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Gross and histological studies of the female reproductive tract of the spur-winged goose (*Plectropterus gambensis*)

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Abstract

The extinction of most wild avian species is becoming apprehensive and some water fowls like the spur-winged goose *(Plectropterus gambensis)* may represent a good model for research, to advance wildlife conservation of related avian species. Currently, there are no baseline information regarding the anatomic characteristics of the reproductive tract of this species, hence; the present study aimed at investigating the gross and histological features of the ovary and oviduct of the wild spur-winged goose. A total of five female adults spur-winged geese with ages between eight to ten months old were used for this study. The bird were purchased from a farm and transported to the Laboratory for quick decapitation and tissue processing. The birds were allowed to acclimatized for seven days, before humanely sacrificed by quick cervical dislocation and reproductive organs (ovary and oviduct) were harvested for both gross and histological evaluations. Thereafter, the ovary and oviduct were fixed, and stained with H & E for light microscopic evaluation using DB2 -180M Digital Biological Microscope at different magnifications (×40, ×100, and ×400). The gross finding on the ovary revealed that it is ovoid in shape and appeared as a cluster of sacs showing yellowish to whitish follicles of different sizes and have a poorly defined oviductal segment. The oviduct appeared to be the longest part of the female reproductive tract (12.5-14.5cm). Histologically, the ovary is characterized by a *membrana granulosa* surrounding the oocytes at various stages of development. Also, the oviduct is by simple cuboidal to columnar ciliated secretory epithelium, and connects the ovary to the cloaca as a thin and un-convoluted tube. In conclusion, this study provided valuable information to serve as a baseline model to further research and understand the reproductive anatomy of other related domestic and wild waterfowl species.

Keywords: Gross, Histology, Spur-winged goose, Reproductive tract, Waterfowl

Introduction

The extinction of most wild avian specie is becoming apprehensive, basically due to poaching and increase hunting activities by man (Makram, 2018; Salih *et al.,* 2022). Recent efforts to curb the menace involved the use of biotechnology measures such as cryopreservation to improve breeding characteristics in some specie models like the geese (Taskin *et al.,* 2022). However, the results were variable and still considered experimental. In our own thought, some waterfowl species like the wild spur-winged goose *(Plectropterus gambensis)* could also represent an excellent model candidate for research, to advance

wildlife conservation of related avian species, due to their proximity with humans and other related birds. A significant step in this direction includes the initial documentation of the morphological and histological characteristics of the reproductive tract peculiar to this species. The spur-winged geese are wild waterfowl species, found predominantly in Africa (Shewell, 1959) and less frequently domesticated for their meat and feather products. They belong to members of the aquatic bird family *Anatidae* and the order *Anseriformes* (waterfowl) similar to geese, swans, and shelducks (Johnsgard, 2010). Birds in the family *Anatidae* are considered significant due to their high adaptation abilities, feed conversion rates, resistance to most avian diseases, and attractive egg sizes (Jalaludeen *et al.,* 2004; Taskin *et al.,* 2017; *Sari* & Saatci, 2020).

The spur-winged geese measured about 75 – 115 cm long and weighed an average of 4.5 - 6.8 kg, making them the largest African waterfowl species reported so far (Madge, 1988; Dunning, 2008; Garst & Genevieve, 2010). They have webbed feet, waterproof feathers, and are capable of swimming. The males are considerably larger than the females (Garst & Genevieve, 2010) but do not only differ in size, the females have smaller red facial patches that extend backward from the red bill with a knob at the base of the upper mandible (Madge *et al.,* 1988). In many rural communities in Africa, the domestication of the spur-winged goose is progressively gaining momentum but requires advanced reproductive biotechnology to enhance adequate reproduction and conservation of its genetic diversity (Taskin *et al.,* 2022). Presently, there are very few valuable reports peculiar to morphologic characteristics of the reproductive tract of waterfowl species, despite the numerous existing literatures on the general anatomy of avian reproductive tracts. This study aimed to examine and provide baseline information regarding the gross and histologic features of the ovary and oviduct of the spur-winged goose; the results of which may serve as a model to further research and understand the reproductive anatomy in many other related wild avian species.

