Advances in Basic and Applied Sciences 2 (2024) 83-91

Advances in Basic and Applied Sciences

journal homepage: https://abas.journals.ekb.eg/

Morphological, Anatomical and Ultrastructural studies on the kidney of Laughing dove, *Streptopelia senegalensis aegyptiaca*

Zainab SH. Abdel Moghith, Mona A. Ibrahim, Tharwat G*. Abd El-Kader and Nehad M. Ibrahim

Department of Zoology and Entomology, Faculty of Science, Helwan University, Cairo, Egypt

ARTICLE INFO

Article history:
Received 6 September 2023
Received in revised form 23 October 2023
Accepted 29 November 2023
Available online 31 January 2024

doi: 10.21608/ABAS.2023.234722.1027

Keywords: Kidney; Avian; Mammalian, Reptilian; Nephron; Habitat.

ABSTRACT

All vertebrates have kidneys. However, the shapes, anatomy and functions of different vertebrate kidneys vary, and these variations allow the organs to be adapted to the habitat in which the animals dwell. The characteristics of the kidney show much variation in different groups of vertebrates. The type of environment, whether aquatic, areal or terrestrial, is of importance in connection with these variations. The function of the kidneys includes osmoregulation, metabolic waste elimination, and endocrine function in addition to managing physiological fluids and electrolytes. The purpose of the current study was to examine the structural features of the kidneys of *Streptopelia senegalensis aegyptiaca*, often known as the laughing dove, in connection to its habitat, which may be connected to distinctive structural renal differences. The animal was killed by being cut off at the head, and its kidneys were removed and processed for morphological analysis. For light microscopy and ultrastructural analysis, the specimens were prepared. The laughing dove makes use of each of these features to aid in adapting to its surroundings. The goal of the current study is to learn more about the kidney morphology, anatomy and function in the laughing dove species *Streptopelia senegalensis aegyptiaca*.

1. Introduction

Kidneys are made up of many nephrons. However, the shape of many vertebrate kidneys varies, and these changes allow the organs to be adapted to the habitat that the animals live in [1]. The kidneys regulate body fluids and electrolytes in addition to removing metabolic waste and performing endocrine functions [2,3]. The nephrons and blood vessels of the kidney are its two main functioning components. According to [4], the renal glomeruli are made up of

* **Corresponding author E-mail:** *tharwat301@gmail.com*

capillaries that overlap, are connected to one another, and form several lobules with typically one afferent and one efferent arteriole in each [5]. Birds have one pair of kidneys and ureters, which carry urine to the urodeum of the cloaca, as part of their urinary system [3]. The avian kidneys were implanted in the synsacrum's fossa and extended from the lungs' caudal border to the end of the organ [6]. Bird species' kidneys differ in structure from those of reptiles and mammals. They have two types of structurally different nephrons. The first one is known as the mammalian or medullary, which is characterized by a big renal corpuscle and Henle's loop. The second form is the reptile type, sometimes known as the cortical type, which lacks Henle's loop but has a smaller renal corpuscle [3,7]. Loops of the nephron occur only in groups capable of producing concentrated urine. Among vertebrates, only the kidneys of mammals and some birds can produce urine in which solutes in the urine are more concentrated than in the blood, and only these two groups possess nephrons with loops [3]. The kidneys of birds work similarly to those of reptiles. Additionally, their main nitrogenous waste is uric acid [3]. Most birds consume a limited intake of fresh water. However, they only need to filter enough water to wash a slurry of uric acid into the cloaca, where enough more water is reclaimed to turn the uric acid into a semisolid paste. It is the whitish substance that birds deposit on status [3].

In the present study, *Streptopelia senegalensis aegyptiaca* has kidney structure and functions that are examined in relation to habitat.

2. Materials and Methods

2.1 Experimental animal

This species can be found in Egypt's Eastern and Western Deserts, Nile Valley, and Delta. It can be found in towns, villages, parks, palm groves, oases and rural areas. According to [8], nests can be found in shrubs, trees, and even on the rooftops of homes. Its rump is blue-gray. The wingtips are dark, and the mantle is bronze. Rust is the color of the head. It consumes both plant material and insects since it is omnivorous [8].

2.2 Experimental design

The animal was captured alive from the Beheira Governorate in Egypt and taken to the histology lab in the Faculty of Science, Department of Zoology and Entomology, at Helwan University. Decapitation was used to sacrifice it. The animal was anesthetized and dissected, with its kidneys removed out and processed for research, following which the species' length and weight were measured.

2.2.1. Morphological anatomy

The length and weight of the kidney was measured and photographed for morphological anatomy description after it was taken out of the body.

2.2.2. Light microscopy preparations

Fresh kidney specimen was fixed in 10% formalin, dehydrated in ascending grades of ethyl alcohol (70, 80, 90, and 100%), cleaned in xylene, and embedded in paraffin wax. The longitudinal and transverse sections were of 4 µm thick were made using *Leica* micotome. The sections were then stained with hematoxylin and eosin (H&E) in accordance with the protocol. Using a *Leica* optic photomicroscope, the sections were examined and photomicrographed [9].

2.3. Histological method

According to [9], specimens were prepared for histological analysis and stained with hematoxylin and eosin.

2.4. Transmission electron microscopy (TEM) specimen's preparation

The sections were prepared and photomicrographed on camera using a JEOL JEM-1200 EX II electron microscope at Ain-Shams University's Transmission Electron Microscope Unit.

