



## Morphological and Histochemical study of lung in swan geese (*Anser cygnoides*)

Hasanain jaafar Ali<sup>1</sup> Fatimah Swadi Zghair<sup>1</sup>

<sup>1</sup>Department of Anatomy and Histology, College of Veterinary Medicine, University of Al-Qadisiyah, Al-Diwaniyah City, Iraq.

Corresponding E-mail: [fatimah.zghair@qu.edu.iq](mailto:fatimah.zghair@qu.edu.iq)

ORCID: <https://orcid.org/0000-0002-8871-0634>

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### Abstract

The current exploration was done to study the morphological and histological characteristic features of the lung in the swan geese (*Anser cygnoides*). For that purpose, the methods included the use of 10 birds. The birds were euthanized, the lungs were collected, and features such as location, relationship, length, weight, and volume were reported. The results revealed that the two tiny lungs seen in swan geese are similar in size and shape, not lobed, flattened, and almost triangular in shape, and bright pink in color. Each lung extended from the craniocaudal and first or second ribs to the seventh rib. The average length of the right and left lungs was  $11.88 \pm 0.929$  and  $10.44 \pm 0.12$  cm, respectively, for males and  $11.88 \pm 1.095$  and  $14.1 \pm 0.944$  cm, respectively, for females, while the average width of the right and left lungs was  $4.52 \pm 0.133$  and  $5.4 \pm 0.341$  cm, respectively, for males and females, and  $5.38 \pm 0.232$  cm, respectively. In the case of histological features, the parabronchial epithelium was simple squamous, and connective tissue bordered the atrium and air capillaries, but smooth muscles were missing. This study reveals the characteristic pictures of the lungs of the swan geese that could be useful for future studies that deal with different sciences.

**Keywords:** *Anser cygnoides*, Lung, histochemical, Swan goose.

### Introduction

The bird's lungs are located in the craniodorsal region of the thorax, and they span from the second rib at the head to the sixth rib at the tail. They are securely linked to the chest wall due to their close proximity to the ribs. Flattened rectangles, extended parallelograms, and trapezoid shapes best describe the lungs of turkeys and ducks, respectively. As a result of the duck lung's being fairly lengthy, slim, and pointy craniomedially, and the medial boundary being nearly twice as long as the lateral boundary, the medial boundary carries six

imprints for ribs and parabronchi. They are not segmented into lobes but rather have a brilliant red triangle or quadrilateral form, and their top margins are grooved from the spinal ribs being buried there (1). The lungs of a fowl are a brilliant red trapezoid shape and quite tiny in comparison to the size of the thoracic cavity; each lung is divided into four pieces by rib imprints. The medial edge is the entrance to the lungs for the principal bronchial tubes, tracheal arteries, and lung arteries. Chickens and turkeys have lungs with thick medial and thin lateral



margins, as well as vertebral, deep, and rib surfaces. Even so, the lungs of ducks have three surfaces related to the ribs, the vertebrae, and the septa. Upon inspection, the lungs of a Japanese quail appear to be brilliant red and sponge-like (2). When compared to the size of the entire body, avian lungs are incredibly small and, when completely inflated, quite rigid as they attempt to deflate. They resemble elastic balloons with firmly linked ribs, leaving deep costal impressions, and they have an elastic appearance. The lungs of an avian are located in the craniodorsal region of the thorax, which extends from the second rib cranially to the sixth rib caudally. These lungs are firmly attached to the ribs and the spine (3, 4). The current exploration was done to study the morphological and histochemical characteristic features of the lung in the swan geese (*Anser cygnoides*).