Materials and Methods

This study was conducted on five female adults spur-winged geese with ages between eight to ten months old. The birds were procured from a farm in Damaturu, Yobe State, Nigeria and transported to the Gross and Histology Postgraduate Research Laboratory of the Department of Veterinary Anatomy, University of Maiduguri, Nigeria. Feed and water were provided in abundance and the bird is allowed to acclimatize for seven days. Prior to sacrifice, according to a technique previously described by Majama *et al*. (2016), the body weight of the bird was determined and recorded using an electronic balance. The bird was sacrificed by quick decapitation that involves severing of the jugular vein, oesophagus, and trachea, respectively. Subsequently, the bird was placed on a dorsal recumbency on an examination table. The abdomen was carefully dissected using sterile scissors and a scalpel blade. Blood, fat, and other tissues attached to the abdominal structures were gently removed to exteriorize the reproductive organ of the bird (Plate I).

Ethical considerations

Prior to the commencement of the research, ethical clearance was obtained from the Animal Use and Ethics Committee (AUEC) of the University of Maiduguri with code No. AUP-R004/2023.

Gross anatomical studies

The ovary and oviduct were dissected and immediately stretched on an examination table for gross study (Plate II). Thereafter, the whole of the reproductive tract was viewed for gross studies. The entire length of the oviduct and other structures were measured using a ruler as described by Rotimi *et al.* (2015).

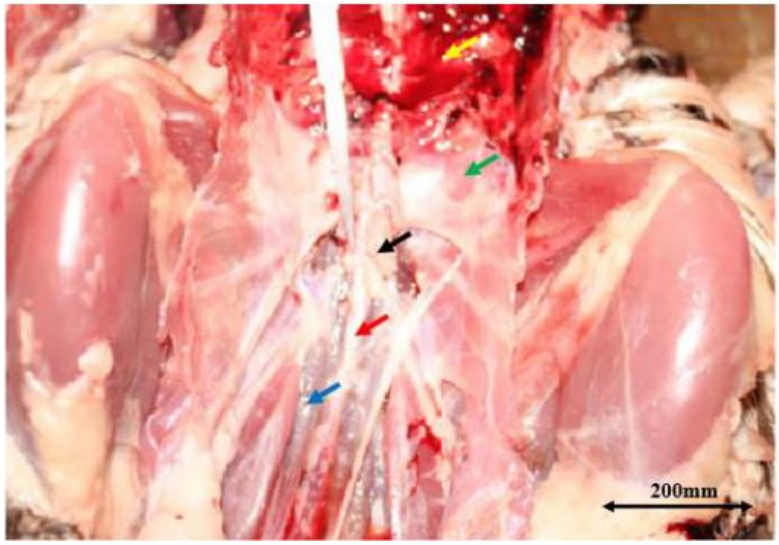
Histological study

The histological method of Winsor (1994) was adopted. About 0.5cm each of the ovary and oviduct tissues were collected. These tissues were fixed in 10% formalin for 48 hours, washed for proper dehydration to remove the fixatives, and then treated with ascending grades of ethyl alcohol (70%, 90%, and 100%) for dehydration. After dehydrating the tissues, the tissue pieces were cleared for 4 hours with xylene. Because the specimen was delicate, an intermediary process of a graded combination of cleaning agent (xylene) and melted paraffin wax was used before embedding it in paraffin wax. The tissue impregnated with a combination of xylene and molten paraffin wax was placed in sample bottles in an oven at 63°C for 3 hours before being transferred to pure paraffin wax at 63°C for 8 hours. The tissue blocks were then mounted on wooden chocks, cooled, and cut at 5µm thickness. The tissue sections were then flattened on warm water at 45^{o} C and were placed on glass slides, smeared with egg albumin, and dried in the oven at 45^{o} C. After that, Haematoxylin and Eosin (H&E) were

used to stain the tissue sections, and observed under a light microscope. The histological slides were thereafter viewed using DB2 -180M digital biological microscope at different magnifications (×40, ×100, and ×400) and relevant photomicrographs of the sections were taken.