3. Results

3.1. Morphological examination of the kidney

Streptopelia senegalensis aegyptiaca, or laughing dove, has paired, symmetrical, dark red to brown, and irregularly elongated kidneys. They are positioned in a depression along the synsacrum's midline, and were covered with the peritoneum. Additionally, the synsacral fossa is deeply enmeshed with the dorsal portion of the kidneys. The pelvic bones and ventral crests (hypophysis) of the lumbar vertebrae separate the kidneys from one another. The kidneys of the laughing dove are 1.8 cm length, 0.48 cm width and weight 0.13 gm. The three lobes that are not completely split are the cranial, middle, and caudal lobes. The small, round cranial lobe, also known as the anterior lobe, projects from the ventral portion of the lungs (0.35 cm length and 0.3 cm width). In comparison to the anterior lobe, the middle lobe (0.4 cm length and 0.45 cm width) is slightly bigger and round in shape. The caudal lobe (posterior lobe; 0.6 cm length and 0.68 cm width), which is round-oval in shape and extends to the synsacrum's extremity, is the largest lobe (Figure 1 A, RK).

3.2. Histological and electron microscopy results

The laughing dove's kidney is made up of three lobes; the cranial (anterior), middle, and caudal (posterior). Histologically, the renal lobes of the laughing dove did not show any structural changes. Each of the numerous, distinct polygonal lobules that make up the primary renal cortex is centered on a central vein and, occasionally, a central artery is present beside the central vein. Large, pear-shaped cortical regions comprise each renal lobule, and small, central medullary regions have the shape of a cone (Figure 1 B, RN, MN, MRCx, MRMd, PLCD & CV).

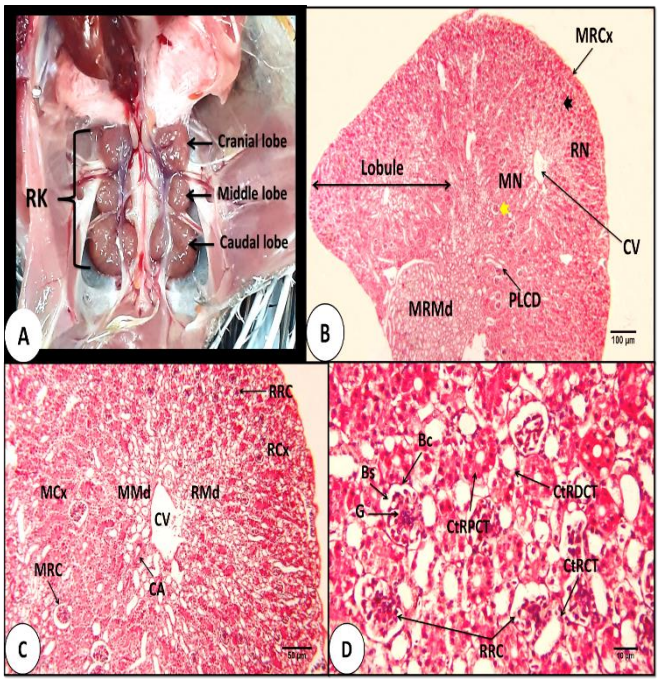

Fig. 1: (A) A photomacrograph showing the right kidney (RK) and three lobes of the left kidney (cranial, middle, and caudal lobe) in *Streptopelia senegalensis aegyptiaca* anatomical specimen. **(B, C &D)** Photomicrographs of a longitudinal section of the anterior lobe of the kidney of *Streptopelia senegalensis aegyptiaca* stained with H&E illustrating **(B)** its main renal cortex (MRCx) and main renal medulla (MRMd) and showing several lobules; each of them has a reptilian nephron (RN), reptilian renal corpuscle (black arrow), a mammalian nephron (MN), mammalian renal corpuscle (yellow arrow), a central vein (CV). Between the renal lobules there are a perilobular collecting duct (PLCD); **(C)** the reptilian nephron`s cortex (RCx), the reptilian medulla (RMd), the reptilian renal corpuscle (RRN), the mammalian cortex (MCx), the mammalian medulla (MMd), the mammalian renal corpuscle (MRC), the central vein (CV) and the central artery (CA); **(D)** the reptilian cortex having the reptilian renal corpuscles (RRC) including the bowman`s capsule (Bc), the glomerulus (G) and the bowman`s space (Bs), the cortical reptilian proximal convoluted tubule (CtRPCT), the cortical reptilian distal convoluted tubule (CtRDCT) and the cortical reptilian collecting tubule (CtRCT). Scale bars: 100 µm, 50 µm, 10 µm; X: 40, 100, 400.

The cortex of each lobule is made up of two different types of nephrons, a mammalian type with a large renal corpuscle and a reptilian type with a small renal corpuscle, depending on the size of the renal corpuscles. The two zones that make up the central medulla are the reptilian medulla, which is close to the reptilian nephron and lacks Henle's loop, and the mammalian medulla, which is close to the mammalian nephron and has Henle's loop (Figure 1 C, RCx, RMd, RRN, MCx, MMd, MRC, CV & CA). The proximal and distal convoluted tubules and collecting tubules, as well as the mammalian and reptilian renal corpuscles (MRC and RRC), were visible in the major cortical zone. At different levels, these renal corpuscles of the two types of nephron were found. Henle's loop segments are also seen in the cortex and medulla of the mammalian nephron. The main renal medullary region (MRMd) contained the collecting duct and medullary collecting tubules. Some of the collecting ducts that divide between the renal lobules are known as perilobular collecting ducts; they come from the primary renal medulla and are made of cuboidal epithelial cells (Figures 1 B & 3 D, MRCx, MRMd, RN, MN, CV & PLCD).

