

# Comparative Anatomical and Histological Study of the Stomach in Two Iraqi Birds (*Columba palumbus* and *Tyto alba*)

**Rasha W. Al-Juboory**

Dept. of Biology/ College of Sciences/ University of Babylon

**Hussain A.M. Dauod**

Dept. of Biology/ College of Education for Pure Science (Ibn Al- Haitham)  
University of Baghdad

**Ali S. Al-arajy**

Dept. of Biology/ College of Sciences/ University of Babylon

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## Abstract

The present study aimed to investigate the anatomical and histological, aspects of the stomach in two different Iraqi birds, (common wood pigeon, *Columba palumbus* (herbivorous) and the barn owl, *Tyto alba* (carnivorous). Stomach in the two studied birds IS divided into two parts, glandular or true stomach (proventriculus) and the muscular stomach or gizzard (ventriculus). Proventriculus in the common wood pigeon appeared as fusiform shaped tube and separated from the gizzard by isthmus while in the barn owl, it was pears-shaped , wider and shorter than that of the common wood pigeon and not separated from the gizzard by isthmus. In common wood pigeon, gizzard appeared as biconvex lens lining with yellowish green tissue, the koilin , while in the barn owl, gizzard was pear shape and the koilin was very thin. Mucosa of proventriculus in the two studied birds was rich with simple tubuler glands, the superficial gastric glands which were longer and wider in the barn owl than of those in common wood pigeon and the sub mucosa was rich with compound branched alveolar glands, the deep gastric glands which were longer and wider in the barn owl than those of common wood pigeon. Muscularis externa and serosa in the common wood pigeon were thicker than in the barn owl. Mucosa in the gizzard of the barn owl filled with more gastric pits than the common wood pigeon and the koilin in common wood pigeon was thicker.

**Key words:** Anatomy, histology, birds.

## Introduction

Avian stomach consists of an upper part, the proventriculus or glandular part and lower part , the ventriculus( gizzard) or muscular part [1]. The proventriculus in carnivorous birds are more developed than the gizzard and it has a thick-walled and cone- shaped and take with the gizzard a pear shape and large cavity due to the lacking of the ventricular isthmus [2,3]. In the contrast, seed-eating birds have a thin-walled simple proventriculus and a thick-walled powerful gizzard. The two parts are connected by the intermediate zone called isthmus [4]. These two parts represented the important portion of enzyme activities [5]. Glandular stomach or true stomach (proventriculus) is lined with glandular mucous layer which secreted gastric juices such as pepsin and hydrochloric acid, by this mechanism, the ingested food with its juices passes quickly to the gizzard in which the food particles are reduced to small particles took by the intestine for more digestion and absorption [6]. Chemically, gizzard have a keratinize nature lining that termed as keratohyalin or koilin, it was insoluble in keratinolytic solvents and resistant to pepsin [7].

The size of the gizzard changed according to the diet nature within the same species, when the bird eat dry seed in winter, the gizzard being thicker and larger in contrast when it eate fruits during summer [4].

Review of the literature revealed that there are few reseach works delt with the anatomy and histology of the different parts of alimentary tract in wild Iraqi bird.This situation supports the idea for the present study,with hope to give the more information about the different aspects of the anatomy and histology of the alimentary tract in Iraqi wild bird.

## Material and Methods

The animals under investigation are collected from Najaf desert. Five birds of each species were used to study the different aspects of the present study. The species of birds under investigation were classified according to Alloose and Salim *et al.*, [8 and 9].

The studied birds were anesthetized using chloroform. The anesthetized birds were weighed, the length of the body of the two species under investigation and the length of each part of the alimentary tract were measured. The digestive tract was removed and specimens of stomach was fixed in Bouins' fluid for 18-24 h, methods of Al –Attar and Kiernan[10 and 11] were employed for histological techniques.

The routine stain of Harris Hematoxylin and Eosin (H&E) were used to show the general components of the tissues and special stains Alcian Blue (AB) and Periodic Acid Schiff reagent (PAS) were used for the general histochemical study.

## Results

### 1. Morphological description

#### The common wood pigeon *Columba palumbus*

The anatomical results showed that the stomach situated in the left median part of the abdominal cavity. The stomach in the common wood pigeon consists of two chambers, these are the glandular stomach or proventriculus and the muscular stomach , ventriculus or gizzard

Proventriculus appeared as a thick-wall fusiform shape tube started at the narrow end of the thoracic esophagus in the abdominal cavity. This tube was separated from the gizzard by isthmus. The mean of length was (2.08 cm) with range (1.8 – 2.5 cm), the mean of diameter (6519.34  $\mu\text{m}$ ) with range (5592 – 8760.8  $\mu\text{m}$ ).

