reproductive tract were not visualised on survey abdominal radiograph. This is the first study that describes the radiographic anatomy of abdominal organs in greater cane rats.

The use of chemical restraints allows for proper positioning and prevents movement during the radiographic examination. The wild nature of GCR makes handling difficult thus necessitating the use of mild anaesthesia. Agents that have been reportedly used to produce chemical anaesthesia in rats during radiographic examination included isoflurane (Ikeda *et al.,* 2022), halothane (Kapoor *et al.,* 2016), ketamine-xylazine combination (Akinloye *et al.,* 2018). There are no reports that the type of chemical restraints used could affect the result of radiographic examination, it is however important to note the potential effect of such agents in the overall assessment of radiographic findings of the rats.

The survey abdominal radiograph of the greater cane rats is similar to findings in laboratory rats (Uysal *et al.,* 2017) and rabbits (Bazanto *et al*., 2016) but different from that of dogs and cats in which the spleen and kidneys are visible on survey radiograph (Elser *et al.,* 2020). The GCR as with other rodents like rabbits has a small spleen believed to be part of gut-associated lymphoid tissue (Reese & Hein, 2011; Touzet *et al.,* 2023). This may explain why the spleen was not visualised radiographically. The findings of this study also have implications for the diagnosis of renal disorders in this spe-

Table 3. Radiographic location, craniocaudal and lateromedial dimensions of the intestine in greater cane rats

Rats	Location	Craniocaudal length	Lateromedial length
1	$T_9 – L_5$	$7.6L_3$	$2.8L_3$
2	$T_9 – S_1$	$7.2L_3$	$2.0L_3$
3	$T_9 – L_5$	$7.4L_3$	$2.0L_3$
4	$T_9 – S_1$	$7.8L_3$	$3.4L_3$
5	$T_{10} – L_5$	$6.0L_3$	$2.2L_3$
Range	$T_9 – S_1$	$6.0L_3 – 7.8L_3$	$2.0L_3 – 3.4L_3$

T: thoracic vertebra; L: lumbar vertebra; S: sacral vertebra.

Table 4. Radiographic location, craniocaudal and lateromedial dimensions of the caecum in greater cane rats

Rats	Location	Craniocaudal length	Lateromedial length
1	$T_{10} – L_5$	$5.4L_3$	$3.2L_3$
2	$T_{10} – L_5$	$6.0L_3$	$2.2L_3$
3	$T_9 – L_5$	$5.4L_3$	$3.2L_3$
4	$T_{10} – L_5$	$8.0L_3$	$2.0L_3$
5	$T_{10} – L_5$	$5.0L_3$	$2.0L_3$
Range	$T_9 – L_5$	$5.0L_3 – 8.0L_3$	$2.0L_3 – 3.2L_3$

T: thoracic vertebra; L: lumbar vertebra.

cies, which implies that excretory urography would be required for visualisation of the kidneys. It should be noted that excretory urography involves the administration of an iodinated contrast agent through the cephalic vein which may be technically difficult in conscious cane rats. However, abdominal ultrasonography can be used in place of contrast radiography since it provides good visualisation of different layers of the kidney.

The liver occupied the majority of the cranial third of the abdominal cavity immediately caudal to the cardiac silhouette. It is surrounded by the intestine, stomach, and caecum. It is relatively dense with somewhat soft tissue opacity and located between thoracic vertebrae. Although the length of the liver was significantly correlated with body weight in a previous study on rabbits (Dorotea *et al*., 2016), the correlation between craniocaudal and dorsoventral measurement of the liver with weight was not done in this study involving GCR.

In the present study, the stomach of the greater cane rat was observed as a radiolucent oval-shaped area which represented the stomach antrum. This finding is similar to that found in dogs (Elser *et al.,* 2020). The GCR stomach was located between the 9th and 13th thoracic vertebrae, while the stomach antrum diameter ranged between $1.0L_3$ and $1.8L_3$. The survey abdominal radiography of the greater cane rats did not allow for visualisation of the wall of the stomach. This will require the use of contrast technique to be able to detect gastric mucosa pathology.