This species has two distinct types of renal corpuscles: the few, large mammalian renal corpuscles and the numerous, tiny reptilian renal corpuscles. Bowman's space and the glomerulus come together to form both. Bowman's capsule, a squamous epithelial capsule, surrounds the glomerulus. The distance between the glomerulus and the Bowman's capsule is referred to as the "Bowman's space." Although they were dispersed across the cortex, the cortical renal corpuscles were more densely packed in its periphery. In the cortex but close to the medullary region, juxta-medullary renal corpuscles were found (Figures 1 D and 2 B & C, RRC, Bc, G, Bs, CtRPCT, CtRDCT, CtRCT, MRC, CtMPCT, CtMDCT, CKLH & CNLH). Transmission electron microscopy was used to examine the glomeruli, and it was seen that they are made up of a more basic network of capillary loops that are encircled by a Bowman's capsule with two layers: an outer (parietal) and an inner (visceral) layer that are separated by a space known as the urinary (Bowman's) space or the nephrocoel. Squamous polygonal cells make up the parietal layer, while many podocytes with distinguishable foot processes make up the visceral layer. These alternating foot processes produce tiny, filtered pores that are joined by diaphragms and rest on the strong basement membrane. The endothelium of the glomerular capillaries has fenestrae of varying sizes. The nucleated endothelial cell bodies penetrate the capillary lumen. Mesangial cells can be seen on the endothelial side of the basement membrane. Thus, the glomerular basement membrane, podocyte foot processes, and fenestrated endothelium of the glomerular capillaries are the three components that make up the filtration barrier (Figures 4 A & B, RBC, Ms, En, Po, Fe, Fp, Fs & WBV). The two different types of nephrons each have the proximal convoluted tubules in the cortex and medulla. The proximal convoluted tubules of mammalian and reptilian nephrons are structurally identical, although mammalian proximal convoluted tubules are bigger than those in reptilian nephrons. The principal cells, or brush-boarded cuboidal epithelial cells, of the proximal tubule, are homocellular and are based on a basement membrane. They have a narrow lumen and many microvilli on their apical surface (Figures 1 D, 2 A, B, C & D and 3 A, RRC, Bc, G, Bs, CtRPCT, CtRDCT, CtRCT, MdRPCT, MdRDCT, MdRCT, CV, MRC, CtMPCT, CtMDCT, CtMCT, CKLH, CNLH, MdMPCT, MdMDCT, MKLH & MNLH). TEM pictures show that the cell's nucleus, which is large, symmetrical, and

spherical and contains a significant amount of heterochromatin, is situated in the cell's middle. Every cell has lysosomes, vacuoles, and elongated mitochondria (Figure 4 C, Bm, N, NM, HC, Mt, Mi, V & Ls). The medulla and cortex of the two various types of nephrons contain the distal convoluted tubules.

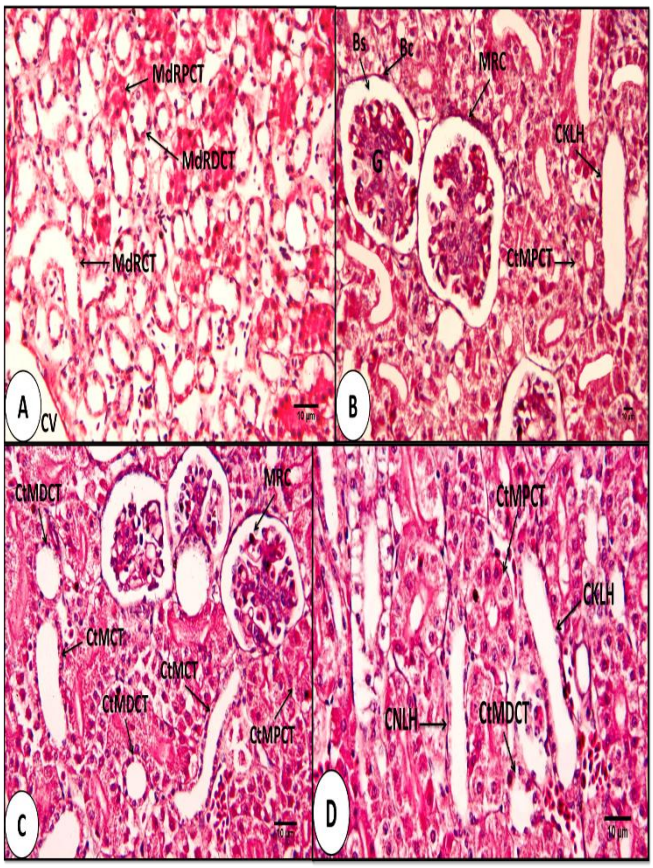

Fig. 2: Photomicrographs of a longitudinal section of the anterior lobe of the kidney of *Streptopelia senegalensis aegyptiaca* stained with H&E illustrating **(A)** the reptilian nephron`s medulla including the medullary reptilian proximal convoluted tubule (MdRPCT), the medullary reptilian distal convoluted tubule (MdRDCT), the medullary reptilian collecting tubule (MdRCT) and the central vein (CV); (**B), (C) & (D)** the mammalian nephron`s cortex showing the mammalian renal corpuscles (MRC) including the bowman`s capsule (Bc), the glomerulus (G) and the bowman`s space (Bs), the cortical mammalian proximal convoluted tubule (CtMPCT), the cortical mammalian distal convoluted tubule (CtMDCT), the cortical mammalian collecting tubule (CtMCT), the cortical thick part of loop of Henle (CKLH) and the cortical thin part of loop of Henle (CNLH). Scale bars: 10 µm for all; X: 400 for all.

The distal convoluted tubules of mammals are larger than those of reptiles in comparison. Both (Figures 1 D, 2 A, C & D, and 3 A & B, RRC, Bc, G, Bs, CtRPCT, CtRDCT, CtRCT, MdRPCT, MdRDCT, MdRCT, CV, MRC, CtMPCT, CtMDCT, CtMCT, CKLH, CNLH, MdMPCT, MdMDCT, MdMCT, MKLH & MNLH) are composed of basic cuboidal epithelial cells that have a wide lumen and are supported by a basement membrane.

