

CHARACTERISTIC FEATURES OF THE PHARYNGEAL CAVITY OF THE LAUGHING DOVE (*STREPTOPELIA SENEGALENSIS AEGYPTIACA*) AND JAPANESE QUAIL (*COTURNIX COTURNIX*)

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ABSTRACT

The purpose of this study was to investigate comparative morphology and morphometry of the pharyngeal cavity of laughing dove (LD) and Japanese quail (JQ) using seven adults of each bird. The length of the pharyngeal roof in JQ was double that of LD but that of the pharyngeal floor was nearly equal in both birds. The ratio of pharyngeal roof length to the total length of the oropharyngeal roof was 13.64% and 27.18% in LD and JQ respectively while that of the pharyngeal floor length constituted 34% in both birds. The surface of the pharyngeal roof in LD was free from papillae with few openings of the sphenopterygoid salivary glands, however, in JQ numerous openings of these glands were scattered between different sizes conical shaped pharyngeal papillae. The openings of the posterior lingual salivary glands at the root of tongue were numerous in LD but they were few in JQ. The laryngeal mound was triangular shape in LD and like heart on playing card in JQ. Behind to caudal commissure of the glottis, the caudal aspect of the laryngeal mound was characterized by V-shaped row of pyramidal-like papillae in LD. While in JQ these papillae which arranged in 3 transverse rows were conical shaped with pointed apices occupied the area extended from the caudal commissure of glottis to the pharyngo-esophageal junction. In LD abundant openings of cricoarytenoid salivary glands were arranged in a longitudinal manner on each side of the caudal third of laryngeal mound but few numbers of them were observed in JQ.

Key words: SEM; pharynx; glottis; laughing dove; Japanese quail.

INTRODUCTION

LD is widely distributed in scrub, becoming very domesticated in Africa, the Middle East and the Indian Subcontinent (Ticehurst, 1923, Ali and Ripley, 1981). JQ is mainly distributed in East Asia and Russia (Barilani *et al.*, 2005, Puigcerver *et al.*, 2007, Pappas, 2013). In bird, oropharynx denotes the combined cavity that extends from the beak to the esophagus due to absence of soft palate (Dyce *et al.*, 2009). The pharyngeal cavity delimited from the oral cavity at point between the choanal and infundibular slits (King and McLelland, 1984). In birds, tongue participates with the jaw and pharynx in generating carefully coordinated movement during various behaviours such as feeding and drinking (Homberger and Meyers, 1989). Birds have different structures of

their oropharyngeal cavity due to differences in feeding habits, so the characteristic features of the avian oropharyngeal cavity are essential to identify the structural variations that may influence nutrition, food intake, and ingestion (Jayachitra *et al.*, 2015). The objective of this study is to attribute the pharyngeal cavity of the laughing dove and Japanese quail of different habits and the findings of this study might be added new data to the avian anatomy literature.

MATERIALS AND METHODS

Seven adult healthy birds of each laughing doves (LD) (94.26 ± 8.02 gm) were collected from bird hunters in Qena governorate, Egypt and of Japanese quails (JQ) (235.67 ± 2.5 gm) collected from researcher's farm in South Valley University, Qena governorate, Egypt. The heads of the carcasses were dissected after sacrificed and good bleeding. For gross studies, 5 heads of each bird were used, the angles of the beaks were incised, and the pharyngeal roof and floor were dissected then fixed in 10%

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neutral buffered formalin. The various gross morphological features for each bird were examined in details and the different measurements in millimeters (mean \pm S.E.) of the studied parts of pharyngeal roof and floor, were taken out using Precision Digital Vernier Caliper. All measurements were statistically analyzed by the Statistical Package for Social Science (SPSS) software program, version 17.0 (Argyrous, 2005). For SEM studies, two heads of each bird were used. Representative specimens from pharyngeal roof and floor were washed several times with normal saline and then fixed in a mixture of 2.5% paraformaldehyde and 5% glutaraldehyde in 0.1 M sodium phosphate buffer, pH 7.3, at 4 °C for 24 h. Thereafter, they were washed 4 times for 5 min in the fixation buffer and postfixed in 1% osmic acid in 0.1 M sodium phosphate buffer for further 2 h at room temperature, followed by washing with 0.1 M sodium phosphate buffer for 15 min 4 times. The samples were dehydrated using increasing concentrations of alcohol: 50, 70, and 90% for 30 min at each concentration and 100% for 2 days (several changes) followed by isoamyl acetate for 2 days. The dehydrated samples were subjected to critical point drying with a Polaron apparatus. Finally, they were coated with gold using JEOL-1100 E ion sputtering device and examined with a JEOL scanning electron microscope (JSM 5500 LV) at 10 kV.

