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Dept. of Anatomy &Histology
Faculty of Vet Med, Assiut University

# MORPHOLOGICAL STUDIES ON THE PHARYNGEAL CAVITY OF DUCK (ANAS BOUSHIUS DOMESTICUS)

(With 18 Figures)

By
*EMAN M.A. HASSOUNA*

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# دراسات مورفولوجية على تجويف البلعوم فى البط

*أيمان محمود حسونه*

أجرى هذا البحث على البلعوم فى خمسة عشرة من البط السليم الناضج. وقد تـم الأسـتعانة بالماسح الألكترونى وكذلك الميكرسكوب الضوئىلتوضيح التفاصيل المورفولوجية التـى تـم وصفها بالعين المجردة.وأظهرت الدراسة أن البلعوم فى البط عبارة عـن أنبوبـة عضليـة غشائية مبطنة.ويحتوى تجويفها على أربعة فتحات الشق القمعى ؛والشق القمعى الأنفىعلـى السقف وفتحة المرى ؛والحنجرة على الأرضية .وبطانة تجويف البلعوم عبارة عـن ظـهارة جلدية ولكن عند مستوى الشق القمعى فهى عبارة عن ظهارة تنفسـية.هنـاك نوعـان مـن الحلمات الميكانيكية تظهر على سطح بطانة البلعوم بطريقة منتظمة فى صفوف أو مبعـثرة . وهذة الحلمات تكون قصيرة سميكة ذو حافة مبطنة علىالأرضية أو طويلة رفيعة ذو حافـة حادة على السقف. وقد شوهد العديد من الغدد اللعابية المخاطية وتتمثل فـى الغـدد اللعابيـة الوتدية الجناحية والحنكية الخلفية على السقف ؛والغدد اللعابية الحلقية الطرجهارية واللسـانية الخلفية علىالأرضية؛ والغدد اللعابية البلعومية الجدارية والتى لم يتم رصدها من قبل. وقـد لوحظ أن الغشاء المبطن للبلعوم يزداد فى السمك ليشكل ثنايات وطيات مستديمة عند حافـة الشق القمعى الأنفى وفتحة الحنجرة وحول الحدود الظهرية للحنجرة الأمامية وهناك طيـات أخرى غيرمستديمة منتشرة على سطح تجويف البلعوم. وقد شوهد تجمع ليمفى كبير متمركزا حول الشق القمعى وقنوات الغدد اللعابية وعند الملتقىالأمامى لفتحة الحنجرة. ولم يتم فى هذة الدراسة رصد براعم تذوق فى أى مكان من البلعوم .

## SUMMARY

The pharynx of duck appeared as a musculo-membranous tube flattened dorso-ventrally. The pharyngeal cavity contained four openings, the choanal slit and the infundibular cleft on the roof, while the oesophageal opening and the laryngeal one on the floor. It was lined by cutaneous

mucous membrane except at the infundibular cleft where, it was respiratory type. There were two forms of mechanical papillae projected from the pharyngeal mucosa; short, thick with blunt apex on the pharyngeal floor and long, thin, with pointed apex on the pharyngeal roof. These mechanical papillae distributed either regularly in rows or scattered on the mucosal surface. Numerous mucous salivary glands were observed as the caudal palatine and sphenopterygoid on the roof; caudal lingual and cricoarytenoid on the floor and the pharyngeal salivary glands on the wall. The mucous membrane was thickened and formed of permanent mucosal folds at the edges of the choanal slit, laryngeal cleft and around the laryngeal mound. Temporal mucosal folds were observed elsewhere. Abundant lymphoid tissue either diffused or in the form of follicles were observed in the pharyngeal mucosa especially around the ducts of the salivary glands; much aggregation at the infundibular cleft and lymphoid infiltration at the rostral commissure of the laryngeal cleft. There was no taste buds could be demonstrated in the pharyngeal mucosa.

## INTRODUCTION

As birds were devoid of soft palate, glossopalatine arch and epiglottis; the anatomical feature of the avian pharyngeal cavity was completely different from that of mammals. McLeod (1939) and Hamliton (1952) in fowl; Nickel, Schummer and Seiferle (1977) in domestic birds; Dyce, Sack and Wensing (1987) in chicken considered that the oropharynx was a combined cavity extending from the beak to the oesophageal opening and they described the pharynx as part of this cavity. Moreover, information on the morphology of the pharynx of birds was meager. Therefore the present study was performed on the pharyngeal cavity of duck, as an example of birds, which feed on intermediate type of food and examined either grossly or by using light and scanning electron microscopes.

***Key words:*** *Morphological studies / Pharyngeal cavity / Duck.*

## MATERIAL and METHODS

The present work was carried out on fifteen adult apparently healthy ducks (Anas Boushius domesticus) of both sexes. The birds were divided into three groups; five for gross study, four for scanning electron microscope and six for light microscope.

The oropharynx of the first group were fixed in 10% formalin, examined and photographed by using surgical microscope.