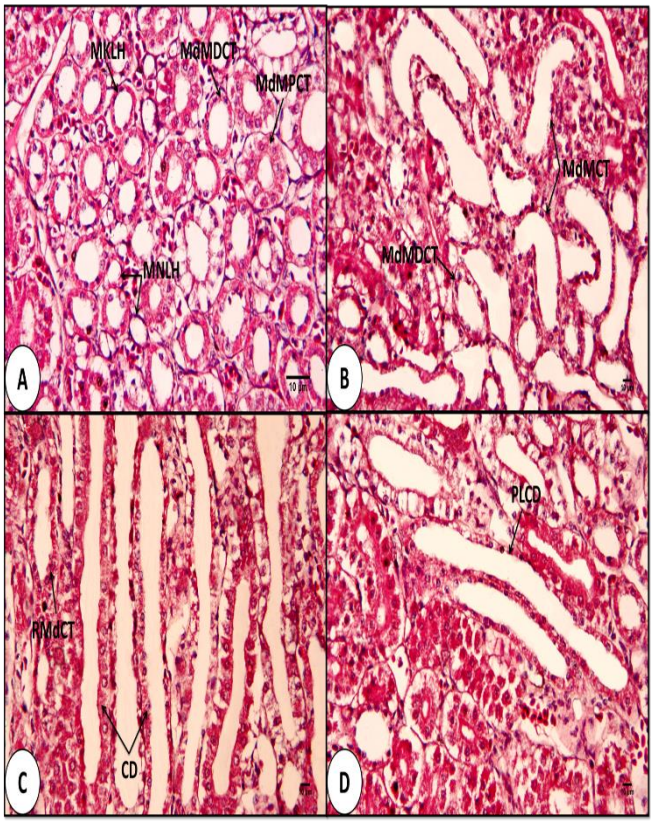

Fig. 3: Photomicrographs of a longitudinal section of the anterior lobe of the kidney of *Streptopelia senegalensis aegyptiaca* stained with H&E illustrating **(A) & (B)** the mammalian nephron`s medulla including the medullary mammalian proximal convoluted tubule (MdMPCT), the medullary mammalian distal convoluted tubule (MdMDCT), the medullary mammalian collecting tubule (MdMCT), the medullary thick part of loop of Henle (MKLH) and the medullary thin part of loop of Henle (MNLH); **(C)** the main renal medulla showing the renal medullary collecting tubule (RMdCT) and the collecting duct (CD); **(D)** the perilobular collecting duct (PLCD). Scale bars: 10 µm for all; X: 400 for all.

The nucleus is spherical to ovoid-shaped, positioned basally or centrally in relation to the basement membrane, and rich in heterochromatin at the TEM level. There are a lot of elongated mitochondria in the cell (Figure 4 D, Bm, N, NM, Nu, HC, Mt & Lu). The cortex and medulla of the mammalian nephron have the loop of Henle. Its two U-shaped limbs have an ascending and a descending limb. The descending limb is adjacent to the proximal convoluted tubule, while the ascending limb is near the distal one. Both thin and thick sections make up each limb. Squamous epithelial cells make up the thin part, and low cuboidal epithelial cells make up the thick part (Figures 2 B & D and

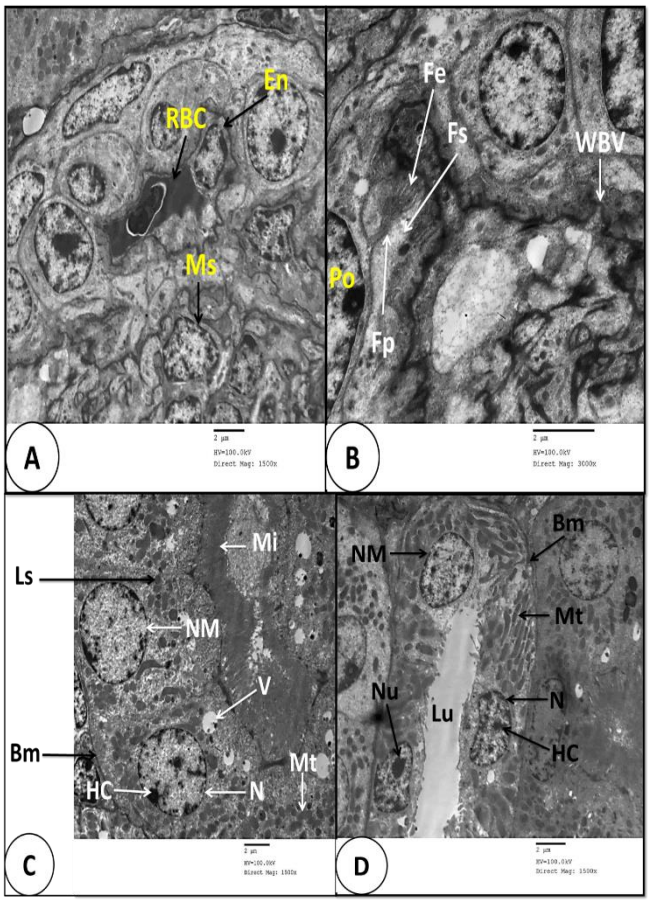

Fig. 4: Transmission electron micrographs of the anterior lobe of *Streptopelia senegalensis aegyptiaca* kidney illustrating **(A) & (B)** the glomerulus having the red blood cell (RBC), the mesangial cell (Ms), the endothelial cell (En), the podocyte (Po), the fenestration (Fe), the foot processes (Fp), the filtration space (Fs) and the wall of blood vessle (WBV); **(C)** the proximal convoluted tubule including the basement membrane (Bm), the nucleus (N), the nuclear membrane (NM), the heterochromatin (HC), the mitochondria (Mt), the microvilli (Mi), the vacuoles (V) and the lysosomes (Ls); **(D)** the distal convoluted tubule showing the basement membrane (Bm), the nucleus (N), the nuclear membrane (NM), the nucleolus (Nu), the heterochromatin (HC), the mitochondria (Mt) and the lumen (Lu). Scale bars: 2 µm for all; X: 1500, 3000, 1500, 1500.