RESULTS

Pharyngeal roof

The roof of the pharynx extended from the line of demarcation between choanal and infundibular slits to pharyngoesophageal junction. The length of the pharyngeal roof was shorter in LD than in JQ. It measured 3.39mm, 7.52mm and constituted 13.64%, 27.18% of the total length of the oropharyngeal roof in LD and JQ respectively. The surface of the pharyngeal roof in LD appeared smooth free from papillae but in JQ it was characterized by fine small caudally directed papillae. The terminal part of the pharyngeal roof of LD was elevated as transverse mucosal fold at the junction with esophagus but this junction demarcated by a fine transverse row of papillae in JQ. The pharyngeal roof occupied by infundibular slit which measured 2.53mm, 3.83mm and constituted from the pharyngeal roof length 74.63%, 50.93% in LD and JQ respectively (Fig.1A, B).

By SEM, in LD, the surface of the pharyngeal roof on each side of the infundibular slit was smooth free from papillae and showed few openings of the sphenopterygoid salivary glands increased in number caudally till the pharyngoesophageal junction. This junction was demarcated by transverse serrated appearance mucosal fold. The infundibular slit was represented by an elongated opening; its edges were

smooth free from papillae (Fig. 2A, C). The surface of the pharyngeal roof of JQ was characterized by different sizes conical shaped papillae with pointed apices, these papillae more concentrated near the infundibular slit which increased in size caudally toward the pharyngoesophageal junction. This junction was demarcated by well-marked transverse row papillae which consisted of large wedge-shaped papillae. Numerous openings of sphenopterygoid salivary glands were scattered between these papillae. The infundibular slit was wider an elongated opening, its edges included caudally directed papillae. This slit continued caudally by a shallow groove which considered the continuation of the caudal commissure of the slit (Fig. 2B, D).

Pharyngeal floor

The floor of the pharynx extended from the row of the caudally directed lingual papillae to pharyngoesophageal junction. The length of the pharyngeal floor measured 8.13mm in LD and 9.41mm in JQ, constituted in both birds about 34% of the total length of the oropharyngeal floor. The floor of the pharynx consisted of root of tongue and laryngeal mound. The root of tongue demarcated from body by one row of caudally directed papillae. It measured 2.14mm, 3.01 mm and constituted 26.32%, and 31.98% of the pharyngeal floor length in LD and JQ respectively. The laryngeal mound was triangular shape in LD and like heart on playing card in JQ. It measured 5.99mm, 6.40mm and constituted 73.67%, 68.01% of pharyngeal floor length in LD and JQ respectively. The laryngeal mound contained laryngeal inlet (glottis) which lied opposite to wide part of choanal slit and lead into the cavity of the larynx. This slit was wedge shaped and measured 2.89mm length in LD; its rostral commissure wider than caudal one. While in JQ, the slit measured 3.55 mm length, its edges were marked by mucosal lips which were slightly elevated above the surface of the laryngeal mound and its caudal commissure continued caudally by short narrow sulcus. The terminal part of the pharyngeal floor of LD was demarcated from esophagus by one row of caudally directed papillae arranged in V-shaped row while in JQ demarcated by 2rows of papillae (Fig. 1C, D).