### Materials and methods

In the present study used 10 birds, the first step was euthanized by inhalation by chloroform. Each bird was dissected by fixing it on a suitable dissecting board to view the lungs. A mid-line incision in the thoracic-abdominal wall was made, after that, the trachea was identified and photographed in situ using a digital camera. The location and relationships of lungs of the studied birds were

well described. Specimens were extirpated and washed with normal saline to remove adhered debris and blood, then they were cleaned again by normal saline. Then, the weight of the lungs was measured in grams by using a sensitive digital scale. The macroscopic measurements (length, width, and weight) of the collected specimens (5). The histology specimens were collected from the middle part of the lung. It was fixed in 10% neutral buffered formalin where they were dehydrated by a series of graded alcohol (70%, 80%, 90%, 95%, and 100%) for two hours for each concentration, and cleared in xylene for ten minutes in two changes and infiltrated in molten paraffin wax. Sections of 5 $\mu$ m thickness were prepared from the blocked specimens using the rotary microtom (Series MRS3500, Histo-Line Laboratories Ltd, Italy). These sections were mounted on clean slides and then stained using Hematoxylin and Eosin to demonstrate the general histological components of the tissues and histochemical stains (PAS stain for polysaccharides, mason trichrome and verhove stains) (6).

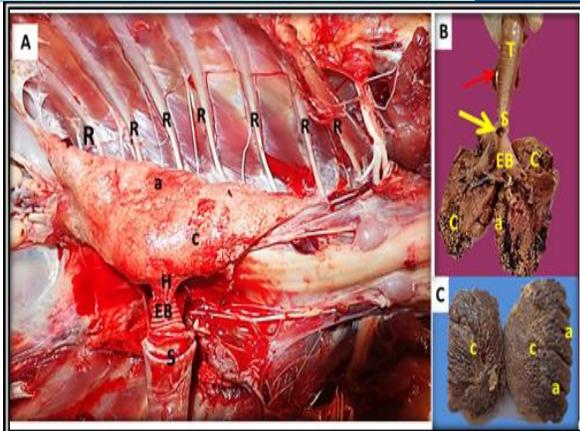
**Ethical approval:** The researchers obtained ethical approval from the research Ethical Approval Committee of the College of Veterinary Medicine, University of Al-Qadisiyah.

## Results

### Morphological findings

The two tiny lungs seen in swan geese are shown in Figure (1) and similar in size and shape, not lobed, flattened almost triangular in shape, and bright pink in color. Each lung stretched between the cranio-caudal and first or second to the seventh rib. Its lateral surface close proximity to the thoracic wall and its six deep grooves were visible along the dorsal margin (Fig.1). The average length of the right and left lungs was 11.88 $\pm$ 0.929 and 10.44 $\pm$ 0.12

cm, respectively, for males and 11.88 $\pm$ 1.095 and 14.1 $\pm$ 0.944 cm, respectively, for females, while the average width of the right and left lungs was 4.52 $\pm$ 0.133 and 5.4 $\pm$ 0.341 cm, respectively, for males and females 4.44 $\pm$ 0.258 and 5.38 $\pm$ 0.232 cm, respectively (Table.1).



**Fig. 1:** A: lateral view of the respiratory organs of swan goose shows: costal ribs surfaces (R), groove of the costal surfaces (a), lung (C), extrapulmonary bronchi (EB), syrinx (S) and hillus of lung(H). B: ventral view of the respiratory organs of swan goose shows: grooves of the costal surfaces (a), lung (C), extrapulmonary bronchi (EB), syrinx (S), sternotrachilis muscle (red arrow)), triangular of the voice (yellow arrow). C: caudal view of lung of swan goose shows: grooves of the costal surfaces (a), lung (C). Note figures B&C snap after fixation

Table (1): morphological measurement for lung of swan geese.

Morphological measurement	gender	lung		T test	P value
		Right	left		
Length	Male	11.88±0.929	10.44±0.12	3.065	0.015
	female	11.88±1.095	14.1±0.944	3.075	0.015
T test		0	7.68		
P value		1	0		
Width(cm)	Male	4.52±0.133	5.4±0.341	4.815	0.001
	female	4.44±0.258	5.38±0.232	5.427	0.001
T test		0.552	0.097		
P value		0.596	0.925		
Weight (gm)	Male	22.01±2.39	21.93±1.029	0.066	0.949(NS)
	female	19.74±0.561	16.38±0.279	10.73	0(S)
T test		1.853	10.41		
P value		0.101(NS)	0(S)		