3 A, MRC, Bc, G, Bs, CtMPCT, CtMDCT, CKLH & CNLH). Collecting ducts and collecting tubules make up the collecting duct system. The collecting tubule, the first part of the collecting duct system, is found in both the cortex and medulla of each kind of nephron in addition to the main renal medulla. It is made up of cuboidal epithelial cells that are founded on the basement membrane. Figures 1 D, 2 A & C, and 3 B & C (RRC, Bc, G, Bs, CtRPCT, CtRDCT, CtRCT, MdRPCT, MdRDCT, MdRCT, CV, MRC, CtMPCT, CtMDCT, CtMCT, MdMDCT, MdMCT, RMdCT, CD) show that the reptilian collecting tubules are smaller than the mammalian collecting tubules in size. When observed at the TEM level, it has a cytoplasmic protrusion that extends from its apical surface, spherical core nuclei with nucleoli, and a lot of heterochromatin. Further components include lysosomes and various-sized mitochondria are found (Figure 5 A, Bm, N, NM, Nu, HC, Mt, Ls, CP & Lu). The collecting duct is only present in the main renal medulla and is lined by cuboidal epithelial cells (Figure 3 C, RMdCT & CD). At the TEM level, it is made up of two separate types of cells; light cells and dark cells. Dark cells contain a thicker cytoplasm and more mitochondria than light cells (Figure 5 B, Bm, N, Nu & Mt).

The ureter is made up of the mucosa, submucosa, muscularis, and serosa. The mucosa was primarily lined by pseudostratified columnar epithelium. The ureter of the laughing dove had a number of mucus-filled vacuoles near the tip of its secreting cells. The mucosa formed of simple longitudinal folds that appeared to be evenly spaced across the whole luminal surface of the ureter. The lamina propria, which is found inside the mucosal folds, has loose connective tissue. The submucosa of the ureter is made of connective tissue, containing blood vessels. The ureter's muscular layer is composed of smooth muscle fibers. Blood veins, nerves, and lymphatics are widely distributed throughout the loose connective tissue that makes up the serosa (Figures 5 C & D, LP).

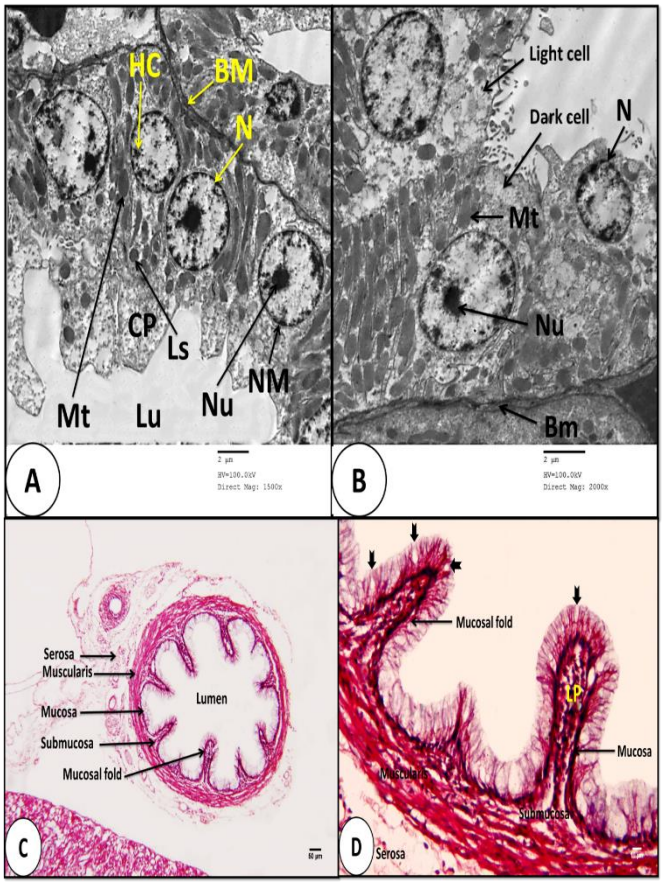

Fig. 5: (A) & (B) Transimission electron micrographs of the

anterior lobe of *Streptopelia senegalensis aegyptiaca* kidney illustrating **(A)** the collecting tubule having the basement membrane (Bm), the nucleus (N), the nuclear membrane (NM), the nucleolus (Nu), the heterochromatin (HC), the mitochondria (Mt), the lysosomes (Ls), the cytoplasmic protrusions (CP) and the lumen (Lu); **(B)** the collecting duct including the light and dark cells including the basement membrane (Bm), the nucleus (N), the nucleolus (Nu) and the mitochondria (Mt)**; (C) & (D)** Photomicrographs of a transverse section of the ureter showing the serosa, the musculosa, the submucosa, the mucosa, the mucosal folds having lamina propria (LP) and including the secreting cells. The apices of the secreting cells filled with mucus (arrow). Scale bars: 2 µm, 2 µm, 50 µm, 10 µm; X: 1500, 2000, 100, 400.

