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Morphological study of syrinx in swan goose (*Anser cygnoides*)

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Abstract

The current work was performed to study the morphological characteristic features of the syrinx in the swan geese (*Anser cygnoides*). For that purpose, the methods included the use of 10 birds (5 males 5 females). The birds were euthanized and the syrinx was collected, and features, such as location, relationship, length, weight, and volume were reported. The results revealed that the syrinx was a wing-shaped cartilaginous structure, on the other hand, partially entirely fused and ossified which was ventral-directed. It was situated between the end of the trachea and the starting tufts of the bronchi near the base of the heart, dorsal to the aorta and pulmonary arteries, and inward-ventral to the esophagus. The syrinx Skeleton was made up of the oscillating medial and lateral membranes, the ligament (interbronchially), and the irregular, compact, and partially ossified cartilages of the trachea and bronchi (the origin of the trachea). This serves as the primary origin of the caudolateral and caudomedial extrinsic muscles of the larynx. The first two cartilage tracheosyringeales rings are arranged in a circle, and their edges are distinct.

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The remaining tracheosyringealis cartilage, on the other hand, with entirely ossified fusions to form the tympanum part. The membrana tympaniformes lateralis was processed on at the dorsal and ventral

portions (right and left) of the caudal. This study clearly shows the characteristic features of the syrinx of the swan geese that could be useful buildups for future studies that deal with different sciences related to this important bird.

Keywords: Anatomical features, *Anser cygnoides*, swan goose, syrinx.

Introduction

The geese one of the oldest birds that have been domesticated in the world and was a part of the history of many countries. This is evident from the excavations in Egypt, as well as the pictures on the walls of the temples. Also, the geese were holy birds of the Romans. In many countries like Egypt, China and Thailand, geese were the main birds in the villages so that farm waste can be effectively utilized, allowing small-scale farmers to earn a supplemental income while also supplying their families with a healthy source of animal protein. The avian respiratory system is one of the vital components in the interchange of oxygen and carbon dioxide during inhalation and exhalation. Also, investigate the maintenance of thermal homeostasis inside the live organism. Nostrils lead air into the nasal cavity, and from there it travels down the trachea and into the lungs (1).

Birds may be divided into passerines and non-passerines based on the structural variations in their voice devices, as well as their singing and calling behaviours. Bird vocalisation plays a significant part in this classification system. Already in 1878, the

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German anatomist categorized different kinds of birds according on the architecture of their syringes. According to the difference that can be made between the tracheal and bronchial syrinx part as well as the topographical area of the major generating mechanism of sounds, three unique kinds of syrinx may be found: tracheobronchial, tracheal, and bronchial. For instance, in long-legged buzzards, the syrinx has its genesis in the tracheobronchial system (2). Whereas in the duck, the bronchi are nearly solely responsible for the development of the syrinx, with the trachea playing a relatively little role in this process. Budgerigars and other members of the suborder Suboscine, which belong to the superfamily Furnarioidea, have a tracheal syrinx. The vibration of air as it passes through the organ, much as in the larynx of mammals, is what causes sound to be created. The syrinx of the bird was located at a level of the second or third thoracic vertebrae and between the trachea and the main bronchus (3). Additionally, it was associated with the clavicular air sac adjacent to the heart at the glandular stomach dorsally and of the oesophagus ventrally. However, in contrast to the human larynx, the syrinx is made up of specialized cartilaginous structures (the tracheosyringeal cartilages, the pessulus, the bronchiosyringeal cartilages, and the intermediate syringeal cartilages), connective tissue masses, vibrating membranes, and a syringeal muscle. The syrinx, the phonatory organ that birds have developed through the course of evolution, varies greatly in its form depending on the species. During the process of shutting and opening the passage airways, the muscles that govern the syrinx, which, like the human larynx, controls airflow and action and modifies acoustic characteristics, are responsible for these functions. The categorization of birds was de-

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termined by whether or not they had a syrinx as part of their basic anatomy or whether or not they had musculature. There are birds that are silent for the whole of the year and others that only make sounds during the breeding season (4).