### Histological findings

The lungs of the swan geese were microscopic examined, and it was see that the "building blocks" of the lungs (lobules) were parabronchi, which opened into the various dilated chambers known as atria, which led to the smaller dilated ducts known as infundibula, which led to a very small and intricate network of the air capillaries. The interparabronchial connective tissue divides each lobule (interparabronchial septa) arteries and veins going through these septa (Fig . 2).The wall thickness (µm) of the secondary bronchial (right and left) was (390.94±0.877 and

389.1±2.0009) and (388.56±1.109 and 388±0.943), for males and females, respectively. The average thickness (µm) of the right and left secondary bronchial respiratory epithelium (101.46±1.615 and 99.8±0.368) and (99.56±0.338 and 98.46±0.581), for males and females, respectively, and the average thickness (µm) of the right and left diameter of secondary bronchial aveoli mucous was (70.38±0.299 and 68.64±0.932) and (69.3±0.141 and 67.86±0.257), for males and females, respectively. While the blood gas barrier thickness (µm) (0.58±0.172 and 0.5±0.089) and (0.51±0.128 and 0.74±0.162), for males and



females, respectively. The parabronchial smooth muscles were missing save for the atrial epithelium and connective tissue bordered the apertures mild reaction for Pas stain (Table 2 atrium, infundibulum, and air capillaries, but and Fig.3).

Table (2): Lung histological measurement  $\mu\text{m}$  in swan geese

Histological measurement/ thickness $\mu\text{m}$	Gender	Right	Left	T test	P value
Secondary bronchial wall $\mu\text{m}$	Male	390.94 $\pm$ 0.877	389.1 $\pm$ 2.0009	1.684	0.131(NS)
	Female	389.56 $\pm$ 1.109	388.56 $\pm$ 0.943	0.549	0.598(NS)
	T test	3.365	0.85		
	P value	0.01(S)	0.420(NS)		
Secondary bronchial epithelium $\mu\text{m}$	Male	101.46 $\pm$ 1.615	99.8 $\pm$ 0.368	2.003	0.08(NS)
	Female	99.56 $\pm$ 0.338	98.46 $\pm$ 0.581	3.269	0.011(S)
	T test	2.302	3.891		
	P value	0.07(NS)	0.005(S)		
Diameter of secondary bronchial aveoli mucous $\mu\text{m}$	Male	70.38 $\pm$ 0.299	68.64 $\pm$ 0.932	3.552	0.007(S)
	Female	69.3 $\pm$ 0.141	67.86 $\pm$ 0.257	9.798	0(S)
	T test	6.525	1.612		
	P value	0(S)	0.146(NS)		
Blood gas barrier $\mu\text{m}$	Male	0.58 $\pm$ 0.172	0.5 $\pm$ 0.089	0.825	0.433(NS)
	Female	0.51 $\pm$ 0.128	0.54 $\pm$ 0.162	2.223	0.057(NS)
	T test	0.653	2.588		
	P value	0.532(NS)	0.032(S)		

**S: Significant difference at  $p < 0.05$ , NS: No significant difference at  $p < 0.05$**

Fine membranes that lack hyaline cartilages were used to separate the bronchial cartilage rings and have identical bronchial wall constituents. Bronchi secondary appeared embedded in the lung parenchyma, which was bordered with ciliated, pseudostratified columnar epithelium with an abundance of different-sized mucous glands taking up the majority of the epithelial thickness and few

infrequent goblet cells (Fig. 2). Although the hyaline cartilage was missing, the lamina propria and submucosa were made out of loose connective tissue, with tiny bundles of collagen fibers encircling the secondary bronchi in their entirety (Fig.4). Small anastomosing parabronchi could be reached through gaps along the secondary bronchial walls.