4. Discussion

Streptopelia senegalensis aegyptiaca, or laughing dove, has one pair, symmetrical, dark red to brown, and irregularly elongated kidneys. They are positioned in a depression along the synsacrum's midline, and the peritoneum covers them. Additionally, the synsacral fossa is deeply enmeshed with the dorsal portion of the kidneys. These facts corroborated numerous earlier reports about various bird species, including those made by (6) about common coot, (10) about domestic duck and fowl, (11) about emus, and (12) about dove and owl. The three lobes that make up the laughing dove's kidney; the cranial, middle, and caudal lobes are not entirely split. The cranial lobe is a small, circular extension of the ventral portion of the lungs. The middle lobe is shaped like a circle and is slightly bigger than the anterior lobe. The caudal lobe, which has a round-oval shape and extends to the synsacrum's end, is the largest lobe. Similar observations were made by (10), (12) and (13). The Harrier, which had the greatest elongated cranial lobe, an elongated middle, and a caudal triangular lobe, was discovered to have several differences by (14). Additionally, (15) discovered that the cranial lobe was bigger than the middle and caudal lobes in the kidneys of Cattle egrets (*Bubulcus ibis*) and Squacco herons (*Ardeola ralloides*). Histologically, the renal lobes of the laughing dove did not show any structural modifications. Each of the numerous, indistinct polygonal lobules that make up the main renal cortex is centered on a central vein and, occasionally, a central artery. Large, pear-shaped cortical regions comprise each renal lobule, and small, central medullary regions have the shape of a cone. All of the research species' well-developed medullary cones demonstrated the ability to concentrate urine (15). Each lobule's cortex is made up of two types of nephrons, a mammalian type with a large renal corpuscle and a reptilian type with a small renal corpuscle, depending on the size of the renal corpuscles. The two regions that make up the central medulla are the reptilian medulla, which is close to the reptilian nephron but lacks Henle's loop, and the mammalian medulla, which is close to the mammalian nephron but has Henle's loop. The result achieved was consistent with that of (10), (12), (14), (16) and (17). The production of hyperosmotic urine by the kidney may be restricted by the reptilian-type nephrons (18) and (19), but the synthesis of concentrated urine may require the juxta-medullary nephrons (18) and (20). In birds, the two types of nephrons have different functional roles and exhibit differences in tubular ion transport (21). Mammalian nephrons' expanding glomeruli may have more surface area for filtration (17). The proximal and distal convoluted tubules and collecting tubules, as well as the mammalian and reptilian renal corpuscles (MRC and RRC), were visible in the main cortical zone. At different levels, these renal corpuscles of the two types of nephron were discovered. Henle's loop segments are also seen in the cortex and medulla of the mammalian nephron. The main renal medullary region (MRMd) contained the collecting duct and medullary collecting tubules. This histological characteristic was highlighted in earlier studies on different bird species, including common coot (6), domestic duck and fowl (10), emus (11) and great flamingos (22). The renal corpuscle is made up of Bowman's space and the glomerulus. A squamous epithelial capsule known as Bowman's capsule surrounds the glomerulus. Transmission electron microscopy (TEM) analysis of the glomeruli revealed that they are made up of two layers: an exterior (parietal) and an interior (visceral) layer that are separated by a space known as the urinary (Bowman's) space or the nephrocoel. The visceral layer is made up of many podocytes, while the parietal layer is made up of squamous polygonal cells. The same results were discovered by (23). The total area of glomerular capillary surface that can be used for filtration and the capillary wall's water permeability affect the integrated rate of glomerular ultrafiltration, according to (24). The nucleated endothelial cell bodies penetrate the capillary lumen. Mesangial cells can be seen on the endothelial side of the basement membrane. Mesangial cells, according to (25), play a significant role in preserving the strength of the glomerular basement membrane. The cortex and medulla of the two different types of nephrons each contain proximal convoluted tubules. The similar results were approved by (10). Although mammalian proximal convoluted tubules are larger than those in reptilian nephrons, both types of proximal convoluted tubules possess the same anatomical characteristics. The proximal tubule's principal cells, also known as brush-boarded cuboidal epithelial cells, are homocellular and based on the basement membrane. They feature numerous microvilli their apical surface in addition to a limited lumen. The same findings were obtained by (18), (23) and (26). Wide intercellular gaps and extensive cell membrane infoldings in the proximal tubule are traits of cells with a high potential to reabsorb ions and water, according to (12). The proximal tubules are the main source of uric acid excretion and ultrafiltrate reabsorption, as stated by (27). These findings agree with those made by (28) about sparrows from various habitats. As previously reported by (29) for honey eaters (*Melphiphagidae*), the presence of well-developed long microvilli plays a crucial role in increasing the surface

