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**GROSS ANATOMICAL AND SCANNING ELECTRON
MICROSCOPICAL STUDIES ON THE PALATE
OF SOME BIRDS**

(With 1 Table and 22 Figures)

By

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دراسات تشريحية وميكروسكوبية ماسحة على الحنك في بعض الطيور

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أجري هذا البحث على الحنك في ثلاثة أنواع من الطيور الأليفة وهي الدجاج والحمام والأوز وذلك لدراسة إمتداده وأبعاده وشكله إضافة إلى الشق القمعي الأنفي. يتميز الحنك بوجود عدد من الأحياد الحنكية والحلمات التي تختلف في شكلها وعددها وتوزيعها في الطيور تحت الدراسة. يقع الحيد الحنكي الأوسط في الجزء الأمامي من الحنك في كل الطيور التي تم دراستها، وينتهي من الخلف عند النهاية الأمامية للشق القمعي الأنفي في الحمام وقليلًا قبل هذه النهاية في الدجاج والأوز. تبدأ الأحياد الحنكية الوحشية عند النهاية الخلفية للحيد الأوسط في الدجاج وعند التقاء الثلث الأمامي والثلثين الخلفيين في الحمام. تمثل هذه الأحياد في الأوز بصفيين مهميين من الحلمات التي تبدأ عند النهاية الأمامية للحيد الأوسط. تقع الأحياد الوحشية في الجزء الأمامي من الحنك في الدجاج، بينما تمتد إلى الجزء الخلفي في الحمام. يحتوي الحنك عموماً في الدجاج والأوز على حلمات متجهة للخلف ومرتبطة في صفوف، طول هذه الصفوف وإتجاهها وكذلك عدد وحجم الحلمات التي تحتوي عليها يختلف في كلا النوعين من الطيور. أما في الحمام فإن الحنك يحتوي على 2-3 حلمات دقيقة أمكن رؤيتها بالميكروسكوب الماسح فقط، هذه الحلمات تقع أسبياً للأحياد الحنكية الوحشية. هذا وتكون الميازيب الحنكية ضحلة في الدجاج وعميقة في الحمام، بينما يحتوي الأوز على ميازيب طويلة ضيقة. ولقد أوضحت الدراسة أن موقع وطول وأجزاء الشق القمعي الأنفي وعلاقته بالشق الحنجري والحلمات التي توجد على حوافه تختلف في الطيور المختلفة. يستنتج من هذا البحث أن حنك كل نوع من الطيور التي تم دراستها يتميز بمواصفات مورفولوجية تتلائم مع نوع الغذاء.

SUMMARY

This work was carried out on the palate of the chicken, pigeon and goose to investigate its extension, dimensions, shape. The palate is characterized by the presence of number of ridges and papillae which differ in their shape, number and distribution in the three species under

study. The median palatine ridge lies in the rostral part of the palate in all examined birds, it terminates caudally at the rostral end of the choanal slit in the pigeon, but shortly before this end in the chicken and goose. The lateral palatine ridges begin at the caudal end of the median palatine ridge in the chicken, at the junction of its rostral and caudal two thirds in the pigeon. In the goose, the lateral ridges are represented by two paramedian rows of papillae which begin at the rostral end of the median ridge. The lateral ridges are confined to the rostral part of the palate in the chicken and goose, but extend to the caudal part in the pigeon. In general the palate contains caudally directed papillae in the chicken and goose. They are arranged in rows, the length and direction of these rows as well as the number and size of the papillae they contain differ in both species. In the pigeon 2-3 fine papillae could be observed, only by scanning electron microscope, medial to the lateral palatine ridges. The palatine grooves are shallow in the chicken and deep in the pigeon, the goose has a narrow longitudinal groove. The position, length and parts of the choanal slit as well as its relation with the laryngeal cleft and the papillae on its edges differ in various examined birds. In conclusion, there are morphological differences between the palates of the examined species depending upon the type of the diet.

Key words: Palate, Birds, Anatomy, SEM.

INTRODUCTION

Birds lack a soft palate and obvious constriction separating the mouth from the pharynx (Dyce *et al.*, 1996). In this respect, Hamilton (1952) reported that the precise point in the oropharynx at which the oral cavity and pharynx join each other is difficult to define precisely since it is impossible to determine the exact position of the oral palate in the late stages of development. According to the same author the caudal limit of the ectodermal component of the roof of the oral cavity lies between the choanal and infundibular slits. Studies on the palate of domestic birds are meager. The aim of this study is to investigate comparatively the gross and scanning electron microscopic features of the palate in three species of birds (chicken, pigeon and goose) that feed on different feed stuffs.