The ventriculus or gizzard appeared in common wood pigeon as disc or biconvex lens shape with mean length of (3.84 cm), with range (3 – 4.3 cm), the mean of diameter (35800  $\mu\text{m}$ ) and range of diameter (33000 – 38000  $\mu\text{m}$ ). The gizzard was lined by yellowish-green tissue, the koilin which was took irregular pleated pattern of longitudinal folds (Figure1). The present study found many of grits inside the gizzard. On both sides of gizzard, there was conspicuous tendinous aponeurosis represented by the white colored regions.

### The barn owl *Tyto alba*

The present study was observed clear differences of the gross anatomical structure of the two parts of the stomach between the two studied birds, in the barn owl, the proventriculus appeared as pear shape, thick wall, dark colour and there was no clear isthmus separated proventriculus from gizzard. The proventriculus in barn owl appeared as short and narrow as that of the common wood pigeon. The mean length was (1.52 cm), the range (1.4 – 1.8 cm), the diameter (5848.3  $\mu\text{m}$ ) and the range of the diameter (4170.7 – 8201.6  $\mu\text{m}$ ).

The gizzard in the barn owl was soft, elongated, spindle to pear shape with longitudinal outer groove on its surface. The mean of length and diameter were less than that of the common wood pigeon. The mean length was (2.38 cm) and the range (1.6 – 2.8 cm), the diameter (22200  $\mu\text{m}$ ) and the range of diameter (21000 – 24000  $\mu\text{m}$ ).

Anatomical results showed that the koilin layer of the gizzard in the barn owl was took the fan shape due to the vertical and longitudinal pattern of the inner folds at the same time, this layer has very poor yellowish green pigment inside the gizzard (Figure2). The present study did not recognize any grit inside the gizzard.

## 2. The histological descriptions

### The common wood pigeon (*Columba palumbus*)

The mucosa of the glandular stomach or proventriculus appeared as finger-like shaped structure, mucosal epithelium was compressed, crowded with plicae which was separated by sulci, these plicae were lined with simple columnar epithelium with cells of clear cytoplasm and oval dark nucleus. The epithelium of mucosa was rested on loose connective tissue represented by lamina propria which contained blood vessels, lymph cells and simple tubular glands lining with columnar epithelial cells called the superficial glands opened at the base of each sulci. The histological results showed that the length of the superficial glands was (280  $\mu\text{m}$ ) and the width (8  $\mu\text{m}$ ). Muscularis mucosa was invaginated under the mucosa toward the submucosa. The mean of thickness was (79.42  $\mu\text{m}$  with range (69.9 – 94.2  $\mu\text{m}$ ) (Figure 3a,c).

The submucosa was composed of loose connective tissue with high blood vessels supply and huge oval to conical compound tubuloalveolar glands called deep gastric glands filling most of the proventriculus wall and separating from each other by connective tissue (Figures 3a,c and 4 a,c).

The histological examination revealed that the deep gastric glands were consisted of numerous adenomers appeared with different shapes and diameter and arranged with two rows, these adenomers were composed of many secreted units or tubes, each one was lined with cuboidal epithelial cells with spherical central nucleus resting on basement membrane which was then rested on loose connective tissue diffusing among the secreted units for strengthening (Figures 3b,c and 4a,c).

The results showed that the mean length of the deep gastric glands was (1500  $\mu\text{m}$ ), the width (1160  $\mu\text{m}$ ) and the mean of thickness in the sub mucosa of Proventriculus was (163.1  $\mu\text{m}$ ) with range (116.5 – 209.7  $\mu\text{m}$ ).

The muscularis mucosa was consisted of inner thick circular muscle fibers and secondary circular smooth muscle cells penetrated with nerve plexus and outer thin longitudinal muscle fibers. The mean of thickness was (186.4  $\mu\text{m}$ ) with range (116.5 – 279.6  $\mu\text{m}$ ). The outermost layer was the serosa which was composed of loose connective tissue containing blood and lymph vessels and nerve ends. The mean of thickness was (83.88  $\mu\text{m}$ ) with range (46.6 – 163.1  $\mu\text{m}$ ).

The muscular stomach, ventriculus or gizzard was exhibited another difference in common wood pigeon, in the mucosa, the epithelium was possessed thin, finger-like projection toward the lumen appear as folds separated by gastric pits, each folds was possessed one lateral extension. The folds of the epithelium was lined with simple cuboidal epithelial cells with central oval nuclei, as the cells progressive toward the lumen, the cells become columnar with hypo-nuclei (Figures 4b,d).

The histological examination revealed that there was a layer of koilin in front of the epithelial folds and adjacent with it, this layer was stained with eosin only and appeared with clear pink color. Lamina propria appeared as a connective tissue rich with lymph cells, blood vessels and few simple tubular glands near the bases of the gastric pits, these glands were lined with simple cuboidal epithelial cells with central spherical nucleus. In the present study, the muscularis mucosa is not clear in the gizzard of the common wood pigeon (Figure 3d,e and f).

The present study thought that the cells which were lined the glands were the chief cells and there were some of columnar epithelial cells at the bases of these glands may be the basal cells (Figure 3f). The mean of thickness in the mucosa of gizzard in common wood pigeon was (172.42  $\mu\text{m}$ ) and the range (93.2 – 326.2  $\mu\text{m}$ ).