The intestines are radiographically located in the right half of the abdominal cavity, running from the last two thoracic vertebrae and the last rib, just beside the liver through the entire part of the last lateral aspect of the abdominal cavity. Radiographically, the intestine had a gritty dense opacity with some radiolucent tubular structure. This may be related to the diet of the rats. Greater cane rats are herbivores (graminivores) feeding on grasses, sugar cane, bark, fruits, and grains (Mustapha *et al.,* 2020). The cane rats used in this study were fed plants and concentrates. The grains might have been responsible for the gritty radiographic appearance of the intestine. In clinical settings, it may be necessary to administer saline enema to the rats for evacuation of the intestinal content to improve the visualisation of the intestinal tract. In this study, it was difficult to differentiate the different segments of the intestine of the greater cane rats except for the caecum. This finding is similar to that reported for small mammals such as rabbits and rats (Bazanto *et al.,* 2016).

The caecum of the cane rats occupied the majority of the left half of the abdominal cavity from the left lateral part of the last two thoracic vertebras through the lumbar vertebra. This is contrary to the location in the rabbits where the caecum is located on the right side with slight distension to the left (Dorotea *et al.,* 2016). The radiographic opacity of the caecum is consistent with that of the intestine and is similar in findings reported for rabbits (Bazanto *et al.,* 2016; Dorotea *et al.,* 2016). The caecal haustrae and the ascending colon are not distinguishable radiographically in the GCR.

Finally, it was not determined if the chemical restraints used could have impact on the radiographic appearance and measurements in the rats. In cats, chemical restraints with xylazine or acepromazine were reported to influence renal opacification and fading during excretory urography (Ajadi *et al.,* 2006). since it is quite impossible to examine the rats without chemical restraints, it may be necessary to determine the chemical restraint agents with the least effect of renal functions in the cane rat.

The first limitation in this study is the small sample size of the rats used which makes it difficult to compare the effect of sex and age on the measured parameters. The second limitation is the inability to visualise the kidneys and the wall of the gastrointestinal tract. This can be overcome by administering contrast agents into the gastrointestinal tract, or the cephalic vein in case of excretory urography. This will also provide insight into the physiology of gastrointestinal transit time and renal function.

CONCLUSION

In conclusion, observable abdominal structures on the survey radiograph of greater cane rats included the liver and the gastrointestinal tract. Radiographic visualisation depends on the condition of the gastrointestinal tract and the nature of the diet of the cane rats. The kidneys, adrenal glands, and pancreas were not visualised radiographically. This might require the use of contrast technique. The abdominal structures of the cane rats did not differ between sexes radiographically. Normal radiographic images and morphometric values are important in the clinical diagnosis of diseases in greater cane rats, thus the need to establish baseline imaging data in these rats.

REFERENCES

Adewumi, A. A., E. O. Famubo, E. E. Ofuya & M. K. A. Wahab, 2021. Economic analysis of grasscutter raised in captivity in Osun and Oyo State, Nigeria. *Scientific Report in Life Sciences,* **2**, 1–7.

Akinloye, A. K., M. Lawal, O. A. Makinde, J. L. Sanni & R. A. Ajadi, 2018. Transcutaneous abdominal ultrasound in African Giant Rat (*Cricetomys gambianus*). *Alexandria Journal of Veterinary Sciences,* **58**, 85–90.

Ajadi, R. A., A. Adetunji, V. O. Omoerah & J. U. Okoh, 2006. Influence of dosage and chemical restraints on feline excretory urography. *Journal of the South African Veterinary Association*, **77**, 202–204.

Babarinde, I. A., A. C. Adeola, C. A. M. S. Djagoun, L. M. Nneji, A. O. Okeyoyin, G. Niba, N. K. Wanzie, O. C. Oladipo, A. O. Adebambo, S. F. Bello, S. I. Ng'ang'a, W. A. Olaniyi, V. M. O. Okoro, B. E. Adedeji, O. Olatunde, A. O. Ayoola, M. M. Matouke, Y. Y. Wang, O. J. Sanke, S. O. Oseni, C. D. Nwani, & R. W. Murphy, 2023. Population structure and evolutionary history of the greater cane rat (*Thryonomys swinderianus*) from the Guinean Forests of West Africa, *Frontiers in Genetics,* **14**, 1041103.