MATERIALS and METHODS

This study was carried out on 30 adult chickens (*Gallus domesticus*), pigeons (*Columbia domestica*) and geese (*Anser domestica*); 10 birds of each. For gross anatomical study 6 birds from

each species were used. The oropharynx was opened, then the palate was dissected and examined grossly as well as with stereomicroscope then photographed. In addition, the lengths of the oropharynx, the palate, the choanal slit (with its narrow and wide parts) and the lengths of palatine ridges were measured. Moreover, the percentage of the length of the palate to that of the oropharynx and the percentage of the length of the choanal slit and its parts to that of the palate were calculated and represented by histograms. For scanning electron microscopy, 4 birds from each species were used. After washing with normal saline, pieces of the palate on both sides of the choanal slit and from its rostral and caudal parts were taken, fixed in paraformaldehyde 2.5% and glutaraldehyde 2.5% solution in 0.1M phosphate buffer for 4 hours at 4°C. After washing in the same buffer, the specimens were postfixed in osmium tetroxide 1% in phosphate buffer for 2 hours followed by washing in the same buffer. The samples were then dehydrated in ascending grades of ethanol followed by critical point drying in carbon dioxide then sputter-coated with gold and examined with a JEOL-5400 LV scanning electron microscope.

RESULTS

The palate occupies the roof of the oral cavity and presents a longitudinal opening; the choanal slit (Figs. 1-6). Its caudal limit lies between the before mentioned slit and the infundibular slit, caudal to the angle of the mouth by 10, 12 and 22mm in the chicken, pigeon and goose respectively. The palate can be divided into two parts, rostral and caudal, the line of division is demarcated between the angles of the mouth. This line lies at the junction of the narrow rostral and wide caudal parts of the choanal slit in the chicken and pigeon, but at the rostral end of the slit in the goose. The shape and size of the rostral part differ in the various examined birds depending upon the size and shape of the beak. It is triangular in the chicken, narrow triangular in the pigeon and elongated in the goose. The palate is concave along its length in the chicken and pigeon but the degree of concavity is greater in the chicken. In the goose, the palate is concave transversely. The palate of the pigeon and goose is relatively longer than that of the chicken as compared to the total length of the oropharynx. It forms about 78% of the total length of the oropharynx in the pigeon and goose, but in the chicken it forms only 67% (Fig.20).

The choanal slit, in all examined birds, is a median cleft through which the oral and nasal cavities communicate. It lies in the caudal part

of the palate, however it extends into the rostral part in the chicken and pigeon. It lies rostral to the laryngeal cleft in the chicken, while its wide part is located opposite to the laryngeal cleft in the pigeon and goose. The choanal slit is separated caudally from the infundibular slit by a mucosal bridge measuring 3mm in the chicken and 6mm in the goose, but in the pigeon the infundibular slit lies immediately caudal to the choanal slit (Figs. 4, 5, 6). The choanal slit constitutes 53.49%, 50.0% and 27.06% of the total length of the palate in the chicken, pigeon and goose respectively (Fig.21). It consists of narrow rostral part and wide caudal part. The length of these two parts and their ratio to the total length of the choanal slit differ in the different examined birds as shown in Table (1) and figure (22). The wide part constitutes 39.1%, 25.0% and 56.5% of the total length of the slit in the chicken, pigeon and goose respectively.

Table 1: Lengths (in mm) of the oropharynx, palate, choanal slit (with its narrow and wide parts) and the palating ridges

Measurements	Chicken	Pigeon	Goose
1- Oropharynx	64 ± 2.5	41 ± 2.1	108 ± 4.6
2- Palate	43 ± 1.4	32 ± 2.0	85 ± 6.3
3- Choanal slit	23 ± 1.3	16 ± 0.9	23 ± 1.7
a- Narrow part	14 ± 0.7	12 ± 0.7	10 ± 0.4
b- Wide part	9 ± 0.2	4 ± 0.2	13 ± 0.5
4- Median ridge	12 ± 0.3	15 ± 0.8	44 ± 2.6
5- Lateral ridge	19 ± 0.4	17 ± 0.9	-

The edges of the choanal slit are thickened and contain number of longitudinally arranged caudomedially directed papillae in all examined birds. The number, distribution, size and shape of these papillae differ in the various examined species (Figs. 4-12). In the pigeon, they include 6-7 fine papillae present only in the narrow part of the slit. In the chicken and goose, the rostral portion of the narrow part is free from papillae. The chicken has 10-11 papillae while the goose has 20-22 papillae arranged in two rows; dorsal row (8-9 papillae) and ventral row (12-13 papillae). The papillae in the chicken have nearly the same size at both the narrow and wide parts, while in the goose they are long at the narrow part then become thinner and shorter caudalwards. As revealed with the scanning electron microscope, the papillae are tongue-shaped with wide base in the chicken and pigeon, but in the goose they are conical with narrow base encircled with concentric scales.