The results showed that the sub mucosa of the gizzard in the common wood pigeon was not separated clearly from the mucosa, it appeared as dense connective tissue containing blood vessels and collagenous fibers. The mean thickness was (163.1  $\mu\text{m}$ ) with range (69.9 – 279.6  $\mu\text{m}$ ) (Figures 3e and 4d).

The histological examination revealed that the muscularis externa in the gizzard of the common wood pigeon consisted of parallel smooth muscle fibers. This layer exhibited the presence of only circular oriented cells and tendeneous connective tissue lines between the muscle fibers i.e. the muscularis externa was appeared as circular layer of smooth muscle bundles interspersed with bands of irregular elastic fibers. There were blood vessels and nerve ends in this layer. The mean thickness was (60.58  $\mu\text{m}$ ) with range (46.6 – 93.2  $\mu\text{m}$ ). The outermost layer in the gizzard was the serosa that was composed of loose connective tissue lined with simple squamous epithelium rich with arterioles, veins, lymphoid vessels and nerve ends. The mean of thickness was (60.58  $\mu\text{m}$ ) with range (46.6 – 93.2  $\mu\text{m}$ ) (Figures 3d and 4b,d).

### **The barn owl *Tyto alba***

The results revealed that the differences between the proventriculus in the two studied birds were represented by the secreted glands although the similarity of the histological structures and the mode of secretion of them. The superficial glands of the proventriculus in the barn owl were took the club shape, they appeared more abundant, larger and wider than that of the common wood pigeon. The height of these glands was (600  $\mu\text{m}$ ) and the width (10  $\mu\text{m}$ ).

The mucosa in the barn owl was not differed from that in the common wood pigeon, it folded and contained the superficial glands within the lamina propria which then contained blood vessels. The muscularis mucosa (Figure 5a,b), appeared as scattered smooth muscle

fibers involving by the mucosa. The mean thickness was (93.2  $\mu\text{m}$ ) and the range (69.9 – 116.5  $\mu\text{m}$ )

The sub mucosa also contained the deep gastric glands which were separated from each other by the connective tissue of the sub mucosa. The deep gastric glands were appeared with longer , more , wider than that of the common wood pigeon and arranged with one row (Figer 5a). The length of these glands was (1933.9  $\mu\text{m}$ ) and width (582.5  $\mu\text{m}$ ).

The muscularis externa nearly exhibited the same histological structure of that in the common wood pigeon. The mean thickness was (121.16  $\mu\text{m}$ ) with range (93.2 – 163.1  $\mu\text{m}$ ). The serosa in the proventriculus of the barn owl built of the same histological of that in the common wood pigeon. The mean of thickness was (60.58  $\mu\text{m}$ ) with range( 46.6 – 69.9  $\mu\text{m}$ )(Figures 5a,c and 6a,c).

In the present study , the gizzard of the barn owl differed from that of the common wood pigeon , the differences were represented by the thickness of the mucosa ,it was less in the prior than the second and the lamina propria of the prior filled with the gastric pits. The mean of thickness was (135.14  $\mu\text{m}$ ) with range (116.5 – 139.8  $\mu\text{m}$ )(Figures5d,e,f and 6b,d).

The sub mucosa was with less thickness than that of the common wood pigeon. The mean thickness was (83.88  $\mu\text{m}$ ) with range (69.9 – 93.2  $\mu\text{m}$ ).

The muscularis externa was the more different layer of the gizzard in the barn owl it was with less thickness than that of the common wood pigeon. The mean of thickness was (1104.42  $\mu\text{m}$ ) with range(862.1–1258.2  $\mu\text{m}$ ). The serosa was thicker than that of the common wood pigeon, its thickness mean was (181.74  $\mu\text{m}$ ) and the range(69.9–326.2  $\mu\text{m}$ ).

## Discussion

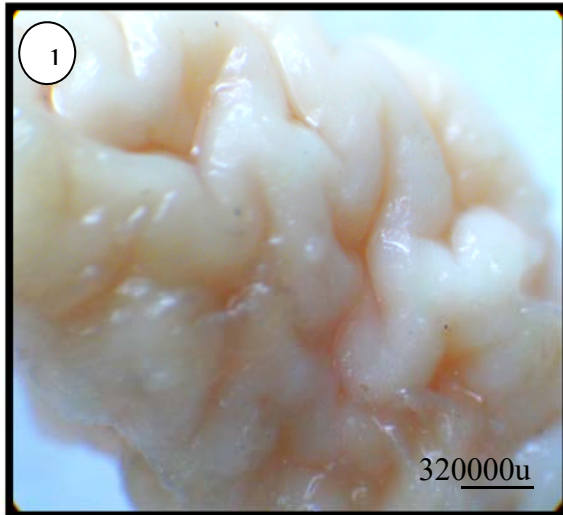
Results of the present study showed clear differences between the stomach of the two studied birds, in common wood pigeon, proventriculus was fusiform shape tube separated from the gizzard by isthmus , while in the barn owl, proventriculus was pear shape, shorter & narrower and not separated from the gizzard by isthmus.