By SEM, V-shaped row processes-like papillae between body and root of tongue in LD increased in size lateralwards while in JQ these papillae were cactus leaf-like and also increased in size lateralwards. Openings of the posterior lingual salivary glands were demonstrated at the middle part of lingual root which increased caudally toward rostral commissure of glottis. These openings were numerous in LD, but they were fewer in JQ (Fig. 3A, B). The glottis of the laryngeal mound was widest at the middle in LD while in JQ had the same width along its length. Besides the rims of glottis of JQ

conical caudally directed papillae were observed which increased in number caudally (Fig. 4A, B). By higher magnification, various sizes of openings of intraepithelial glands with ciliated cells were demonstrated near rims of glottis in LD but these openings were away from rims of glottis by short distance in JQ (Fig. 4C, D). Behind the caudal commissure of the glottis of LD, the caudal part of laryngeal mound was characterized by V-shaped row pyramidal-like papillae decreased in size medialwards which demarcated from pharyngoesophageal junction. These papillae were arranged in 3 transverse

rows in JQ, they were conical shaped with pointed apices occupied the area extended from the caudal commissure to the pharyngoesophageal junction; the papillae of the most rostral row were generally larger in size and numerous while those of the second row were smallest and fewer in number than the other rows. Abundant openings of caudal cricoarytenoid salivary glands were arranged in a longitudinal manner on each side of the caudal third of laryngeal mound in LD but they were few numbers in JQ (Fig. 5A, B).

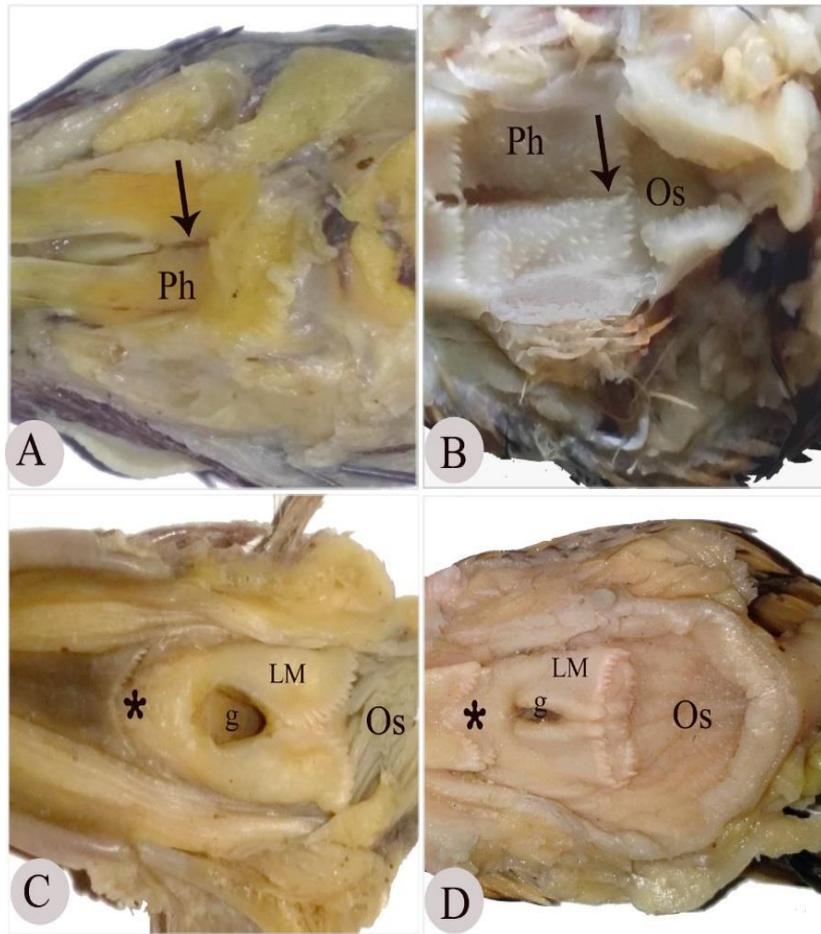


Fig.1: Photograph of the pharyngeal cavity of laughing dove (A&C) and of Japanese quail (B&D) showing pharyngeal roof (Ph), infundibular slit (arrow), esophagus (OS), root of tongue (star), laryngeal mound (LM), glottis (g).