The palate of the chicken and pigeon is characterized by the presence of three longitudinal palatine ridges, one median and two lateral (Figs. 1, 2). In the chicken, the median palatine ridge begins 6mm behind the tip of the upper beak and terminates caudally 8mm rostral to the choanal slit. This ridge measures 12mm long and is flanked by two small swellings, which are united rostral to the ridge. The lateral ridges measure 19mm long and begin at the caudal end of the median ridge, diverge caudolaterally to terminate at the level of the fifth row of palatine papillae opposite to the level of the junction between the narrow rostral and wide caudal parts of the choanal slit (Fig. 4). In the pigeon, the median palatine ridge measures 15mm long and begins just behind the tip of the upper beak and terminates caudally at the rostral end of the choanal slit. The lateral palatine ridges measure 17mm long and begin at the junction of the rostral and caudal two thirds of the median ridge. They run caudally parallel to the median ridge for a short distance then they diverge to terminate opposite to the caudal end of the choanal slit (Figs.2, 5).

In both chicken and pigeon the lateral ridges are bounded medially and laterally by two longitudinal grooves (Figs. 1, 2, 4, 5). These grooves are shallow and confined to the rostral part of the palate in the chicken, but they are deep and extend in both rostral and caudal parts of the palate in the pigeon. The caudal part of the lateral groove in the chicken shows a low ridge which begins from the caudal end of the lateral ridge and extends rostrolaterally. In general and unlike the chicken, the palate and its ridges project below the edges of the upper beak in the pigeon.

The triangular area lying between the lateral ridges is characterized in the chicken by the presence of five rows of caudally directed papillae, in addition, smaller irregularly scattered papillae are also demonstrated between these rows (Fig. 1). The position, direction and length of these rows as well as the number and size of the papillae they contain are different. The first row (5 papillae) lies 5mm rostral to the choanal slit, while the second (6 papillae) lies at the rostral end of the slit. The third row (10 papillae) and the fourth row (8 papillae) are located on both sides of the rostral part of the choanal slit. The fifth row (30 papillae) is present at the junction of the rostral and caudal parts of the choanal slit. The length of the foregoing rows is variable, the first is the shortest then they increase in length caudalwards. Among these rows the papillae of the fourth row are the weakest while those of the fifth row are the most prominent ones. Concerning the direction of these rows, the

first row is directed caudolaterally, while the others are directed rostralaterally. In addition, numerous fine, caudally directed papillae are irregularly scattered in the caudal part of the palate and on both sides of the choanal slit. In the pigeon, 2-3 fine irregularly distributed papillae could be observed only by scanning electron microscope medial to the lateral palatine ridges (Fig. 8). In the latter bird and shortly rostral to the junction between the rostral and caudal parts of the choanal slit, two small swellings are found on both sides and are followed by two short longitudinal depressions.

In the goose (Figs. 3, 6), the rostral part of the palate contains a median longitudinal palatine ridge which begins 5mm caudal to the tip of the upper beak and terminates caudally 12mm rostral to the choanal slit. This ridge contains about 14 wide-based caudally directed papillae. In addition, three paramedian rows (lateral, intermediate and medial) of caudally directed papillae are demonstrated in this part. The lateral one, which includes 17 papillae, is the best developed and is the homologous to the lateral palatine ridge of the chicken and pigeon. It begins at the rostral end of the median ridge, curves laterally then continues caudally to end about 4mm rostral to the level of the choanal slit. The papillae of this row which appear as overlapped protrusions are small rostrally, enlarge caudalwards except the last three ones that become smaller again. The other two paramedian rows are weakly developed of which the intermediate one (with 7 papillae) is the shortest and is confined to the middle third of the rostral part of the palate, however the medial row (with 10 papillae) is found along the rostral two thirds. The lateral row of papillae in the goose (Figs. 3, 15) is separated from the lamellae of the lateral edge of the upper beak by a narrow longitudinal groove. The lamellae (25 in number) are caudoventrally and laterally directed with free pointed ends. They are short rostrally then become longer and close together caudally. The caudal part of the palate in the goose contains the choanal slit.