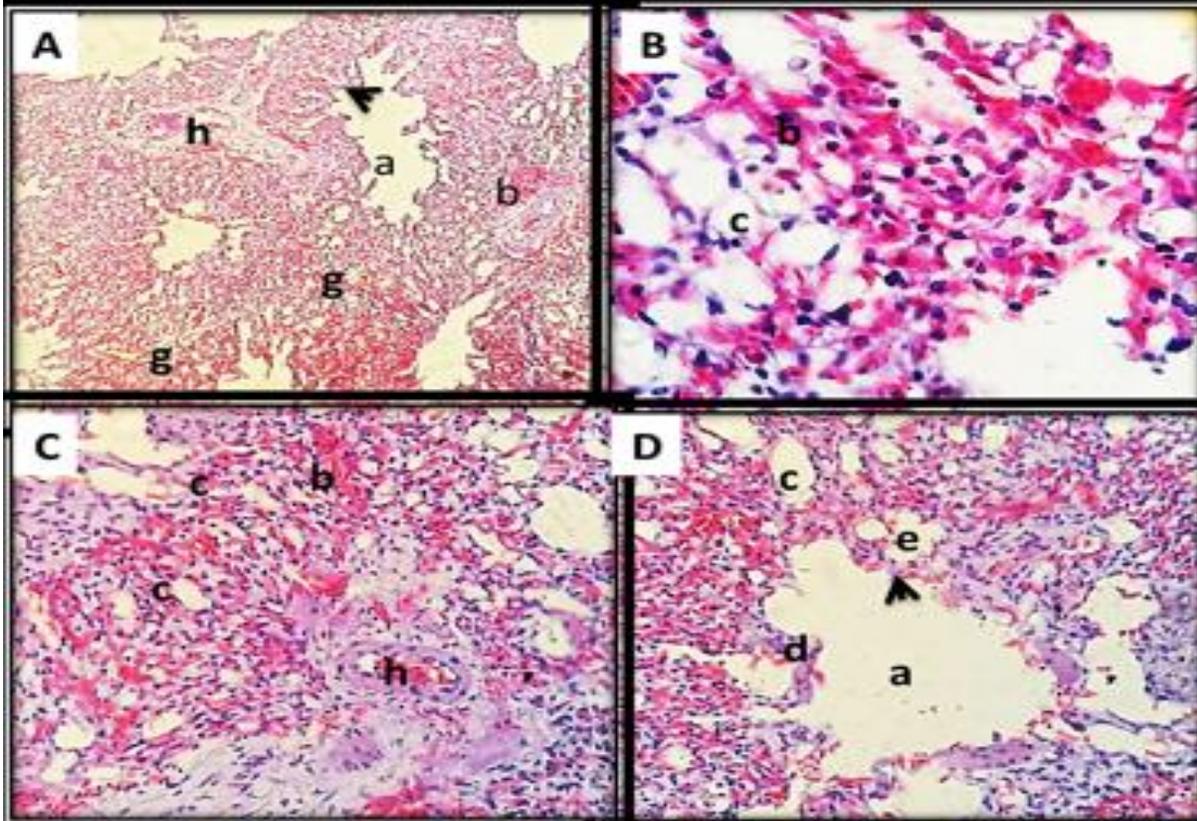


Fig.(2). A, B,C,D: Cross histological section of swan goose's lungs shows parabronchial lumen (a), simple squamous epithelia (head arrow), blood vessels (h), atria (d), air capillaries (e), blood capillaries (c) H&E stain: A:X100,B,C,D:X400