area exposed to the lumen to facilitate the movement of large fluid volumes and to absorb a large proportion of fluid from the glomerular filtrate to maintain the water balance of arid inhabitant species. The nucleus of the PCT cell is massive, symmetrical, and spherical, and is located in the center of the cell, as seen by TEM images. It also contains a high quantity of heterochromatin. Vacuoles, elongated mitochondria, and lysosomes are components of every cell. These cells have basal enfolding's, which are typical of ion-transporting cells, as well as a large number of mitochondria, in agreement with (30). According to (15), the presence of lysosomes suggests that the animal has a high level of transport activity. The medulla and cortex of the two various types of nephrons contain the distal convoluted tubules. The same result is found by (10). The distal convoluted tubules of mammals are larger than those of reptiles in comparison. Both are composed of basic, basement membrane-supported cuboidal epithelial cells with a wide lumen. This is in agreement with (12) and (23). The avian nephron's distal tubule actively reabsorbs sodium chloride from the nephron tubule while passively reabsorbing water (31). The nucleus is spherical to ovoid-shaped, positioned basally or centrally in relation to the basement membrane, and rich in heterochromatin at the TEM level. There are a large number of elongated mitochondria in the cell. According to (15), the distal tubules' high density of mitochondria indicates a high level of electrolyte transfer. The mammalian nephron's cortex and medulla contain the Henle loop. The present study's findings and those of (10) were consistent with the current state of Henley's loop and its function in salt and water conservation in various avian species. The loop of Henle is in charge of additional reabsorption of water from the filtrate, together with sodium and chloride ions. The very close relationship of the ascending and descending limbs causes the opposite current exchange to take place. The majority of various molecules, including as glucose, water, and sodium ions, have been reabsorbed into the tubular fluid after leaving the Henle loop (32). Collecting ducts and collecting tubules make up the collecting duct system. The collecting tubule, the first part of the collecting duct system, is found in both the cortex and medulla of each kind of nephron in addition to the main renal medulla. It is made up of cuboidal epithelial cells that are founded on the basement membrane. The same results were provided by (10). By reabsorbing water from the tubular lumen, the collecting tubules also contribute to the production of concentrated urine (15). The collecting duct, which is composed of cuboidal epithelial cells, only exists in the main renal medulla. At the TEM level, it is composed of two distinct cell types: light cells (intercalated cells) and dark cells (principle cells). Both secrete potassium and take up ions like sodium, water, and others. Mucus is secreted by the principle cells to stop uric acid precipitation due to the fact that uric acid can excrete solutes with little water loss was approved by (15). Some of the collecting ducts between the renal lobules, called perilobular collecting ducts, come from the main renal medulla and are made of cuboidal epithelial cells. According to (18), the same findings were obtained. The ureter is made up of the mucosa, submucosa, muscularis, and serosa. Pigeons and Japanese quail (33), (34) exhibit the similar results. According to previous researches (33) and (35), pseudostratified columnar epithelium lined the mucosa in its entirety. At the tip of its secreting cells in the ureter, the laughing dove possessed numerous mucus-filled vacuoles. This conclusion is consistent with that of (36) in chickens, (37) in European starlings, and (33) in pigeons. According to (38), mucus may be essential for physiological lubrication and serving as binding agents for precipitated uric acid. The mucosa formed straightforward longitudinal folds that appeared to be evenly spaced across the whole luminal surface of the ureter. The lamina propria, which is found inside the mucosal folds, included loose connective tissue, which is consistent with earlier findings (33) and (34). The ureter's submucosa is made of connective tissue, containing blood vessels, as has previously been discovered (34) and (37). The ureter's muscular layer is composed of smooth muscle fibers. The serosa is made up of loose connective tissue and is rich in lymphatics, blood arteries, and nerves. The same findings were reported by (33) and (34).

Conclusions

The renal cortex of the *Streptopelia senegalensis aegyptiaca* was examined microanatomically. Both reptilian and mammalian nephron types can be found in each lobule. Both the reptilian (cortical) and mammalian (juxta-medullary) renal corpuscles were discovered. In the laughing dove, it was discovered that the cortical renal corpuscles were more numerous than the juxta-medullary corpuscles. The cortical renal corpuscles were smaller than the juxta-medullary renal corpuscles in size. Proximal, distal, and collecting tubules are present in both nephrons. The primary renal medulla of each lobule contained the majority of the collecting ducts. *Streptopelia senegalensis aegyptiaca* may be able to adapt to its environment by virtue of all of these kidney structural characteristics that influence body water balance.

References

1. Kimball J. W. (2023): In “Biology: Vertebrate kidney”. Tufts Uni., Harvard Uni.; Pp. 573-574.
2. Ross M. H., Kaye G. I., and Pawlina W. (2003): Histology: A text and atlas. 4th Ed. Baltimore, Lippincott Williams & Wilkins.; Pp. 864.
3. Kardong V. K. (2019): Vertebrates Comparative Anatomy, Function, Evolution: The Urogenital System. 8th Ed. McGraw-Hill Education, 2 Penn Plaza, New York, NY.; Pp. 548- 554.
4. Kikuta A., and Murakami T. (1989): Three dimensional vascular architecture of the Malpighi's glomerular capillary beds as studied by vascular corrosion casting-SEM method. In “Cells and tissues: A three-dimensional

approach by modern techniques in microscopy" (Ed.) Motta P. M. New York, NY: Liss Inc.; Pp. 181-188.