The current work was performed to study the morphological characteristic features of the syrinx in the swan geese (*Anser cygnoides*).

Materials and methods

Birds and collection of syrinxes

The methods included the use of 10 birds (5 males 5 females). The birds were euthanized and the syrinx was collected, and features, such as location, relationship, length, weight, and volume were reported.

Morphological examination

All studied birds were weighed, then euthanized by inhalation by chloroform (Leary et al., 2013). Each bird was dissected by fixing it on a suitable dissecting board to view the syrinx. A mid-line incision in the thoracic- abdominal wall was made, after that, the syrinx was identified and photographed in situ using a digital camera (Sony Dsc-H90). The location and relationships of syrinx of the (5 males and 5 females) studied birds were well described. Samples 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 syrinx was measured in grams by using a sensitive digital scale (Notebook Series-Digital scale). The macroscopic measurements (length and diameters) of the collected segments were conducted in centimeter and millimeters by using the electronic Vernier caliber, while the volume was measured by water displacement method.

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Results

Morphological features of syrinx

Macroscopic examination of the syrinx of the swan-goose appeared in this study as a wing-shaped cartilaginous structure, on the other hand, partially entirely fused and ossified which was ventral-directed. It was situated between the end of the trachea and the starting tufts of the bronchi near the base of the heart, dorsal to the aorta and pulmonary arteries, and inward-ventral to the esophagus. The syrinx Skeleton was made up of the oscillating medial and lateral membranes, the ligament (interbronchially), and the irregular, compact, and partially ossified cartilages of the trachea and bronchi (the origin of the trachea) (Fig. 1).

The first two cartilage tracheosyringeales rings are arranged in a circle, and their edges are distinct. The remaining tracheosyringealis cartilage, on the other hand, entirely ossified fusions to form the tympanum part. The membrana tympaniformes lateralis was processed on at the dorsal and ventral portions (right and left) of the caudal (Fig.1).A "C"-shape of six pairs that made up the syrinx structure came together to form the cartilage bronchosyringeales. The cartilaginous ends of the last four "C"-shaped rings, with the exception of the first two bronchial half rings, are quite close to one another. The bronchial tube and connective tissue were closely connected (Fig. 1). Membrana tympaniformes fall between the caudo-lateral wall-convexity of the lateral tympanum and the first ring of the cartilage bronchosyringeales. The dorsal and ventral tympanic caudal process was where this membrane was joined. Additionally, the cartilage bron