Banzato, T., L. Bellini, B. Contiero, A. Martin, S. Balick, & A. Zotti, 2014. Abdominal anatomic features and reference values determined by the use of ultrasonography in healthy common rats (*Rattus norvegicus*). *American Journal of Veterinary Research,* **75**, 67–76.

Debenhaum, J. J., T. Brinchmann, J. Sheen & D. Veila, 2019. Radiographic diagnosis of small intestinal obstruction in pet rabbits (*Oryctolagus cuniculus*): 63 cases. *Journal of Small Animal Practice,* **60**, 691–696.

Dorotea, B. S., T. Banzato, L. Bellini, C. Barbara & Z. Alessandro, 2016. Radiographic anatomy of dwarf rabbit abdomen with normal measurements. *Bulgarian Journal of Veterinary Medicine*, **19**, 96–107.

Elser, E. B., W. Mai, J. A. Reetz, V. Thawley, H. Bagshaw & J. N. Suran, 2020. Serial abdominal radiographs do not significantly increase accuracy of diagnosis of gastrointestinal mechanical obstruction due to occult foreign bodies in dogs and cats. *Veterinary Radiology & Ultrasound,* **61**, 399–408.

Ikeda, K., H. P. Osuni & K. Thiele, 2022. Intraoperative administration of isoflurane improves survival in rats exposed to caecal ligation and puncture. *British Journal of Anaesthesia (Open),* **2**, 1000014–1000019.

Kapoor, S., D. Rodriguez, K. Mitchell & R. P. Wuthrich, 2016. High resolution ultrasonography for assessment of renal cyst in PCK rat model of autosomal recessive polycystic kidney disease. *Kidney & Blood Pressure Research*, **41**, 186–196.

Kilwanila, S. I., C. M. Lyimo, A. A. Rija & R. H. Makundi, 2023. Phylogeographic patterns of the greater cane rat (*Thyronomys swinderianus*) population from Eastern, Western and Southern African and implications for wildlife conservation. *Tropical Conservation Science,* **16**, 1–8.

Mpakige, F. H. & M. Makungu, 2023. Osteology and radiographic anatomy of the thoracic limb of the greater cane rat (*Thyronomys swinderianus*). *Anatomia, Histologia & Embryologia,* **52**, 393– 402.

Mustapha, A. O., E. E. Teriba, S. O. Ezekiel, M. A. Olude, K. A. Akinloye & J. O. Olopade, 2020. A study of scientific publications on the greater cane rat (*Thyronomys swinderianus*, Temminck 1827). *Animal Model & Experimental Medicine,* **3**, 40–46.

Reese, S. & J. Hein, 2011. Abdomen. In: *Diagnostic Imaging of Exotic Pets*, eds M. E. Krautwald-Junghanns, M. Pees, S. Reese & T. N. Tully, Schlutersche Verlagsgesellschaft GmbH & Company, Hannover, Germany, pp. 280–285.

Touzet, C., T. Coutart, E. Gomes & M. Huynh, 2023. Ultrasonographic features of the spleen in pet rabbits (*Oryctolagus cuniculus*). *Journal of Exotic Pet Medicine,* **44**, 46–50.

Uysal, M., S. S. Gul, S. Karaman, U. Tas, H. I. Sapmaz, F. Uysal, K. Aytekin & M. K. Tümer, 2017. Caecum location in laboratory rats and mice: An anatomical and radiological study. *Laboratory Animals,* **51**, 245–255.

Paper received 14.09.2024; accepted for publication 21.12.2024

Correspondence:

Prof. Ajadi Rasheed Adetola
Department of Veterinary Surgery
and Theriogenology
Federal University of Agriculture, Abeokuta
PMB 2240, Alabata Road, Abeokuta,
Ogun State, Nigeria
tel: +234-703-380-0326; +234-802-257-2535
e-mail: ajadiar@funaab.edu.ng;
ade_vsr@hotmail.com