Gizzard in the common wood pigeon appeared with disc or biconvex lens shape, lined with yellowish-green tissue (koilin) taking the irregular pleated pattern of longitudinal folds and grooves, while in the barn owl, gizzard was soft, elongated, spindle to pear shape, lined with very poor yellowish koilin layer took the fan shape with vertical and longitudinal pattern of the inner folds. The difference between stomach of under investigation birds are probably due to the feeding habits or perhaps the amount of food engulfed by birds under investigation [1, 12 and 13]. The relative size of these organs was variable according to the food habits and this may be the reasons of the differences between the two stomachs, so, in the birds that eat hard food items as in common wood pigeon proventriculus (bird species under investigation) was wide due to the high number of glands component , gizzard was powerful and big and the intermedian zone (isthmus) connect the two parts of stomach for segregation[4]. These results were conformable with what have been found by [14] who studied the stomach of Eurasian hobby *Falco subbuteo* and [15] who studied the stomach of partridge *Rhynchotus rufescens*. This conformance probably came from the functional needs of the studied birds, as the bird feed on relative large soft items of food, so, it required a stomach adapting more for storage than digestion as in the stomach of barn owl under investigation, by contrast, in the common wood pigeon which feed on indigested items of food, so, required a stomach adapting for more digestion than storage [1] .

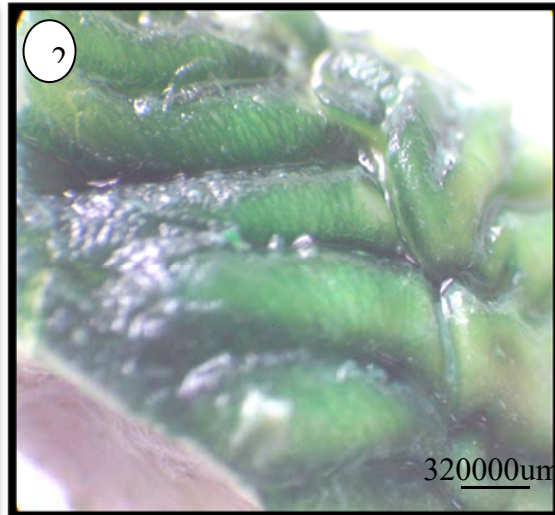


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**Figure (1):** Inner view in the gizzard of the common wood pigeon *Columba palumbus* shows the inner folds.16x.