Results

In the current study, the left ovary was observed in the coelomic cavity and located cranio-dorsally, in close contact with the cranial pole of the kidney and also the caudal part of the left lung. The suspensory ligaments (mesovarium) were apparently seen in close contact with the peritoneum. The ovary resembles a cluster of sacs that appeared yellowish to whitish considered as the numerous follicles of different sizes (Plate I).



A Photograph showing the gross appearance of the ovary (black arrow), oviduct (red arrow), kidney (blue arrow), heart (yellow arrow) and air sacs (green arrow) within the abdominal cavity of the Spur-winged goose

Plate II: A Photograph showing the gross appearance of the reproductive tract of the Spur-winged goose. The structures are ovary (green arrow), infundibulum (red arrow), Magnum (blue arrow), Isthmus (yellow arrow), uterus (brown arrow), and cloaca (black arrow)

The left oviduct was a long tube of 12.5 – 14.5 cm in length (Plate II). It was the longest part of the female reproductive tract of the Spur-winged goose connecting the ovary to the cloaca. The tube was long and thin. It does not fill the dorsal and caudal part of the left side of the coelomic cavity but is found suspended ventrally just below the ovary. The different segments of the oviduct (infundibulum, magnum, isthmus, uterus, and vagina) were not clearly visible in the current study.

In this study, the histologic view showed that the ovary of the wild spur-winged goose is divided into a cortex and medulla. A *membrana granulosa* was also found surrounding the oocytes at various stages of development. Numerous follicles of different sizes were visible and the different concentric layers of the ovarian follicles could apparently be distinguished (Plate III).

In this study, the mucosal folds of the infundibulum were lined with simple cuboidal to columnar ciliated secretory epithelium. The tubular parts of the infundibulum showed the lamina propria, mucosal fold, and muscularis mucosa and were all apparent histologically (Plate IV). The lamina propria sub-mucosa consisted of loose connective tissue and blood vessels. The lamina muscularis consisted of two layers of smooth muscle fibers which include the inner circular and outer oblique. The mucosal folds of the magnum were lined with simple columnar secretory cells where the lumen and the crypts were histologically visible (Plate V). The lamina propria sub-mucosa contained branched tubular glands while the tunica muscularis consisted of two layers; inner longitudinal and the outer oblique smooth muscle

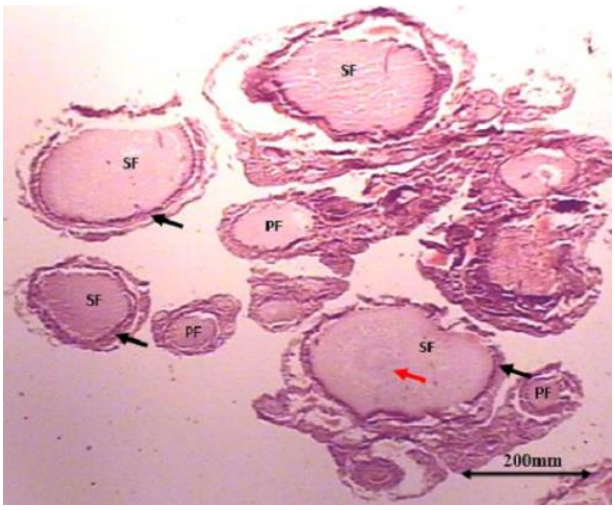


Plate III: A Photomicrograph of the ovary showing primary follicles (PF), secondary follicles (SF) and *membrana granulosa* (black arrow) and oocyte with different concentric layers (red arrow). (H and E x100)