For scanning electron microscope; birds were anaesthetized with chloroform inhalation, perfused transcardially with warm physiological saline and then with cold fixative (1% paraformaldehyde and 1.5% glutaraldehyde in 0.1M phosphate buffer, PH 7.2). The samples were cut into small pieces and immersed in the same fixative for 2h at 4C°. After washing in the same buffer the samples were postfixed in 0.1M Osmium tetraoxide in the same buffer for 2h then, the specimens were dehydrated in graded series of ethanol followed by critical-point drying carbon dioxide. After that; the specimens were sputter-coated with gold before being examined under a JEOL-5400 LV scanning electron microscope.

For light microscopical study the pharyngeal cavity was opened and fixed in Bouin's solution for 24h. 5Um thickness cross, sagittal and frontal paraffin sections were cut and stained with hematoxline and eosin.

## RESULTS

The pharyngeal cavity of duck was that part of the oropharynx which extended rostrally from the level of the rostral end of the choanal slit on the roof (Fig.1) and the transverse row of the caudal lingual papillae on the root of the tongue (Fig.2) until the pharyngeo-oesophageal junction caudally. It has four openings the choanal slit, infundibular cleft on the roof (Fig.1), laryngeal cleft and the oesophageal opening on the floor (Fig. 2). The wide caudal part of the choanal slit was observed at the same level of the laryngeal cleft (Fig.1). The total length of the pharyngeal cavity was about 7cm. The choanal slit constituted about 51.4% of the total pharyngeal length. The rostral part of the choanal slit was narrow, short and formed about 36.1% of the total choanal length. While the caudal part was wide and double in length (64%) as compared with that of the narrow part. The laryngeal cleft measured about 2.3cm and formed about 32.9% of the total pharyngeal length.

**I- The roof of the pharynx (Fig. 1):**

At the junction of the narrow and wide parts of the choanal slit; a transverse row of thin, pointed, caudally directed papillae were observed. On the edges of the choanal slit especially that of the wide caudal part, 1-2 rows of longitudinally arranged papillae directed caudally were found. At the rostral narrow part these papillae were few

and short while those at the wide caudal part were longer, numerous and exhibited pointed edges. Similar rows of papillae arranged in a longitudinal manner were also observed on the wall. Caudal to the choanal slit and around the infundibular cleft numerous smalls, fine caudally directed papillae with pointed end were observed. These papillae were increased in number and length towards the oesophageal opening where they formed a well-marked transverse row that demarcating the pharyngeo-oesophageal junction.

With scanning electron microscope; the surface epithelial cells at the infundibular cleft appeared covered with microvilli of variable length and density (Figs.3, 3`). In paraffin sections, the pharyngeal cavity was lined by stratified squamoue epithelium (cutaneous mucous membrane) except at the infundibular cleft, which was lined by respiratory epithelium (Fig.3``). At the pharyngeal wall and around the choanal slit the papillae were characterized by their long, and caudally directed pointed apices (Fig.4). These papillae formed an elevated root encircled with concentric layers of mucosal folds. On either side of the infundibular cleft these papillae appeared shorter, thicker and caudally directed with pointed ends. Each two or three papillae originated by single root, which viewed as inverted molar cheek tooth (Fig.5). Secretory droplets covered their surfaces. In paraffin sections these papillae appeared as elongated cone with caudally directed pointed ends covered by thick layer of keratin (Figs. 5`, 5``).

On the roof and lateral walls of the pharyngeal cavity particularly on both sides of the wide caudal part of the choanal slit and around the infundibular cleft many raised circular white areas of mucous membrane with small opening at its apical part were observed (Fig.1). With scanning electron microscope they appeared as fine, clear orifice of ducts of the caudal palatine and sphenopterygoid salivary glands (Fig.6). These openings were filled with secretory droplets and desquamated epithelial cells. With light microscope (Figs. 5`, 7), these glands were mucous in nature of compound tubular in type. Abundant lymphoid tissue either diffused or in follicles were observed in the connective tissue of the salivary glands especially around their ducts (Fig.7), palatine mucosa (Fig. 8); in addition much lymphoid aggregations were observed in the infundibular mucosa (Fig. 8`).

The mucous membrane at the edges of the choanal slit particularly at the wide caudal part was thickened forming permanent mucosal folds (Fig.1). With scanning electron microscope; these mucosal folds appeared as fingers like processes with different thickness

runs in a longitudinal wavy manners (Fig.9). On the roof and lateral walls of the pharyngeal cavity, temporary mucosal folds were also observed (Fig.1). With scanning electron microscope the mucosal surface of these parts showed several minute projections (Figs.10, 10`), which appeared as scale like protrusions directed caudally and covered the undulating mucosal surface.

**II-The floor of the pharynx:** (Fig. 2)

1-2 transverse rows of caudally directed lingual papillae were observed at the base of the tongue on either sides of the midline; 2-3 longitudinal rows of short, thick, caudally directed pharyngeal papillae were found rostral to the laryngeal mound. Few number of very short thin, caudolaterally directed papillae, the laryngeal papillae were observed at the edges of the laryngeal cleft especially at the caudal commissure. 5-7 transverse rows of thin, medium sized caudally directed laryngeal papillae lay paramedian to the midline at the caudal part of the laryngeal mound. At the midline; these laryngeal papillae lost their arrangement where they became condensed, thinner and longer. The last row of these papillae with a fold of mucous membrane at the same level demarcated the pharyngeo-oesophageal junction.