**Figure (2):** Inner view in the gizzard of the barn owl *Tyto alba* shows the inner folds. 16x.

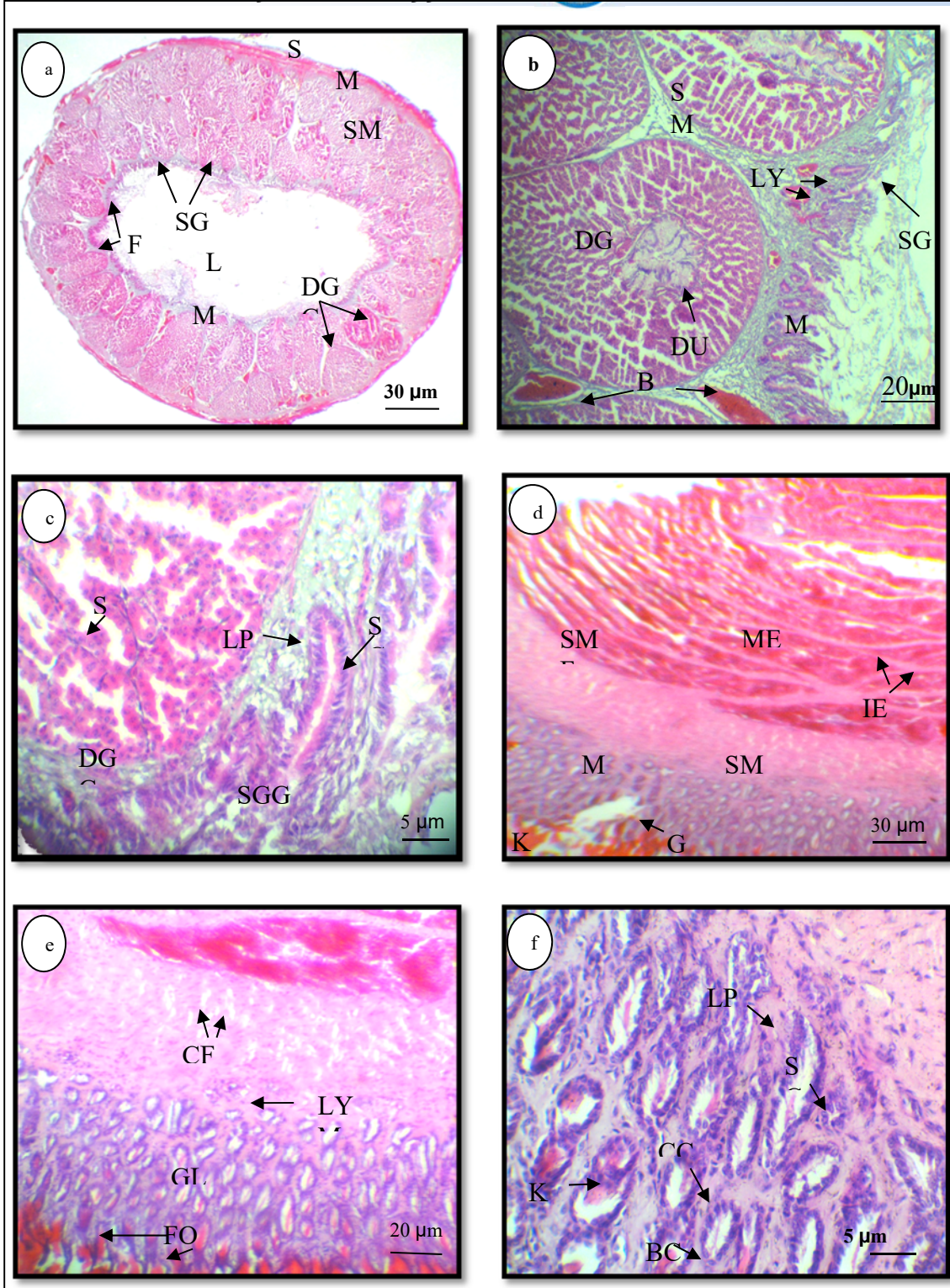
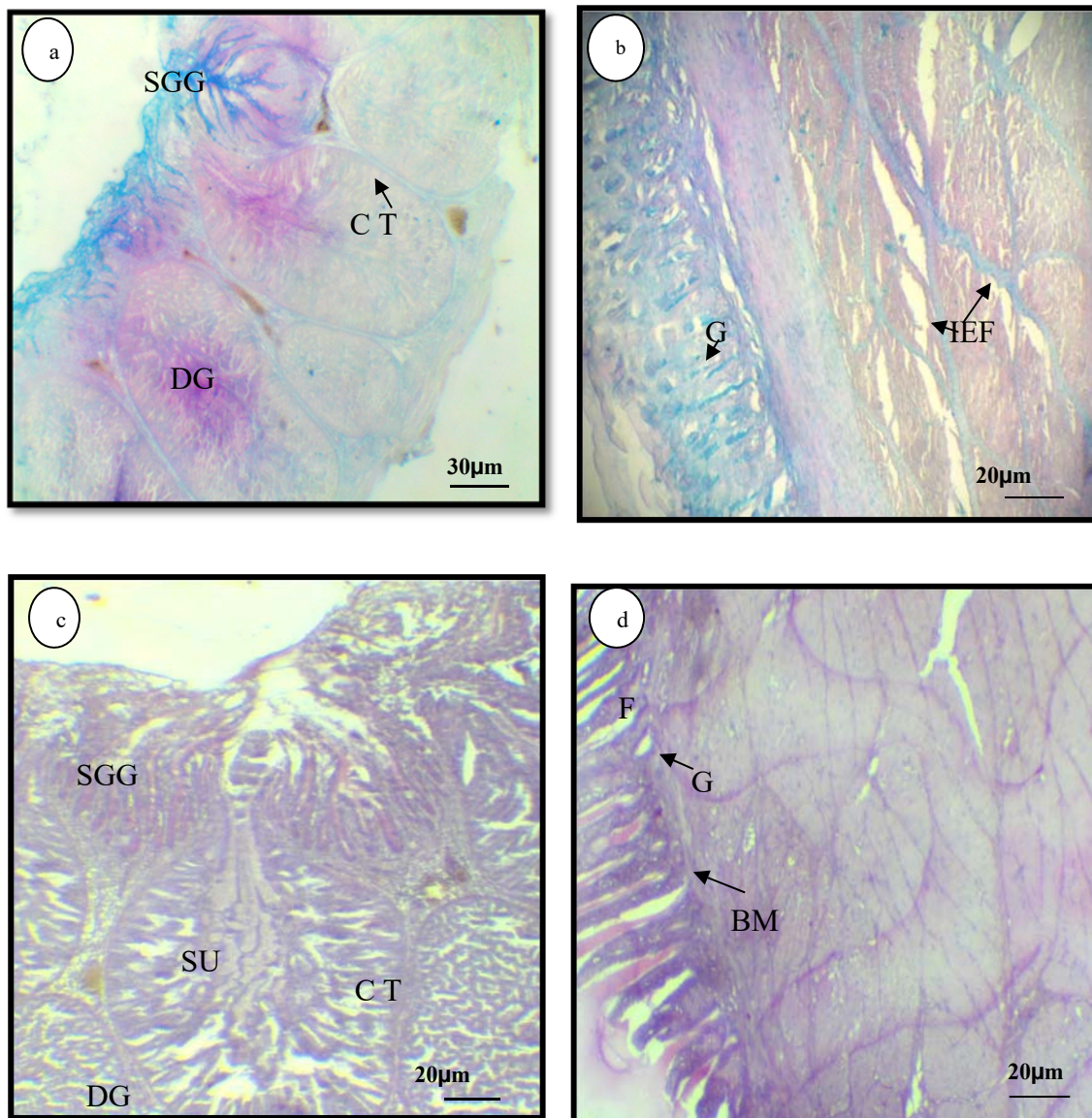