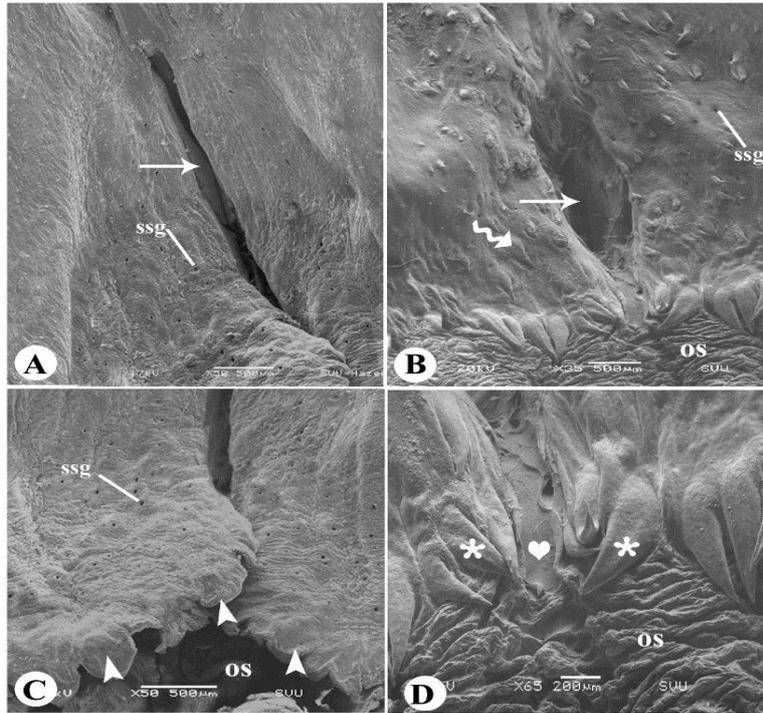


Fig.2: Scanning electron micrograph of the pharyngeal roof of laughing dove (A, C) and of Japanese quail (B, D) showing esophagus (os), infundibular slit (arrow), openings of sphenopterygoid glands (ssg), conical shaped papillae (twisted arrow), shallow groove (heart-shape) at the caudal commissure of the infundibular slit, transverse serrated appearance mucosal fold (arrowheads) and transverse row conical-shaped papillae (stars) at pharyngoesophageal junction.

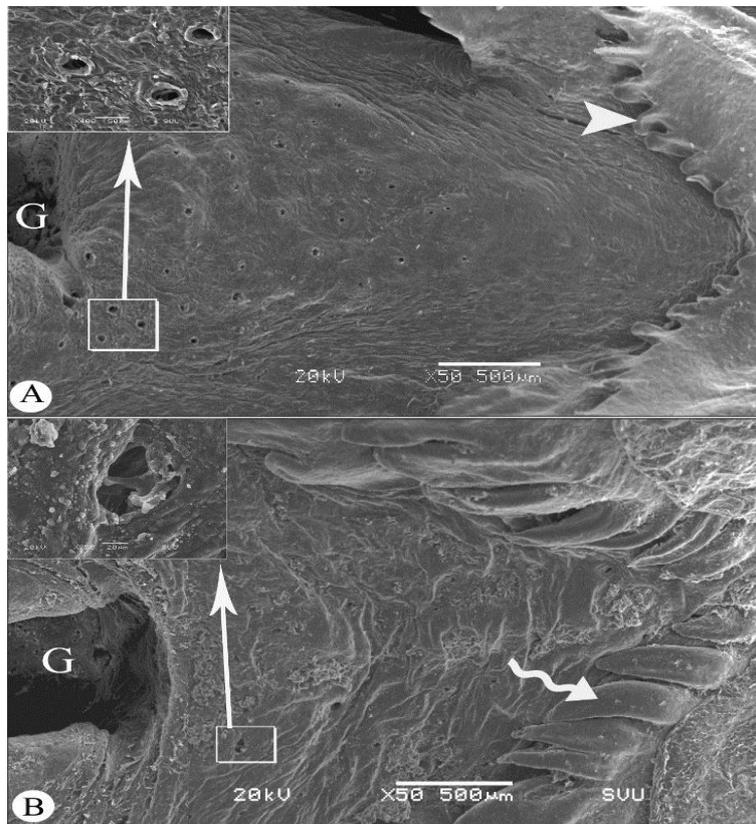


Fig.3: Scanning electron micrograph of the root of the tongue of laughing dove (A) and of Japanese quail (B) showing openings of posterior lingual salivary glands (square), V- shaped row processes like papillae (arrowhead), cactus leaf-like papillae (spiral arrow) between body and root of tongue, glottis (G).