The mucosal papillae of the pharyngeal floor appeared cone shaped, short and thick, with blunt ends (Figs.11, 11`). At the level of the laryngeal mound these mucosal papillae appeared rose-shaped with openings of salivary ducts at its apices (Fig.12).

In paraffin sections (Fig.13) the lamina propria projected to form the core of the papillae, which covered with stratified squamous epithelium highly cornified.

On both sides of the laryngeal mound and rostral to it, low circular white mucosal projections were detected and exhibited small pores at their apices (Fig. 2). The scanning electron microscope showed that; these pores contained secretory droplets and desquamated epithelium (Fig.14). In paraffin sections, these pores were the openings of mucous secreting glands, the caudal lingual and cricoarytenoid salivary glands (Fig15). Similar pores were observed on the wall of the pharynx, these pores belonged to the salivary glands of the wall of the pharynx (pharyngeal salivary glands)(Fig. 1).

The mucous membrane on the floor of the pharynx formed temporal folds but gets thickened to form well distinct permanent ones around the laryngeal mound and guarding the laryngeal cleft (Fig.2). These mucosal folds by scanning electron microscope; appeared to be

arranged parallel in transverse and longitudinal directions (Fig. 16). The surface epithelium of these folds showed variable degree of desquamation.

At the rostral commissure of the laryngeal cleft the mucosal folds were lined by respiratory epithelium; contained numerous mucous secreting glands and lymphoid infiltration (Figs. 17, 17`, 17``). Those at the caudal commissure formed many mucosal folds lined by cutaneous mucous membrane (Fig. 18). In the present study, no taste buds could be observed on the pharyngeal mucosa.

## DISCUSSION

In domestic birds McClelland (1975) mentioned that the point of connection between the oral cavity with the pharynx was difficult to define. He also reported that, the pharynx was that part caudal to the oral cavity and extending from both the caudal lingual papillae and the rostral limit of the choanal slit until the pharyngeo-oesophageal junction. This was in consistence with that mentioned by McLeod (1939) and Hamliton (1952) in fowl; Dyce *et al.* (1987) in chicken. Embryologically, however Hodges (1974) stated that the junction between the buccal and pharyngeal cavities in fowl was actually more posterior where it reaches the opening of the glottis. King and McClelland (1984), from embryological ground, suggested that the homologous boundary between the oral and pharyngeal cavities lay between the choanal slit and the infundibular cleft. Other embryological investigations recorded that in birds the region analogous to the boundary between the mouth and pharyngeal cavities of mammals was where the infundibular cleft began (by Nickel *et al.*, 1977). Functionally, Nickel *et al.* (1977) stated that the boundary between the oral and pharyngeal cavities lay at the junction of the narrow and wide parts of the choanal slit. This was because the rostral narrow part did not participate in process of respiration and the wide part was the only part that remained opened during respiration.

The present study was in consistance with that stated by the previously mentioned authors that the choanal slit formed only half of the total length of the pharyngeal cavity. McClelland (1975, 1979). in ducks, herons and ratites stated that the choanal slit was usually short and restricted to the caudal part of the palate and the wide caudal part was longer than the rostral narrow one. Nickel *et al.* (1977) in domestic

birds concluded that the size of the slit depended on the size and shape of the beak.

Squier and Kremer (2001) mentioned that the mucosal lining of the oral cavity and esophagus was stratified squamous epithelium (masticatory mucosa), functioned to protect the underlying tissue from mechanical damage and from entery of microorganisms and toxic materials that may be presented in the oral cavity and the oropharynx. Dyce *et al.* (1987), King and McClelland (1984), Nickel *et al.* (1977), McClelland (1975) and Hodges (1974) added that in areas subjected to considerable wear, such as the tip and under surface of the tongue and the various buccal papillae the epithelium became cornified. Similar finding was observed in the present study. The present work added that at the infundibular cleft the lining epithelium was stratified ciliated columnar (respiratory epithelium). The present investigation observed microvilli with variable length and density only on the epithelial surface of the infundibular cleft. Similar to that was mentioned by Nickel *et al.* (1977) who stated that the orbital fossa and the tubo-pharynx were lined by stratified ciliated columnar epithelium. The present study suggested that these microvilli might be correlated to the lymphoid tissue of that area; where it stimulated with the absorptive function of these microvilli. Belz and Heath (1996) concluded that the lymphoepithelium which covered the tonsilar lymphoid tissue have a variable surface morphology; some were covered by relatively regular and well-formed microvilli. In addition Belz and Heath (1995) observed that the epithelium of the palatine tonsil in dogs indicated the apical membranes of M cells that form folds from which microvilli extended into the lumen of the oropharynx. Similar results were observed in the present study at the rostral commissure of the laryngeal cleft.