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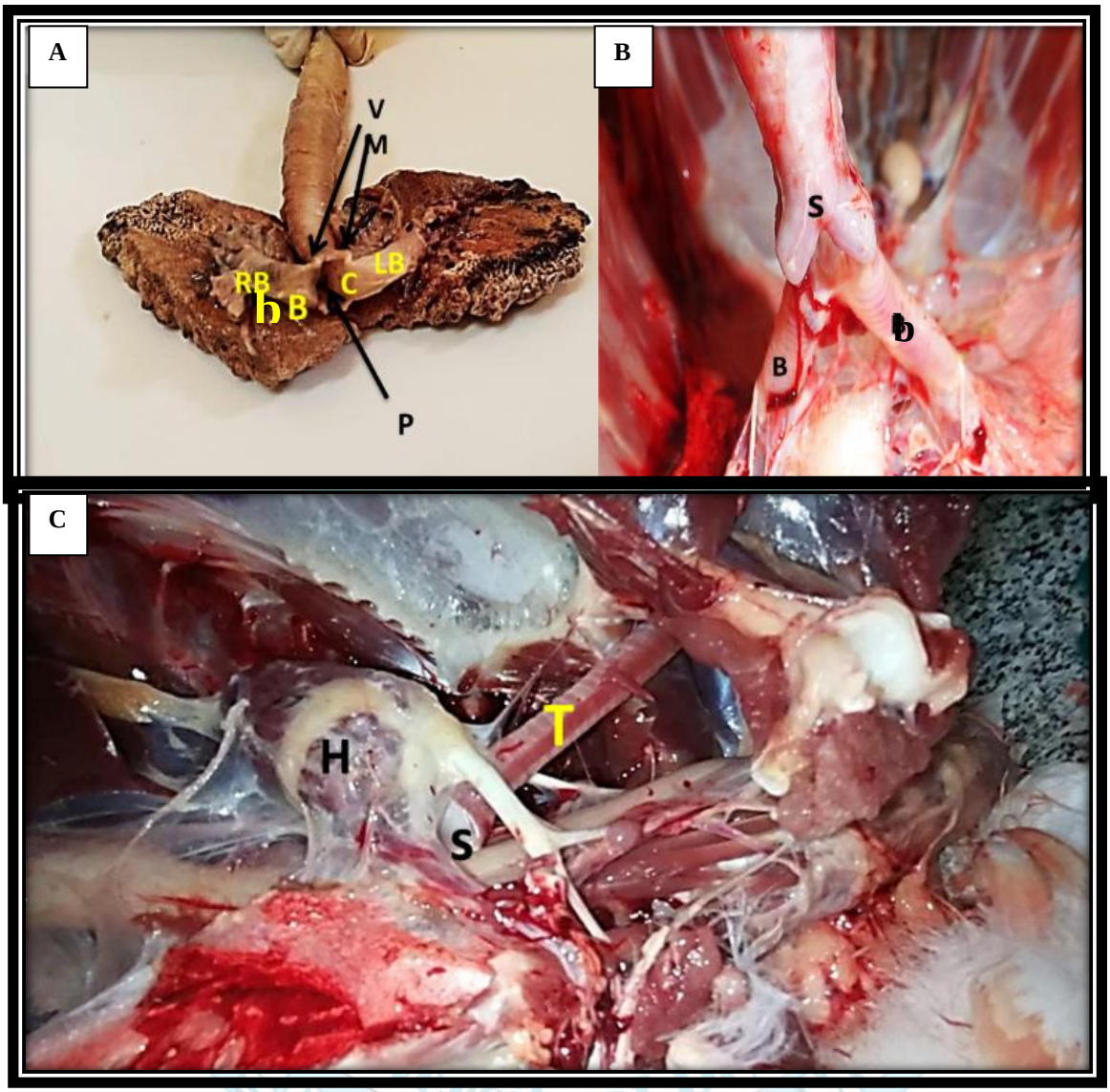

Fig. 4-5: (A): Caudal view of the syrinx of swan goose shows: right and left extrapulmanry bronchi (RB. & LB), bronchidismus (b), bronchiosyringeal cartilage(C), right and left vibrating membrane(VM), caudal surface of pessulus(p). (B): ventral view of the syrnix of swan goose shows: right and left extrapulmanry bronchi (B), syrnix(S). (C): lateral view of trachea of swan goose shows: trachea (T), heart(H), syrinx (S).

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chosyringealis (pessulus and the secondary) were tympaniformes medialis membrane-joined of the syrinx second membrane. This organ, which produced sound, was not very long. At the centric line of the caudal portion, the tympaniformes medialis membrane (both sides) firmly connect.

About 15 cartilage rings in both males and females that make up the major bronchi were seen to give fork-based branches linked to one another, just as the middle area rings of the trachea, after the cartilage bronchosyringeales. The ligament interbrochiale, which lies between these rings, was seen to be thin and membranous. The other cartilage named Pessulus, which showed as centralized bony hyaline cartilages with sharp cranial edges dividing the trachea's lumen into the main bronchi, and connecting with the tracheosyringeal cartilages craniodorsally forming the bony cartilaginous plate (dorsal), was thought to be responsible. However, the cartilaginous edges (dorsal and ventral) of the fused ends (dorsal and ventral) of the syringeal cartilages (intermediate) join caudodorsally and ventrally. The caudal side of the pessulus serves as the point of attachment of the left and right medial vibrating membranes to the apex and the triangle of voice (Fig. 1).