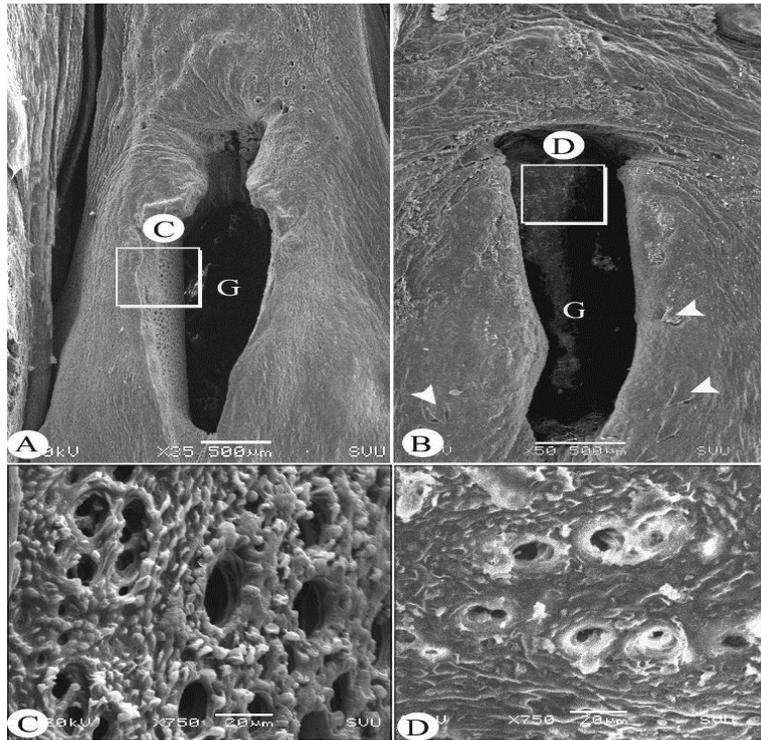


Fig.4: Scanning electron micrograph of the laryngeal mound of laughing dove (A&C) and of Japanese quail (B&D) showing glottis (G), conical caudally directed papillae (arrowheads) beside the rims of glottis, various sizes openings of intraepithelial glands within glottis (square), (C&D) higher magnification of openings of intraepithelial glands within glottis.