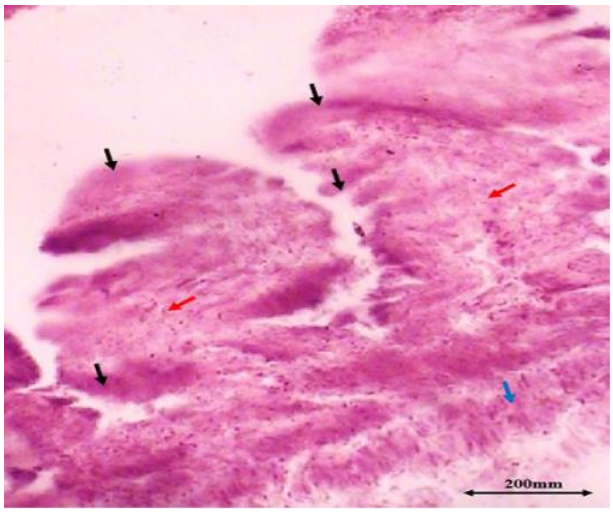


Plate IV: A Photomicrograph of the tubular part of the infundibulum showing mucosal fold lined with simple columnar epithelium (black arrow), muscularis mucosa (red arrow) and lamina propria (blue arrow). (H&E x400)

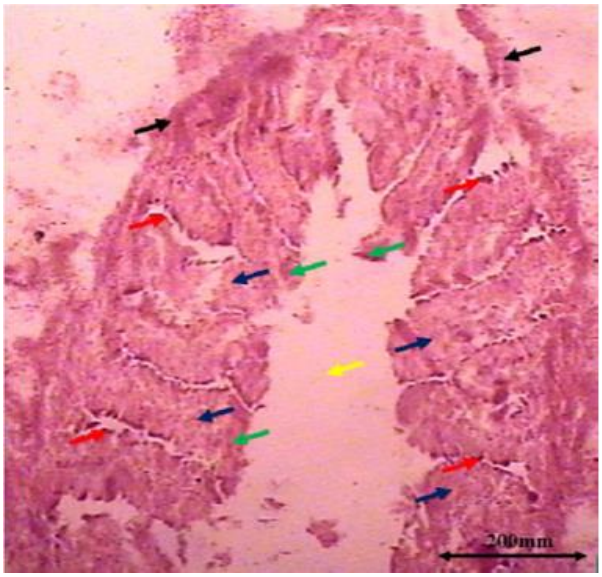


Plate V: A Photomicrograph of the magnum of the Spur-winged goose showing the lumen (yellow arrow), lamina propria forming the crypts (blue arrow), simple columnar epithelium (red arrow) and tunica muscularis (black arrow) (H and E x100)

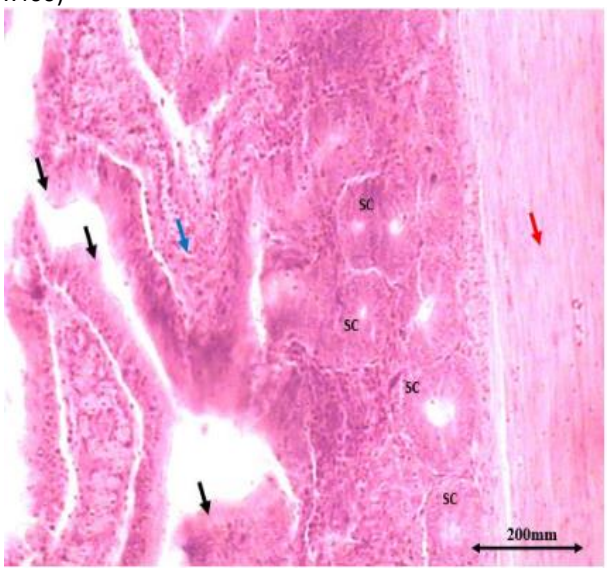


Plate VI: A Photomicrograph of the uterus of the Spur-winged goose showing the non-ciliated secretory cells (SC), pseudostratified columnar ciliated epithelium (black arrow), lamina propria (blue arrow) and tunica muscularis (red arrow) (H and E x100)

fibers. The transition zone between the magnum and isthmus presented very low mucosal folds with no glands. The mucosal folds of the isthmus were lined with pseudo-stratified columnar ciliated epithelium. The tunica muscularis could not be differentiated histologically from that of the magnum but were arranged in layers (inner longitudinal and outer circular).