Figure (3)a: Cross section in the proventriculus of the common wood pigeon *Columba palumbus* shows the lumen L , the folds FO , the superficial gastric glands SGG and the deep gastric glands DDG.H&E , 4x . b: Cross section in the proventriculus of the common wood pigeon *Columba palumbus* shows the mucosa M , superficial gastric glands SGG , deep gastric glands DGG , the ducts of the deep gastric glands DU , lymph vessels LYM and the blood vessels. H&E 10x. c: Cross section in the proventriculus of the common wood pigeon *Columba palumbus* shows the superficial gastric glands SGG, deep gastric glands DGG, lamina propria LPR, simple columnar epithelial tissue SCE and the secretion unite SU. H&E 40x. d: Cross section in the gizzard of the common wood pigeon *Columba palumbus* shows the mucosa M, sub mucosa SM, muscularis externa ME, irregular elastic fibers IEF, gastric pits GP and the koilin KO. H&E 4x. e: Cross section in the gizzard of the common wood pigeon *Columba palumbus* shows the folds FO , lymph cells LYM , glands GL and the collagenous fibers. H&E 10x.f: Cross section in the gizzard of the common wood pigeon *Columba palumbus* shows the simple cuboidal epithelial tissue SCE , lamina propria LPR , koilin KO ,the basal cells BC and the chief cells CC . H&E 40x.





Figure(4)a: Cross section in the proventriculus of the common wood pigeon *Columba palumbus* showed the superficial gastric glands SGG, deep gastric glands DGG and the connective tissue C T . Note the strong reaction of the superficial glands and the weak reaction of the deep gastric glands with the stain. AB .10x. **b**: Cross section in the gizzard of the common wood pigeon *Columba palumbus* showed the irregular elastic fibers IEF and the glands GL . Note the few number of the glands. AB , 10x. **c**: Cross section in the proventriculus of the common wood pigeon *Columba palumbus* showed the superficial gastric glands SGG, deep gastric glands DGG , basement membrane BM, and the secretory units SU. Note the strong reaction with the stain . PAS 10x. **d**: Cross section in the gizzard of the common wood pigeon *Columba palumbus* showed the folds FO , glands GL and the basement membrane BM. PAS.10x.