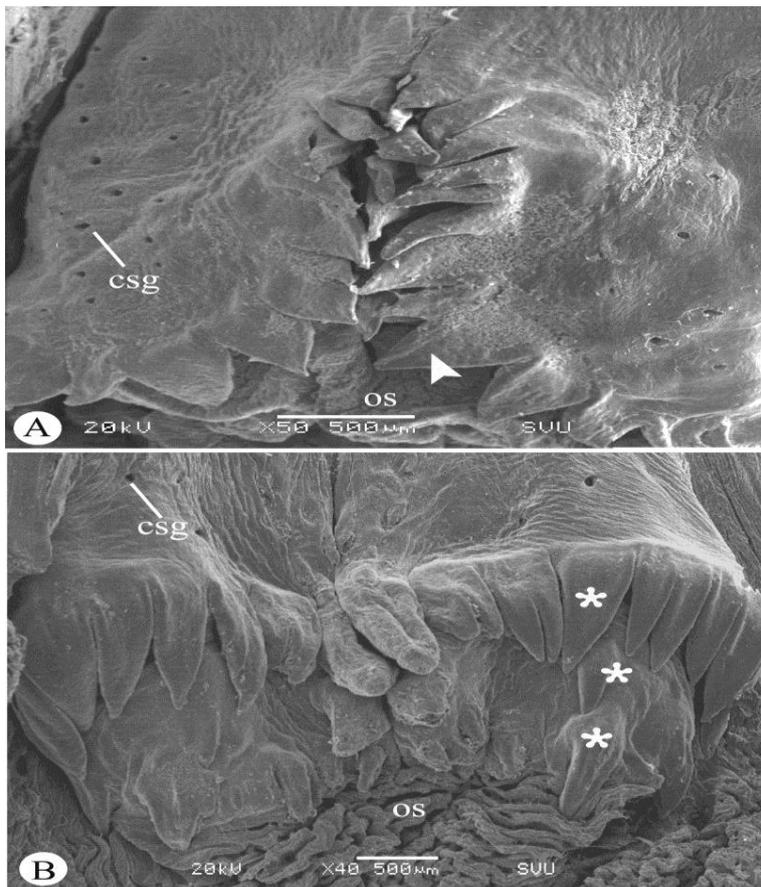


Fig.5: Scanning electron micrograph of the caudal third of the laryngeal mound of laughing dove (A) and of Japanese quail (B) showing openings of posterior cricoarytenoid salivary glands (csg), V-shaped row pyramidal-like papillae decreased in size medialwards (arrowhead), 3 transverse rows conical shaped papillae (stars) demarcated from esophagus (os).

DISCUSSION

In this investigation, the surface of the pharyngeal roof of LD was free from papillae while that of JQ was characterized by fine small variable papillae. The findings of LD agreed with that obtained by Abumandour (2014) in falcon and Moussa and Hassan (2013) in cattle egret. In the same line with Madkour (2011) in ducks and Sayed *et al.* (2016) in turkey, the present scanning electron microscopical results in JQ showed numerous openings of sphenopterygoid salivary glands scattered between numerous different sized conical shaped caudally directed pharyngeal papillae. Moreover, this result added in LD that few openings of the sphenopterygoid salivary glands were observed on the pharyngeal roof. The secretion of the salivary glands in LD and JQ is thought to aid swallowing of dry foods as reported in Nutcracker (Jackowiak *et al.*, 2010). From the current morphometrical study, it was revealed that the ratio of the length of the pharyngeal roof to that of the oropharyngeal roof was 13.64% in LD and 27.18% in JQ. Nearly like our findings in LD mentioned in turkey (Sayed *et al.*, 2016). In 60 days old duck, the length of the pharyngeal roof was 15.19% of the oropharyngeal roof length (Madkour, 2011). On other hand, the length of the pharyngeal floor to that of the oropharyngeal floor was recorded about 34% in studied birds.

The infundibular slit measured 2.53mm in LD and 3.83mm long in JQ. In fowl, it was 0.61 ± 0.02 cm long (Gupta *et al.*, 2015), 8.04mm in duck (Madkour, 2011), 4.65mm in southern lapwing (*Vanellus chilensis*) (Erdoğan and Pérez, 2015) and 1.97 cm in ostrich (Tivane, 2008). Moreover, in falcon the infundibular cleft is very narrow, small, shorter, reach 8ml in long (Abumandour, 2014). When viewed with SEM, the edges of the infundibular slit in LD were free from papillae while caudally directed papillae were recognized in JQ. In turkey, a short transverse row of papillae located on both sides of the infundibular slit (Sayed *et al.*, 2016). The latter authors added that there was a shallow groove occupied by longitudinal mucosal folds separating the choanal cleft from the infundibular cleft while in raven there was a transversal fold between two slits (Erdogan and Alan, 2012). On other hand, Sayed *et al.* (2016) in turkey and Madkour (2011) in duck recorded that the infundibular slit continued caudally with a shallow groove like findings of JQ. Functionally, the infundibular opening and glottis are reflexly closed to prevent food from entering the infundibular and laryngeal cavities (McLelland, 1975, King and McLelland, 1984).

By SEM, in examined birds the root of the tongue demarcated from the body by V-shaped row of papillae increased in size lateralwards. However, this row of papillae is absent in the cattle egret except one

lateral long papilla on both sides of the base of the tongue (Moussa and Hassan, 2013). In ostrich, the root of the tongue was demarcated from body by presence of the flat fold with lateral processes sliding over lingual root (Jackowiak and Ludwig, 2008). Moussa and Hassan (2013) clarified that the direction of the food toward esophagus and prevent its regurgitation performed by help of this row. In the examined birds, the length of the glottis which was very short in comparison with other birds as reported in the obtained literature. It was 2.89mm in LD and 3.55 mm in JQ. It was 12.91mm in geese (Mohamed *et al.*, 2018), 13.6 mm in turkey (Saleh, 2013). But the ostrich had very long glottis measuring 33.3 mm (Tadjalli *et al.*, 2008).