Membranes with vibrations, Medial vibrating membranes were depicted as a pair of delicate membranes called the caudal side of the pessulus, where the membranous connective tissue of the walls (left and right) joined at the triangular apex of voice (Fig. 1).

Lateral vibrating membranes are two pairs of connective tissue of the membrane located on the syrinx craniolateral wall and limited to the pessulus (dorsal and ventral as-

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pects), as well as the caudal aspect of the final tracheosyringeal cartilage (Fig. 1).

The medial sides of the left and right principal bronchi were joined by a large cord known as the bronchidesmus, an interbronchial ligament. The bronchidesmus served as the foundation of the vocal triangle by dividing the medial vibrating membrane from the medial membranous wall of the extrapulmonary main bronchi.

Triangle of Voice (interbronchial foramen) The left and right principal bronchi departed the obvious foramen immediately caudal to the pessulus, acquiring a triangle configuration. Its left and right medial vibrating membranes were considered its left and right walls, while the pessulus (caudal side) referred to the and the interbronchial ligament represented the base of the triangle.

Discussion

The current macroscopical examinations of the swan goose syrinx revealed a pavilion-shaped cartilaginous structure, pointed ventrally, with analogous sides; this finding is consistent with (5) in chicken but contradicts (6), who described a large dilated box on the left side of the syrinx. These findings are consistent with those of (7), who have found the syrinx in the thoracic cavity between the last tracheal ring and the primary ring of the bronchi. This finding was supported by (7) in geese (*Anser anser* domesticus), but not by (8) in Oilbirds (*Stetornis caripnsis*).

The tympanum was made up of two hyaline cartilages, the cranial and caudal tracheosyringeal cartilages. These findings agree with those of Odula (9) in bronchial types such as (Steatornise), but they contradict those of (10), who all established that the tympa-

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numewas unique to tracheobronchial and, to a lesser extent, tracheal types.

A pair of membranous medial vibrating membranes in swiftlets and oscines, such as the brown thrasher, is responsible for voice production via adduction into the lumen of bronchi and also functions as a valve to syringeal-regulate of airflow via restriction or closure of the ipsilateral side lumen of the syrinx. Other researchers have validated these results in a variety of species (11).

Consequences in birds such as the long-legged buzzard, male mallard, and scaup (Aythyamarilae) are consistent with (12), and include an apparent foramen immediately caudal to the pessulus, where the interbronchial ligament (bronchidesmus) represented the base of the triangle.

Because the syringeal muscles were absent in swan goose in present study, sound was controlled by upper vocal organ adaptations such as sternotrachealis muscle contraction and relaxation, while the intrinsic syringeal muscles (syringealis dorsalis and ventralis, and tracheobronchialis dorsalis and ventralis) in songbirds (brown thrashers and cardinalis) were responsible for sound production (13).

Swan goose have a tracheobronchial syrinx with a tympanic membrane, medial tympaniform membranous layer, interanular membranous layer, an interbronchial ligament, and semi-ring of the bronchosyringeal cartilage. Syringeal valves on the external right side of the tympanic membrane were documented in a frozen sagittal slice. The pessulus of the male swan goosewas large and had a lengthy, oval, translucent region on the underside. The medial tympaniform membrane of the left side of the cochlea formed on a nose-shaped structure on the left side of the middle section of the pessu-

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lus. More advanced ossification could be seen in the first pair of C-shaped bronchosyringeal cartilages on the left and right. The initial bronchosyringeal cartilage on the left side was also much thicker than its counterpart on the right, which agrees with (14) in stock duck.

This study clearly shows the characteristic features of the syrinx of the swan geese that could be useful buildups for future studies that deal with different sciences related to this important bird.

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