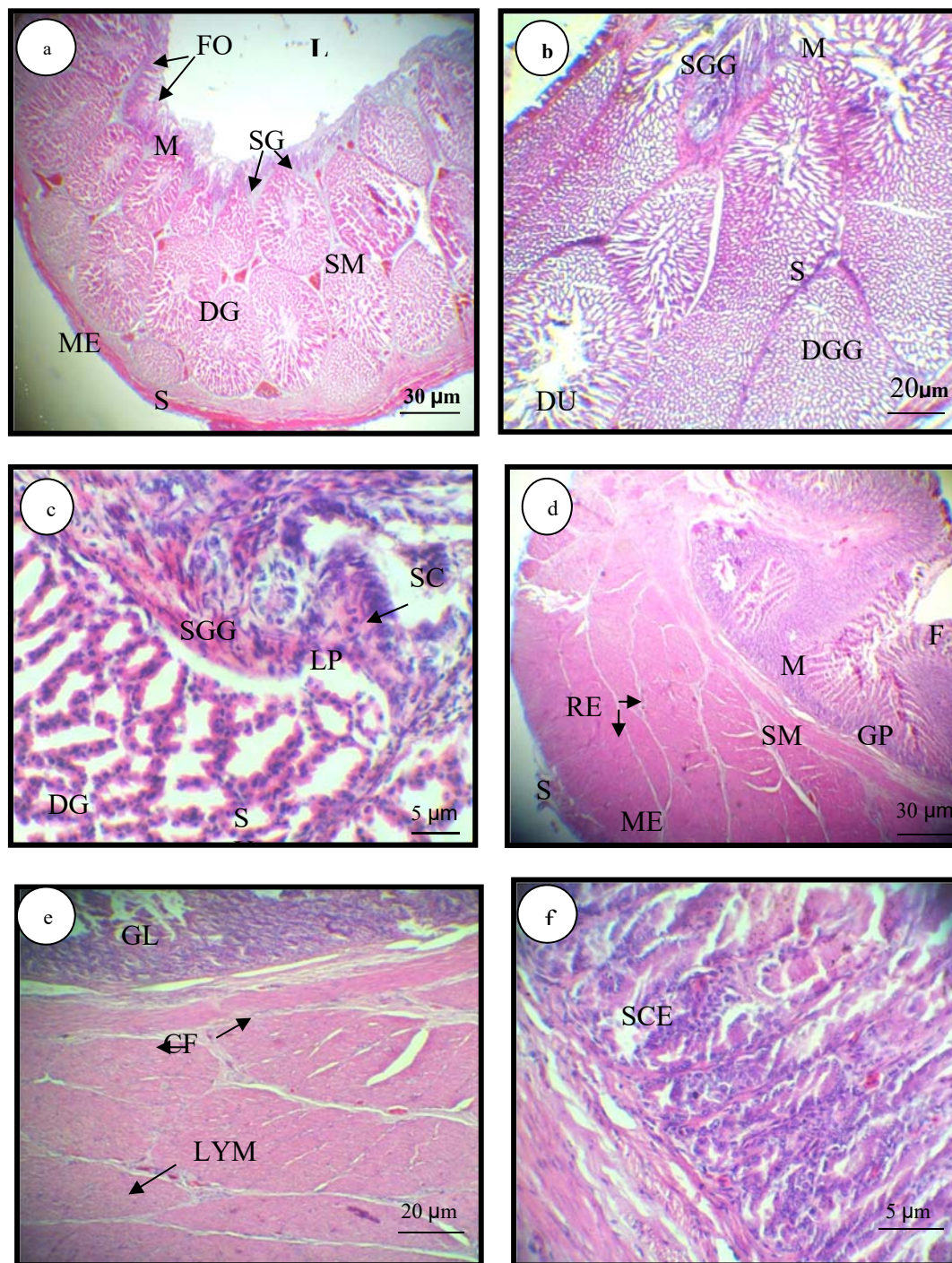
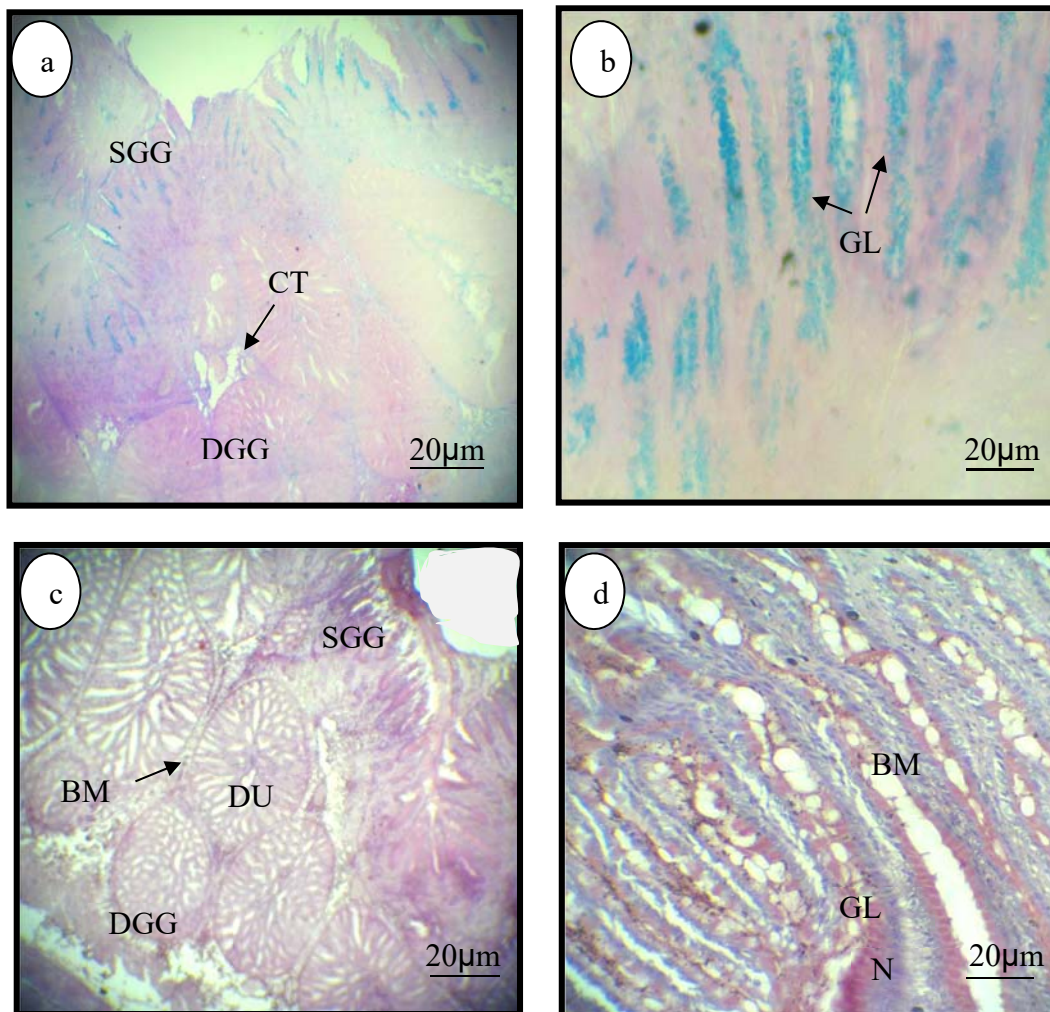