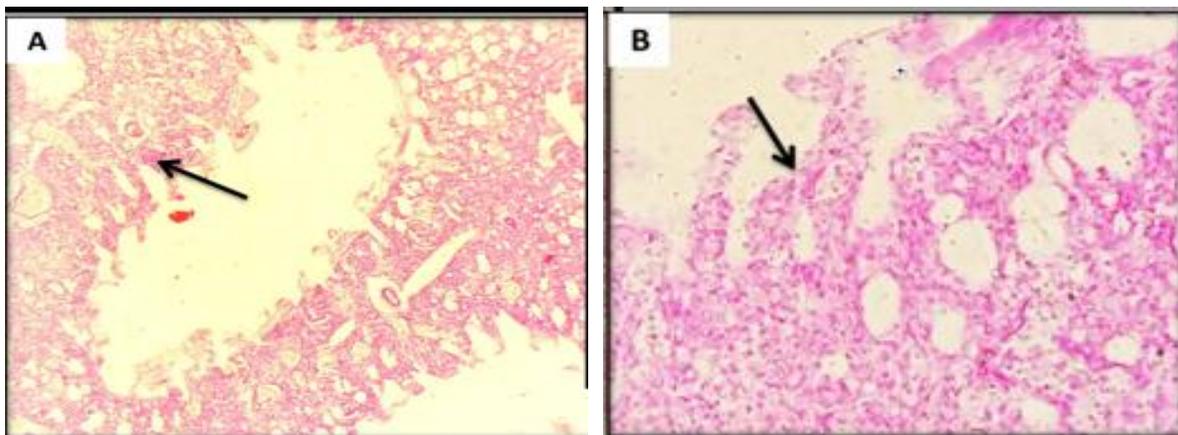


Fig. (3): A, B : Cross histological section of swan goose's lungs shows : connective tissue and epithelium tissue weak reaction to PAS stains (black arrow), PASstain (A:X200,B:X400)



layer of loose connective tissue, and thick smooth muscle fibers, collagen and elastic fibers made up the wall of the parabronchi (Fig . 4, 5).

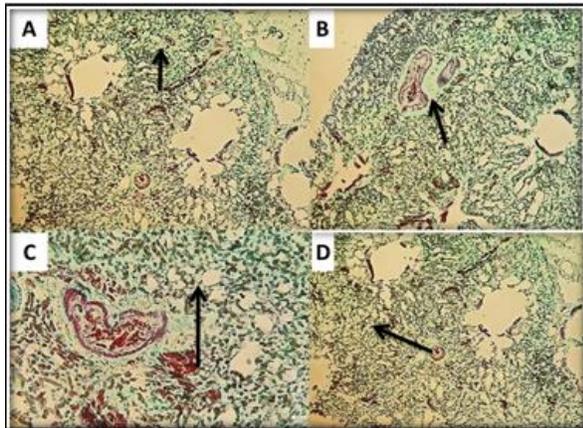


Fig. (4). A, B, C, D: Cross histological section of swan goose's lungs shows : collagen fiber (black arrows), masson's trichroms stain: A,B,C,D:X200

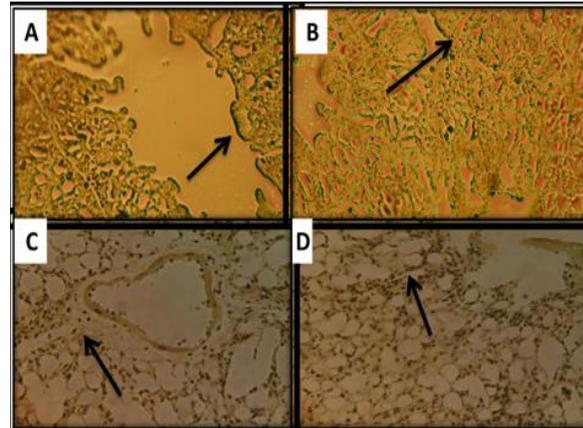


Fig. (5). A, B, C, D: Cross histological section of swan goose's lungs shows : elastic fibers (black arrows), verrhoffe vangeason stains: A,B,C,D:X200

## Discussion

### Lung morphology

It has been understood for some time that the air sacs in a bird's lung behave like bellows, causing air to stream in one direction. The previously contentious explanations of the form and functioning of the avian lungs have been further complicated by this. The intricacy of the avian lung architecture, which has fascinated researchers for decades is only now coming into focus (7,8). Important foundational knowledge about how swan geese lungs work, including the characterization of unidirectional air flow and cross-current gas exchange. A number of approaches, have been performed to clarify the spatial configuration of the gas exchange tissue, although several elements that might be directly connected to function still remain obscure. In addition, birds have the most sophisticated lung structure of any vertebrate since their blood gas-barrier is the thinnest (9). It has come to light, as a result of recent morphological investigations that were