The present investigation described projections from the lamina propria resulted in an elevation of the mucosal surface forming the mucosal papillae; this result was in accordance with that mentioned by Hodges (1974); McClelland (1975); Nickel *et al.* (1977); King and McClelland (1984), as well as Dyce *et al.* (1987). Our result revealed that; the shape and distribution of these mechanical papillae were in consistence with that referred by all previously mentioned authors. Nickel *et al.* (1977) mentioned that the hard palate of the duck has median and 2-3 paramedian rows of blunt cornified papillae. On the other hand, Gardner (1926, 1927) stated that the papillae of transverse row at the base of the tongue were long, pointed, strong, cornified and caudally directed. He concluded that; this adaptive feature may help to

propel the food caudally to the esophagus and prevented its regurgitation. The present observation suggested that, the papillae around the laryngeal cleft and choanal slit acted as guard to the respiratory passage.

The present study observed numerous salivary glands in the submucosa of the pharyngeal cavity. King and McClelland (1984) in birds mentioned that, the salivary glands were totally absent in some species of Great cormorant. The previously mentioned authors and Sturkie (1976) mentioned that in avian species that ingest slippery aquatic food, they have poorly developed glands, while those eating dry food have well-developed ones. Hodges (1974) stated that the salivary glands were mucous in nature of compound tubular type and he added that, no serous cells were found in these glands. Similar findings were recorded in the present study. McClelland (1975) in domestic birds mentioned; that the caudal laryngeal salivary glands were tubulo-alveolar while the lateral laryngeal were simple tubular in type. Sturkie (1976) mentioned that these glands were usually tubular glands. On the other hand Nalavade and Varute (1977) in different species of birds mentioned that the posterior lingual salivary glands were seromucous in nature. The present investigation revealed that the caudal palatine and the sphenopterygoid salivary glands represented the mucous secreting glands of the pharyngeal roof as that mentioned by King and McClelland (1984) and Hodges (1974). The latter author termed the sphenopterygoid salivary glands as the pharyngeal salivary glands. On the other hand, McClelland (1975) described only the sphenopterygoid salivary glands, while Nickel *et al.* (1977) described medial palatine, pterygoid and the tubariae salivary glands. Samar, Avila, De Fabro, Porfrio, Esteba, Pedrosa and Peinado (1999) described only the palatine salivary glands.

The result of the present study was in accordance with that mentioned by King and McClelland (1984) and Hodges (1974) that the mucous secreting glands of the floor of the pharynx were represented by the caudal lingual and the cricoarytenoid salivary glands. McClelland (1975) in domestic birds described only the cricoarytenoid salivary glands and termed them the lateral and medial laryngeal salivary glands. Nickel *et al.* (1977) described only the caudal lingual and termed them the laryngeal salivary glands as they extend to the larynx and the entrance of the esophagus. Liman, Bayram and Kocak (2001) described lingual, preglottal and the laryngeal salivary glands in the pharyngeal floor of the quail. They classified the lingual salivary glands into medial and lateral, the preglottal salivary glands into two lateral and one medial;

the medial one extended to the row of the laryngeal papillae on each side of the glottis and known as the laryngeal salivary glands. Samar *et al.* (1999) described that there were a lingual and the glands of the bottom of the mouth cavity. Bradley and Grahame (1960); McClelland (1975); Nickel *et al.* (1977), King and McClelland (1984), as well as Dyce *et al.* (1987) concluded that the mucous secreting glands acted as a lubricant for the boli to help in swallowing, however Gargiulo, Lorvik, Coccarelli and Pedini (1991), Samar *et al.* (1999) added that these mucous secretion not only for nutrient ingestion but also for non-immune protection of the buccal cavity. Dyce *et al.* (1987) mentioned that the pharyngeal cavity contained numerous salivary glands without terming any of them. The present study observed some salivary glands in the wall of the phgaryngeal cavity, which can be termed as the salivary glands of the wall of the pharynx; these glands were not described by any of the previously mentioned authors.

The present study revealed the presence of thickened mucous membrane at certain areas forming folds which may be permanent mucosal folds (around the laryngeal mound, at the laryngeal cleft and at the edges of the choanal slit) or temporary folds elsewhere. Similar to that observed by Hodges (1974), McClelland (1975) and Nickel *et al.* (1977).

The result of the present study was in accordance with that mentioned by Nickel *et al.* (1977) who stated that; taste buds were absent from the tongue of birds. McClelland (1975, 1979) mentioned that, sense of taste in birds appeared to be much less developed than mammals. He added that the buds were distributed in the epithelium of the base of the tongue. Nickel *et al.* (1977) added that taste buds may find around the ducts of the salivary glands and seen mainly in the mucosa of the pharynx and extended to the entrance of the esophagus. Stornelli, Lossi and Giannessi (2000) in duck reported on the localization of taste buds in epithelium of the palate (70%), the floor of the oral cavity (28%) and the tongue (2%). However, King and McClelland (1984) declared that, recent work has shown that taste buds were much more numerous than had previously supposed in domestic birds and lay on the base of the tongue.