Furthermore, the mucosal folds of the uterus were also lined with pseudostratified columnar ciliated and non-ciliated secretory cells. The lamina propria sub-mucosa consisted of highly vascularized loose connective tissue housing branched tubular glands. The tunica muscularis mucosa was thicker than the preceding parts and constituted thick inner circular and outer longitudinal layers.

Discussion

Although reports on morphologic characteristics of several avian species are available in literature, this study is the first documented type regarding the gross and histological appearances of the female reproductive tract of the wild spur-winged geese domesticated in Nigeria. In the study, the left ovary and oviduct, which were grossly visible conform to other reports about the generality of the female reproductive tract of birds in which the left tract persist and the right is vestigial. The latter was thought to have regressed during embryonic development (Rahman, 2013; Hanaa *et al.,* 2019). The shape of the ovary is ovoid and resembled a punch of grapes in the current study, similar to a previous report by Robert *et al.* (2011) and Hanaa *et al.* (2019), but then, appeared smaller in size compared with other reported sizes of the ovary in most avian species. The length of the left oviduct was slightly lower than those of the local geese and turkey hens previously documented by Mirhish & Nsaif (2013) and Hanaa *et al.* (2019) respectively. The oviduct was the longest part of the female reproductive tract of the Spur-winged goose and connected the ovary to the cloaca. The tube was long and thin but non-convoluted as frequently observed in most avian species (Essam *et al.,* 2016; Hanaa *et al.,* 2019). It does not fill the dorsal and caudal part of the left side of the coelomic cavity as obtained in other birds but is found suspended ventrally just below the ovary. A striking observation about the gross anatomy of the oviduct of the spur-winged goose was that different segments of the oviduct were not clearly visible as obtained in other avian species reported by Essam *et al.* (2016) and Majama *et al.* (2016). This showed that, despite the similar singular appearances of the oviduct in all avian species, the gross appearances are species-specific and may translate to some level of functional differences, although requires further investigation.

The ovary of the spur winged goose has an outer cortex and inner medulla with numerous ovarian follicles, this concur with similar findings by Bacha & Bacha (2000) in chicken. However, it differed slightly from those of ducks reported by Deka *et al.* (2015). In the duck, the ovary had a simple squamous epithelium with patches of cuboidal epithelia with no mark of separation between the inner medulla and the outer cortex of the ovary (Deka *et al.,* 2015). As previously documented, ovarian follicles with different stages of development occur throughout the stroma of the cortex and are classified as primordial, primary, secondary, tertiary, and mature follicles (Ribeiro *et al.,* 1995; Hanaa *et al.,* 2019).

The wall of the oviduct in the current study, presented several tunicae including *tunica mucosa, tunica sub-mucosa, tunica muscularis, and tunica serosa.* The infundibulum which was lined with a simple cuboidal to columnar ciliated secretory epithelium differs from that of local geese (pseudostratified ciliated columnar epithelium) that was previously reported by Hanaa *et al.* (2019). For turkey hens, the epithelium of the infundibulum was mentioned to vary from simple cuboidal in the upper part into ciliated simple columnar in the middle and the lower end (Muhammadpour & Keshtmandi, 2008). These variations were not apparent in the current study. Furthermore, the magnum and isthmus of the spur-winged goose had a well-developed tubular gland similar to previous findings of Hanaa *et al.* (2019).

Based on the findings of this study, it was concluded, that the oviduct was the longest part of the female reproductive tract of the Spur-winged goose and connects the ovary to the cloaca as a thin and un-convoluted tube. Its segments are not well defined but lined histologically by simple cuboidal to columnar ciliated secretory epithelium. This study is the first of its kind regarding the gross and histological assessments of the female reproductive tract of the wild spur-winged goose, and as such should serve as a baseline model to further research and understand the reproductive anatomy of other related wild waterfowl species.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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