carried out on the lungs of the swan geese (*Anser cygnoides*), that these organs have the appearance of a brilliant red colour, have the shape of an extended triangle, and are arranged craniocaudally. These findings are consistent with those of AL- Ahmed & Sadoon (10) in the duck and with those of (11) in the japanese quail; however, they are not consistent with those of Ackermann & Cheville; Makanya *et al* (12,13) in the chicken, turkey, and duck as well as with those of (13) in the West African guinea fowl. In the context of this inquiry, the color of the turkey's lungs indicated to how lavishly the animal was supplied with blood. This was determined based on the color of the swan geese (*Anser cygnoides*)'s lungs (13). The lungs are tightly connected to the ribs and the vertebral column, and they extend from the first to the sixth vertebral ribs . As a result, the capacity of the lungs stays constant during the breathing cycle. This clarification is supported by a recent study conducted by Kumar *et al* (2), which



proposed that the avian lung's rigidity and constant volume throughout the respiratory cycle provide the mechanical foundation for an enlargement of the oxygen exchange surfaces into a three-dimensional structure. This explanation is backed by a recent research conducted by (2). These results seemed to be consistent with those obtained by other avian studies, such as in Iraqi pigeons (14). The swan goose lung is similar to that of other birds, such as the duck, in that it has two boundaries (dorsal and medial) and three surfaces (costal, vertebral, and septal) (15). These results, however, contradict those of Rani et al., 2020 and Vidyadaran et al (3,4), who states that chicken (vertebral, visceral, costal surfaces) and (The right and left lungs had a mean length of 6.375 millimetres (0.24 centimetres) and 6.725 millimetres (0.17 centimetres) respectively. The current study lung weight (gm) was  $22.01 \pm 2.39$  (right) and  $21.93 \pm 1.029$  (left) and  $19.74 \pm 0.561$  (right) and  $16.38 \pm 0.279$  (left) for males and females, respectively. The current study lung length was  $11.88 \pm 0.929$  (right) and  $10.44 \pm 0.12$  (left) and  $11.88 \pm 1.095$  (right) and  $14.1 \pm 0.944$  (left) for males and females, respectively. In contrast to Getty's (16) findings, which suggested that chicken lungs had a maximum length of 7 centimetres and a maximum width of 5 centimetres.

### Lung histology

The neopulmonic parabronchi and produced a complex feltwork on the lung ventral third. The pulmonary parenchyma was structured like a network of tiny tubes called bronchi. The present microscopic examination of the lungs in the swan geese shed

light on the fact that the building units of the lung are known as parabronchi. This allowed access to a number of enlarged chambers known as atria. The atria led to smaller enlarged ducts known as infundibula, which in turn led to a very tiny and intricate network of air capillaries. These findings are consistent with (17) in poultry. The wall thickness ( $\mu\text{m}$ ) of the secondary bronchial (right and left) was ( $390.94 \pm 0.877$  and  $389.1 \pm 2.0009$ ) and ( $388.56 \pm 1.109$  and  $388 \pm 0.943$ ), for males and females, respectively. There were three distinct layers that made up the wall of the parabronchi. The epithelial layer consisted of simple squamous epithelium, followed by a layer of loose connective tissue, and then thick bundles of smooth muscle. Atria, infundibula and air capillaries are lined by similar epithelium to that of the parabronchial tissue, and connective tissue is present. In the case of the average thickness ( $\mu\text{m}$ ) of the right and left secondary bronchial respiratory epithelium ( $101.46 \pm 1.615$  and  $99.8 \pm 0.368$ ) and ( $99.56 \pm 0.338$  and  $98.46 \pm 0.581$ ), for males and females, respectively. Contrary to the findings of (18), who demonstrated that the helial layer of the parabronchi in avian was cuboidal epithelium, we believe that the avian helial layer was not cuboidal epithelium.

### Conclusion

This study reveals the characteristic information of the lungs of the swan geese that could be useful for future studies that deal with different sciences.

**Conflict of interest:** The authors declare that there is no conflict of interest



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