Abundant lymphoid tissues either diffused or in follicles were observed in the submucosa of the roof of the pharyngeal cavity especially at the level of the infundibular cleft. McClelland (1975), King and McClelland (1984) described these lymphoid tissues as the pharyngeal tonsils; however Nickel *et al.* (1977) termed them tubal

tonsils. They also added that these lymphoid centers were abundant in geese than in pigeon. Bradley and Grahame (1960), Hodges (1974) and Ohshima and Hiramatsu (2000) observed large lymphoid accumulation located in the connective tissue of the salivary glands especially around their ducts in chicken. Similar findings were observed in the present study.

The present observation suggested that the presence of lymphoid infiltration with the mucous glands of the rostral commissure of the laryngeal cleft played an important role to protect the respiratory passages during the process of swallowing as they compensate the absence of the epiglottis, where they enlarged by increase lymph flow. This mechanism was similar to the erection of the copulatory organs in birds. In addition, the mucous secreting glands purify the inspired air and coated the boli, which pushed directly to the esophagus by the action of the mechanical papillae and mucosal folds of the caudal commissure of the laryngeal cleft. Moreover, the anatomical position of the choanal opening at the same level of the laryngeal opening; facilitate the inspired air to pass directly to the respiratory passage.

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## LEGENDS

**Fig 1:** A photograph of the roof of duck pharyngeal cavity showing: N-Narrow part of the choanal slit W-Wide part of the choanal slit T-Infundibular cleft V-Vomer bone O- esophagus ⇀Transverse row of papillae between the narrow and wide parts of the choanal slit ▷-Longitudinal papillae around the choanal slit ●-Transverse rows of papillae at infundibular cleft "-Pharyngeo-oesophageal limit ■-Longitudinal rows of papillae of the lateral pharyngeal wall 0- Excretory openings of sphenopterygoid salivary ducts ★-Excretory openings of pharyngeal salivary ducts in the lateral pharyngeal wall.

**Fig 2:** A photograph of the floor of the duck pharyngeal cavity showing: ■-Transverse rows of lingual papillae ⇀-Excretory pores of caudal lingual salivary ducts ✖-Longitudinal rows of pharyngeal papillae ⇀Longitudinal papillae of laryngeal cleft ⋎-Dorsal commissure of the laryngeal cleft ⮞-Ventral commissure of the laryngeal cleft ›-Mucosal folds around laryngeal cleft 0-Excretory openings of cricoarytenoid salivary glands ★-Excretory openings of pharyngeal salivary ducts ●-Transverse rows of laryngeal papillae □-Thread like long laryngeal papillae of the midline →-Mucosal folds demarcate the laryngeal mound -Pharyngeo-oesophageal junction. "-Mucosal folds in the floor and lateral wall of the pharynx. O-Esophagus

**Fig 3:** Scanning electron micrograph of the roof of the duck pharyngeal cavity showing well demarcated polyhedral epithelium cells covered with surface microvilli of different length and density of distribution.

**Fig 3`:** Closer view of fig (3) showing: dome shaped cells covered by microvilli with different length, density.

**Fig 3``:** A photomicrograph of transverse paraffin section of the roof of duck pharyngeal cavity at the level of the infundibular cleft showing mucosal folds with two types of lining epithelium; ●-

Cutaneous membrane ▣-Respiratory epithelium Ó-Lymph infilteration ↘-Ciliated epithelium.

**Fig 4:** Scanning electron micrograph of the roof of the duck pharyngeal cavity at the level of the choanal slit and lateral walls showing long, fine, horn like papillae projected from the mucosal surface by a (●) root and encircled by a (♀) longitudinal mucosal folds

**Fig 5:** Scanning electron micrograph of the roof of the duck pharyngeal cavity at the level of the infundibular cleft showing short, thick pointed caudally directed papillae (→) each 2-3 projected from the mucosal surface by one root (●) (together similar to the inverted molar cheek tooth) covered with secretory droplets.

**Fig 5`:** A photomicrograph of transverse paraffin section of the roof of duck pharyngeal cavity at the level of the infundibular cleft showing the shape, direction of the mucosal papillae ●-Thick layer of cornification ▣-Thick layer of stratum corium -▲-Dense core of lamina propria ➡-Sphenopterygoid salivary glands ↘-Excretory duct ◯– Muscular layer (X-5x10).

**Fig 5``:** A photomicrograph of transverse paraffin section of the lateral walls of the duck pharyngeal cavity at the level of the infundibular cleft showing: each 2-3 papillae (arrows) projected from the mucosal surface by one root (●), Lamina propria (▲), Stratum corium (▣), Thick layer of keratin (□) (X- 10x10)

**Fig 6:** Scanning electron micrograph of the roof of duck pharyngeal cavity showing excretory opening of the duct.

**Fig. 7:** A photomicrograph of transverse paraffin section of the roof of duck pharyngeal cavity at the level of the choanal slit showing: ▲-Thick layer of stratum corium "stratified squamous epithelium ▣-Dense layer of lamina propria ●-Caudal palatine salivary glands ➳-Excretory duct ➡-Lymphoid infiltration around the salivary glands and excretory ducts (X-10x10).