Figure (5)a: Cross section in the proventriculus of the barn owl *Tyto alba* shows the lumen L, the folds FO, the superficial gastric glands SGG and the deep gastric glands .H&E, 4x . b: Cross section in the proventriculus of the barn owl *Tyto alba* shows the mucosa M, sub mucosa SM, superficial gastric glands SGG, deep gastric glands DGG, the ducts of the deep gastric glands DU. H&E 10x. c: Cross section in the proventriculus of the barn owl *Tyto alba* shows the superficial gastric glands SGG, deep gastric glands DGG, lamina propria LPR, simple columnar epithelial tissue SCE and the secretion unite SU. H&E 40x. d: Cross section in the gizzard of the barn owl *Tyto alba* shows the mucosa M, sub mucosa SM, muscularis externa ME, regular elastic fibers REF, gastric pits GP and the folds F. H&E 4x. e: Cross section in the gizzard of the barn owl *Tyto alba* shows the folds FO, lymph cells LYM, glands GL and the collagenous fibers. H&E 10x.f: Cross section in the gizzard of the barn owl *Tyto alba* showed the simple cuboidal epithelial tissue SCE,H&E 40x.



Figure(6) **a**:Cross section in the proventriculus of the barn owl *Tyto alba* showed the superficial gastric glands SGG, deep gastric glands DGG and the connective tissue C T . Note the strong reaction of the superficial glands and the weak reaction of the deep gastric glands with the stain. AB .10x. **b**: :Cross section in the gizzard of the barn owl *Tyto alba* showed the glands GL . Note the high number of the glands. AB , 40x. **c**: Cross section in the proventriculus of the barn owl *Tyto alba* showed the superficial gastric glands SGG, deep gastric glands DGG , basement membrane BM, and the secretory units SU. Note the strong reaction with the stain . PAS 10x. **d**:Cross section in the gizzard of the barn owl *Tyto alba* showed the glands GL and the basement membrane BM, glands GL and folds F. PAS 10x.



## دراسة تشريحية ونسجية مقارنة للمعدة في نوعين من الطيور العراقية (*Columba palumbus* and *Tyto alba*)

رشا وحيد الجبوري

قسم علوم الحياة/كلية العلوم/جامعة بابل

حسين عبدالمنعم داود

قسم علوم الحياة/كلية التربية للعلوم الصرفة(ابن الهيثم)/جامعة بغداد

علي شعلان الاعرجي

قسم علوم الحياة/كلية العلوم/جامعة بابل

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### الخلاصة

هدفت الدراسة الحالية التعرف على النواحي التشريحية والنسجية للمعدة في نوعين مختلفين من الطيور العراقية (حمام الغابات *Columba palumbus* وبومة المخازن او البومة البيضاء *Tyto alba*). تقسم المعدة في الطيرين موضوع الدراسة على جزأين، الغدي او المعدة الحقيقية والعضلي او القانصة المعدة الامامية او الغدية في حمام الغابات تظهر بشكل أنبوب مغزلي مفصول عن القانصة ببرزخ (Isthmu)، بينما تظهر في البومة البيضاء بشكل كمثري، وهي أوسع واقصر مما هي عليه في حمام الغابات وتكون غير مفصولة عن القانصة ببرزخ.

اظهرت نتائج الدراسة الحالية ان القانصة في حمام الغابات تظهر بشكل عدسة محدبة الوجهين مبطنة بنسيج اخضر مصفر يدعى كولين (Koilin)، بينما تكون في البومة البيضاء بشكل كمثري ومبطنة بطبقة نحيفة جدا من الكولين. الطبقة المخاطية في المعدة الغدية لكلا الطيرين موضوع الدراسة تكون غنية بغدد انبوية بسيطة، السطحية فيها طويلة و واسعة في البومة البيضاء مقارنة بما في حمام الغابات، والطبقة تحت المخاطية تكون غنية بغدد مركبة حوصلية متفرعة، اما الغدد المعدية العميقة التي تكون أطول واوسع في البومة البيضاء مقارنة بما في حمام الغابات. الطبقتان العضلية الخارجية والمصلية تكون في حمام الغابات اسماك مما في البومة البيضاء. والطبقة المخاطية في القانصة في البومة البيضاء تبدو مليئة بنقر معدية مقارنة بما هو الحال في حمام الغابات.

الكلمات المفتاحية: تشريح، انسجة، طيور.