5. Lametschwandtner A. (2020): Renal microvasculature in the adult pipid frog, *Xenopus laevis*: A scanning electron microscope study of vascular corrosion casts. J Morph.; Pp.1-12.
6. Batah L. A. (2012): Morphological and histological study for the kidneys of coot bird (*Fulica atra*). Bas J Vet Res.; 11: 128-136.
7. Koral T. S., Gulmez N., and Aslan S., (2020): Immunohistochemical localization of Catalase in Geese (*Anser anser*) kidney. Kafkas Univ Vet Fak Derg.; 26(1): 41-46.
8. Tharwat M. E. (1997): Birds Known to Occur in Egypt. 1st Ed. Egypt, Cairo, Ain Shams Uni.; Pp. 106-107.
9. Drury R. A., and Wallington E. A. (1980): Immunocytochemical localization and biochemical analysis of α and β. keratins in the avian lingual epithelium. J Am Anat.; 184: 66-75.
10. Ali M. A., and Reshag A. F. (2020): Comparative Morphohistological Study of the Kidneys in Domesticus Fowl (*Gallus gallus*) and Domesticus Duck (*Anas platyrhynchos*). Plant Arch.; 20(2): 6344-6348.
11. Michalek K., Danutaszczer E. R., Binsk A., and Martagrabowsk A. (2016): Anatomical and morphological study of the kidneys of the breeding Emu (*Dromaius novachollandia*). Turk J Zool.; 40: 314-319.
12. Nabipour A., Ali S. E., and Asadian M. (2009): Some Histological and Physiological Features of Avian Kidney. J Appl him Res.; 36: 195-198.
13. Reshag A. F., Abood D. A., and Mohammed S. D. (2016): Anatomical and histological study of the kidneys and salt glands in great flamingos (*Phoenicopterus roseus*). Iraqi J Vet Med.; 40(1): 140-146.
14. Abood D., Reshag A. F., Azhar S., and Ahmed M. A. (2014): Comparative anatomical and histological features of the kidney in Harrier (*circus aueroginosus*), chicken (*Gallus domestic us*) and Mallard duck (*Anas platyrhynchos*). Iraqi J Vet Med.; 38(1): 107-113.
15. El-Bakary N. E. R., Abd-Allah G. A., and Bassiony S. (2015): Comparative morphological, histological and ultrastructural study of the kidney of Cattle egret (*Bubulcus ibis*) and Squacco heron (*Ardeola ralloides*) birds. Int J Env Sci.; 12(1): 37-47.
16. Al-AJeely R. A., and Fadhils S. M. (2012): Morph-histological study on the development of kidney and ureter in hatching and adulthood racing pigeon (*Columba Livia domestica*). Int J Sci Nature.; 3: 665-677.
17. AL-AJeely R. A. (2012): Study the Anatomical Descriptions and Histological Observations of the Kidney in Golden Eagles (*Aquila Chrysaetos*). Iraqi J Vet Med.; 36(2): 145-152.
18. Sivakumar S. A., Ushakumary S., and Basha S. H. (2012): Microanatomical Studies on the Renal Cortex of Guinea Fowl. Tam J Vet and Anim Sci.; 8(1): 29-35.
19. Braun E. J. (1993): Renal function in birds. In "New insights in vertebrate kidney function". (Eds.) Brown J. A., Balment R. J., and Rankin J. C. Cambridge, Cambridge University Press.; Pp: 167-188.
20. Wideman R. F., and Nissley A. C. (1992): Kidney structure and responses of two commercial single comb white leghorn strains to saline in the drinking water. Brit Poult Sci., 33: 489-504.
21. Da Cruz Höfling M. A., Paronetto C. C. L., Cogo J. C., Rodrigues-Simioni L., and D'abreu A. C. F. (2001): Histopathological changes in avian kidney caused by *Bothrops insularis* (*jara racailhôa*) venom and a phospholipase A2- containing fraction. Histol Histopathol.; 16: 185-195.
22. Reshag A. F., Abood D., and Dawood M. S. (2015): Anatomical and histological study of the kidneys and salt glands in great flamingos (*phoenico pterusroseus)*. Iraq J.; 40(1): 140-146.
23. Sivakumar S. A., Paramasivan S., and Ushakumary S. (2019): Histological Observations on the Kidneys of Indian Black Ibis (*Pseudibis pappillosa Temminck*). Int J Sci Env Techno.; 8(3): 658-662.
24. Dantzler, W. H. (2005): Challenges and intriguing problem in comparative renal physiology. J Exp Biol.; 208(4): 587-594.
25. Cross P. C., and Mercer K. L. (1993): A functional perspective. In "cell and tissue ultrastructure" (Ed.) Freeman W. H. New York. Pp. 163-187.
26. Baragoth A. F. (2015): Histomorphological and morph metrical comparative study of the kidney between Quail (*Conturnix coturni*) and Green-winged Teal (*Anas crecca*) according to their environment type. Qadis J Vet Med Sci.; 14(1): 118-126.
27. Meteyer C. U., Rideout B. A., Gilbert M., Shivaprasad H. L., and Oaks J. L. (2005): Pathology and proposed pathophysiology of diclofenace poisoning in free-living and experimentally exposed oriental white-black vultures (*Gyps bengalensis*). J Wild life Dis, 41(4): 707-716.
28. Casotti G., and Braun E. J. (2000): Renal Anatomy in Sparrows from Different Enviroments. J morphol.; 243: 283-291.
29. Casotti G., and Richardson K. C. (1993): A qualitative analysis of the kidney structure of *Meliphagid* honey eaters from wet and arid environments. J Anat.; 182: 239-247.
30. Simon E. (1982): The osmoregulatory system of birds with salt glands. Comp bioch phys.; 71: 547-556.
31. Braun E. J., and Dantzler W. H. (1997): Vertebrate renal

system. In "Handbook of physiology: Comparative physiology" (Ed.) Dantzler W. H. New York, Oxford University Press.; Pp. 481-576.

32. Nabipour A. (2008): Histological Structure of the Kidney of Insectivorous Bats. W J Zool.; 3(2): 59-62.
33. Abdul-Gahaffor R., Al-Ajeely A., and Mohammed F. S. (2012): Morphohistological study on the development of kidney and ureter in hatching and adulthood racing pigeon (*Columba livia domestica*). Int J Sci Nat.; 3(3): 665-677.
34. Oliaii A., and Mobini B. (2017): The Histological Differences of the Ureter in Japanese Quail (*Coturnix japonica*) Compared With Some Other Domestic Avian Species. Int J Morph.; 35(1):193-198.
35. Islam K. N., Khan M. Z. I., Islam M. N. Ahad A., and Mazumder M. S. (2001): Light microscopic structure of the ureters of Rhode Island Red (RIR) and White Leghorn Chicken (WLH) during their postnatal stages of growth and development. J Biol Sci.; 1(4): 272-274.
36. Bacha W. J., and Bacha L. M. (2012): Color Atlas of Veterinary Histology. 3rd Ed. Philadelphia, Wiley Blackwell.; Pp. 184-185.
37. Williams G. R., and Nicholson J. K. (1983): The histology and fine structure of the ureter of the European starling (*Sturnus vulgaris*). J Anat.; 136(3): 585-594.
38. Mcnabb F. M. A., Mcnabb R. A., and Steeves H. R. (1973): Renal mucoid materials in pigeons fed high and low protein diets. Auk.; 90: 8-14.