**Fig 8:** A photomicrograph of transverse paraffin section of the roof of duck pharyngeal cavity at the level of the narrow part of the choanal slit showing: ➳-Numerous minute papillae (mucosal protrusion), ●-caudal palatine salivary glands ↘-lymphoid follicles (X-10x10).

**Fig 8`:** A photomicrograph of transverse paraffin section of the roof of duck pharyngeal cavity at the level of the infundibular cleft showing ◯-Aggregations of lymphoid tissue (X-10x10).

Fig 9: Scanning electron micrograph of the roof of duck pharyngeal cavity showing fingers like mucosal folds with different thickness appeared in longitudinal wavy manner.

Fig 10: Scanning electron micrograph of the roof and lateral wall of duck pharyngeal cavity showing the undulating folds of the mucosal surface with minute papillae (scale like minor protrusion).

Fig 10`: Closer view of fig (10) showing surface cellular scales.

Fig 11: Scanning electron micrograph at the rostral part of the floor of duck pharyngeal cavity showing pharyngeal papillae (corne shaped, thick, short with blunt end).

Fig 11`; Closer view of fig (11) showing □-Excretory openings of caudal lingual salivary ducts ↘-mucosal folds ●-Different sizes of mucosal papillae.

Fig 12: Scanning electron micrograph of the rostral part of duck pharyngeal floor at the level of the laryngeal mound showing rose shaped papillae with concentrically arranged mucosal folds.

Fig 13: A photomicrograph of transverse paraffin section of the floor of duck pharyngeal cavity showing the shape, direction of the papillae ●-Thick layer of cornification □-Thick layer of stratum corium ▩-Dense core of lamina propria (X-5x10).

Fig 14: Closer view of fig (11`) □→ showing: excretory opening of the caudal lingual salivary ducts, secretory droplets, desquamated epithelium around the secretary opening.

Fig 15: A photomicrograph of frontal paraffin section of the floor of duck pharyngeal cavity at the level of the laryngeal mound showing: (from medial on the right side to the lateral on the left side) T- Laryngeal mucosa K- Laryngeal cartilage M-layer of longitudinal muscle fibers Q- Cricoarytenoid salivary glands (X-6.3x10).

Fig 16: Scanning electron micrograph of duck pharyngeal floor showing the mucosal folds parallel to each other in a transverse and longitudinal directions.

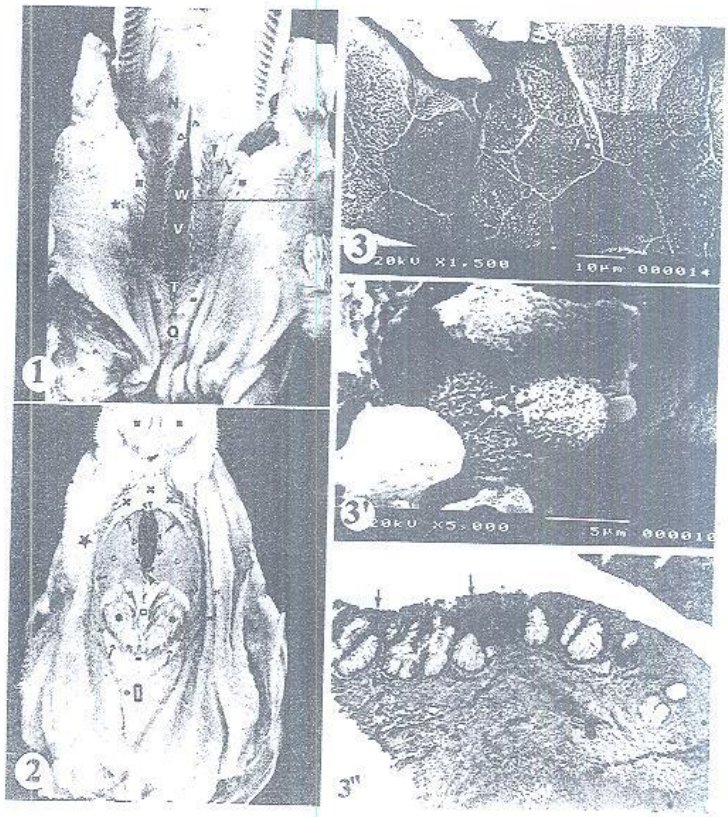
Fig 17: A photomicrograph of frontal paraffin section of the floor of duck pharyneal cavity at the level of the laryngeal mound showing: ▶-The laryngeal cavity ●-Laryngeal cartilage ←- Laryngeal mucosa ○-Laryngeal muscles ⫽⫽ Rostral laryngeal