The present work showed that the pharyngoesophageal junction at the pharyngeal roof in LD was demarcated by transverse serrated appearance mucosal fold. Like the description of Ali and Ripley (1981) in ostrich while in JQ it was obvious from the present findings that this junction demarcated by well-marked transverse row papillae which consisted of large wedge-shaped papillae similar to that mentioned in other birds (Hassouna, 2002, Jayachitra *et al.*, 2015). In duck, the papillae at the pharyngoesophageal junction have the appearance of nails of the carnivores (Madkour, 2011). Moreover, in turkey, the papillae of this junction were caudally directed and elongated conical shaped, the lateral located papillae were smaller than the medial ones (Sayed *et al.*, 2016). On other hand, Tadjalli *et al.* (2008) in ostrich illustrated that lack of a transverse row of papillae at the junction with the esophagus. Furthermore, the current study showed that the caudal part of laryngeal mound occupied by V-shaped row pyramidal-like papillae in LD and 3 transverse rows of conical shaped papillae with pointed apices. In this connection, in geese, numerous closely packed caudally directed and different sized pharyngeal papillae occupied the area behind to the laryngeal inlet (Mohamed *et al.*, 2018). However, in red jungle fowl, a single row of pharyngeal papillae was observed behind glottis (Kadhim *et al.*, 2011). The caudally directed papillae on the laryngeal eminence and the pharyngeal roof simplify the direction of the bolus towards the esophagus (McLelland, 1975, King and McLelland, 1984). Thus the distribution and number of the pharyngeal papillae of JQ was more than that of LD due to behavior of JQ in eating which is ground bird and eat rapacity.

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الصفات المميزة للتجويف البلعومي في اليمام الضاحك والسمان الياباني

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الغرض من هذه الدراسة هو دراسة التوصيف الظاهري والقياسات الشكلية للتجويف البلعومي في اليمام الضاحك والسمان الياباني باستخدام سبعة طيور بالغين من الطائرين من كلا الجنسين. كان طول سقف البلعوم في السمان الياباني ضعف طول اليمام الضاحك ولكن بالنسبة لطول قاع البلعوم في الطائرين متساوين تقريبا. بلغت نسبة طول سقف البلعوم الى الطول الكلي للبلعوم ١٣,٦٤٪ في اليمام الضاحك و ٢٧,١٨٪ في السمان الياباني بينما نسبة قاع البلعوم بلغت ٣٤٪ في كلا الطائرين. سطح سقف البلعوم في اليمام الضاحك خاليا من اي حلقات مع وجود عدد قليل من فتحات الغدد اللعابية الوترية الجناحية. بينما في السمان الياباني تنتشر العديد من فتحات هذه الغدد بين الحلقات مخروطية الشكل ذات الاحجام المختلفه. فتحات الغدد اللسانية اللعابية الخلفية الموجوده في جذر اللسان عديدة وكثيرة في اليمام الضاحك بينما اقل في السمان الياباني. التله الحنجريه مثلث الشكل في اليمام الضاحك وتشبه القلب على بياضه اللعاب في السمان الياباني. يتميز الجزء الخلفي للتله الحنجريه خلف الاتصال الخلفي للفتحة الحنجريه في اليمام الضاحك بصف على هيئة حرف (V) يتكون من حلقات هرميه الشكل. بينما في السمان الياباني هذه الحلقات مرتبه في ٣ صفوف عرضيه مخروطيه الشكل مع قمم مدبيه شغلت المنطقه الممتدة من الاتصال الخلفي للفتحة الحنجريه الى الاتصال البلعومي المرئي. في اليمام الضاحك يوجد عدد وفير من فتحات الغدد اللعابية الحلقية الطرجهاليه مرتبه بطريقه طوليه على كل جانب من التلت الاخير من التله الحنجريه بينما في السمان الياباني لوحظ عدد قليل من فتحات هذه الغدد.