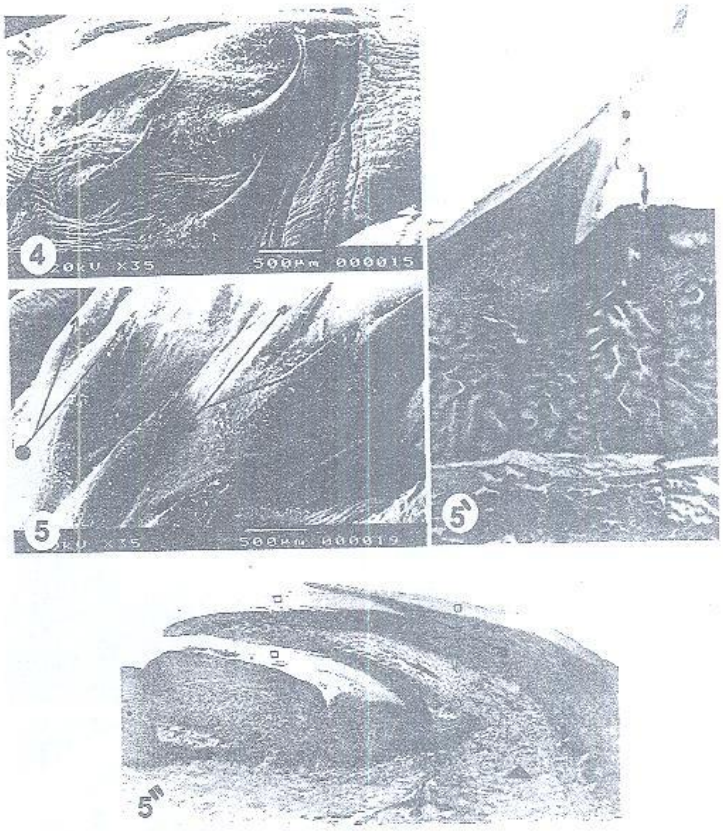
↓ - Caudal laryngeal commissure with numerous mucosal folds (X-2.5x10).

Fig 17': Closer view of fig (17) at the rostral commissure showing the numerous ● -mucous glands - Lymphoid infiltration. (X-10x10).

Fig 17": Closer view of fig (17') showing the ●-shape of mucous glands ↓-Respiratory epithelium. (X-25x10).

Fig 18: Closer view of fig (17) at the ventral commissure showing the shape of the mucosal folds. (X-10x10).

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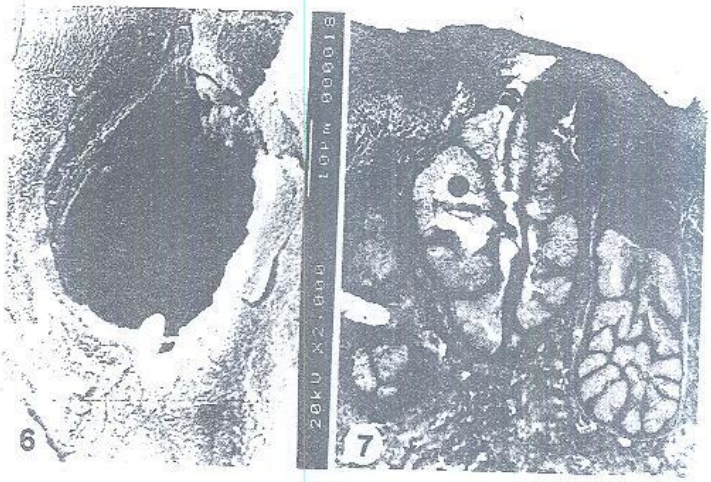
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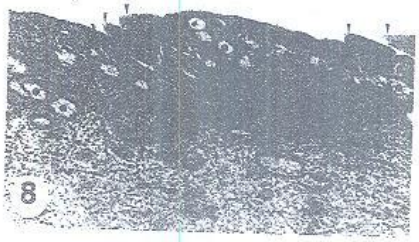
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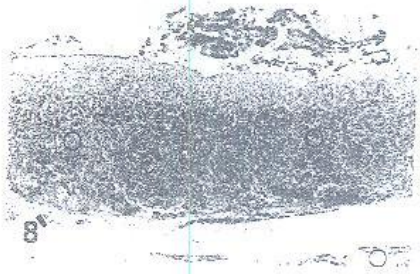
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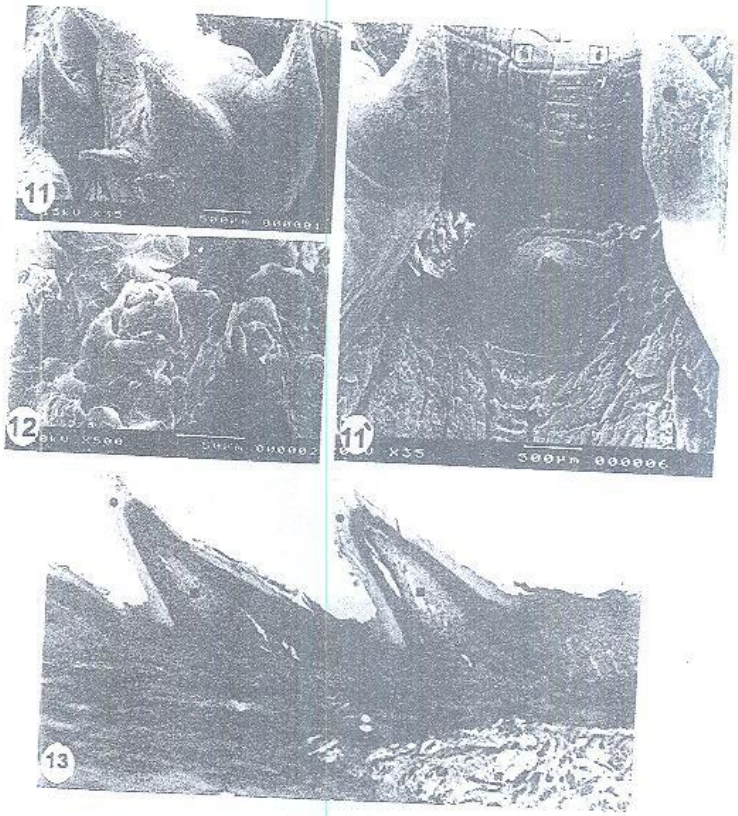

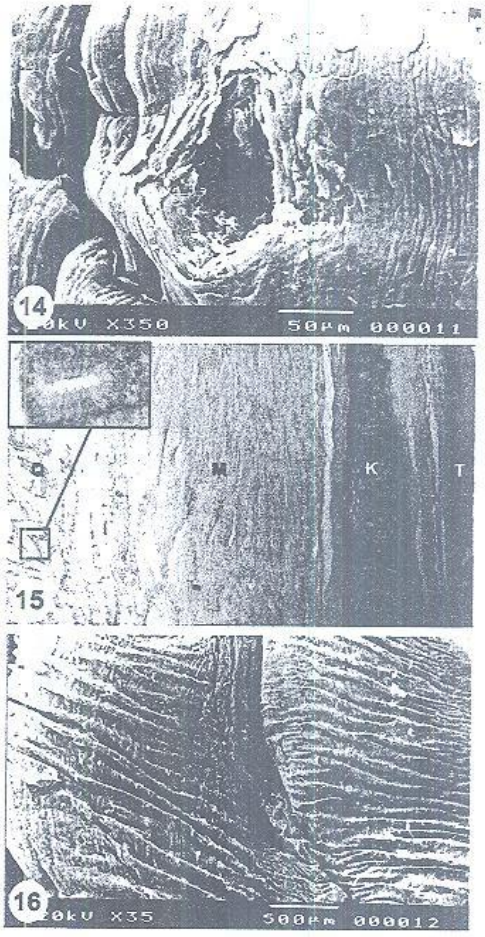
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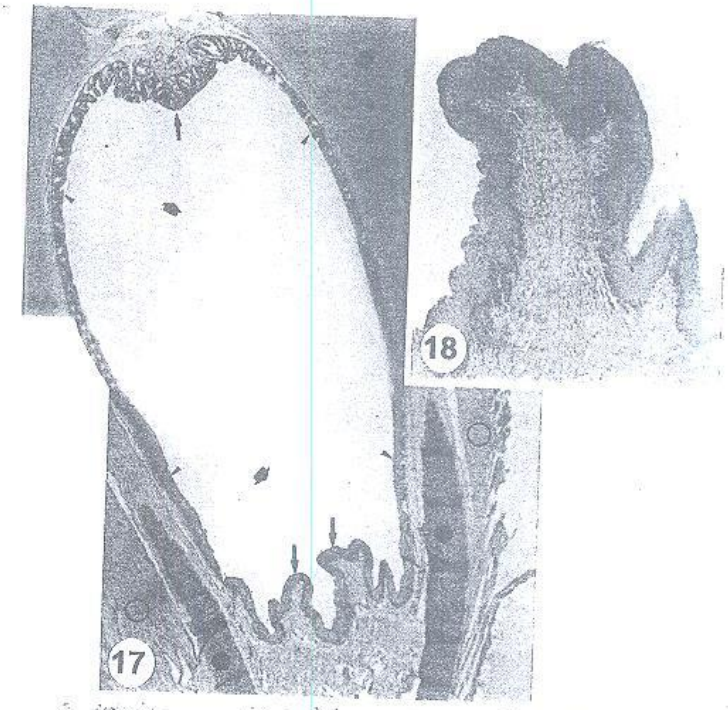
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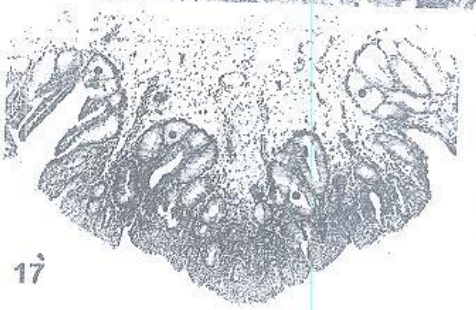
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