The scanning electron microscope of the palate of the goose (Fig. 13) reveals that, rostral to the median and paramedian ridges, rod-shaped projections with free ends are demonstrated. They are separated from each other by narrow longitudinal grooves. The lateral halves of these projections are branched and carry many minute papillae. The area between the foregoing projections and the tip of the upper beak is studded with several rose-shaped papillae (Fig. 14)

Generally and in all examined birds, the openings of the maxillary salivary glands lie in the rostral part of the palate on both sides of the

median palatine ridge (Figs. 1-3). In the chicken a single opening is observed on each side at the junction of the median and lateral palatine ridges. In the pigeon, four openings are demonstrated in the form of a longitudinal row on both sides of the median palatine ridge 5mm rostral to its caudal end. In the goose several small openings are demonstrated on either side of the median palatine ridge shortly caudal to its rostral end (Fig. 13). These openings appear containing secretory droplets (Fig. 16).

The scanning electron microscope indicates that the caudal part of the palate in the chicken and goose shows several openings of palatine salivary glands, arranged in rows, on both sides of the choanal slit. The openings are more numerous in the goose (Fig. 9). In addition, the rostral part of the palate in the chicken has longitudinally arranged numerous openings on both sides of the lateral palatine ridges (Fig.4). In the pigeon, few minute openings are demonstrated on both sides of the choanal slit at the junction of its narrow and wide parts. Most openings of the palatine glands in all examined birds are filled with secretory droplets and some desquamated cells (Figs. 17-19).

DISCUSSION

The present work indicates that the caudal limit of the palate is determined at the junction between the choanal and infundibular slits. This is supported by the statement of Hamilton (1952) and McLelland (1979) that on the basis of the embryology, the boundary between the oral and pharyngeal cavities has been placed dorsally at the junction of the choanal and pharyngeal clefts. In addition, Nickel *et al.* (1977) reported that the embryological investigations have shown that in the birds the region analogous to the boundary between the mouth and pharyngeal cavities of mammals is where the infundibular cleft begins. However, Hodges (1974) mentioned that the point of the junction of the buccal and pharyngeal cavities is actually more caudally where it reaches the opening of the glottis.

In accordance with Nickel *et al.* (1977) the present study reveals that the palate is divided into rostral and caudal parts. The shape and size of the rostral part differ in the various examined birds depending upon the shape and size of the upper beak. It is triangular in shape in the chicken, narrow triangular in the pigeon and elongated in the goose. It is concave along its length in the chicken and pigeon but concave transversely in the goose. In this respect, McLelland (1975) stated that

- King, A.S. and J. McLelland (1984): Digestive System. In: "Birds, their structure and function". 2nd edition. London, Baillierre Tindall.
- Koch, T. (1973): Anatomy of the chicken and domestic birds. The Iowa State University Press/Ames, Iowa.
- Lucas, A.M. and P.R. Stettenheim (1972): "Avian Anatomy. Integument". Agriculture handbook 362. U.S. Dept. Agric., U.S. Government printing office, Washington D.C.
- McLelland, J. (1975): Aves digestive system. In: Sisson and Grossman, s. "The anatomy of the domestic animals". Getty, R. Vol. II, 5th edition. Philadelphia, Saunders Company, London, Toronto.
- McLelland, J. (1979): Aves digestive system. In: King and McLelland "Form and function in birds". Vol. I, 5th edition. London, New York, Toronto, Sydney, San Francisco.
- Nickel, R.; A. Schummer and E. Seiferle (1977): Digestive system. In: "Anatomy of the domestic birds". Verlag Paul Pary, Berlin, Hamburg.
- Petrack, M.L. (1982): Diseases of cage and avian birds. Lea & Febiger, Philadelphia.
- Ziswiler, V (1965): Zur Kenntnis des Samenöffnens und der structur des hornernen Gaumens bei Kornerfressenden Oscines. J. Ornith., 106 : 1-48.

LEGENDS

Figs. 1-3: Photographs showing the palate in the chicken (Fig. 1), pigeon (Fig. 2) and goose (Fig. 3). The palate terminates caudally between the choanal (C) and infundibular (I) slits. The palate in the chicken and pigeon presents a median (M) and lateral (L) palatine ridges. The lateral palatine ridge is bounded by medial and lateral grooves (G). In the chicken, the rostral part of the palate shows 5 rows of caudally directed papillae (1-5). In the goose, the rostral part of the palate demonstrates a median (M) and three paramedian (P) longitudinal rows of papillae. In the latter bird, the lateral paramedian ridge is separated from the lamellae (A) of the upper beak by a longitudinal groove (G). Note the openings of the maxillary salivary gland (arrows).

allow the stream of air to enter the larynx (Nickel *et al.*, 1977).

The present study demonstrates that the ratio between the narrow and wide parts of the choanal slit differs in the examined birds. The wide part constitutes about 39%, 25% and 56% of the total length of the slit in the chicken, pigeon and goose respectively. This means that the narrow part is longer than the wide part in the chicken and pigeon while in the goose the narrow part is slightly shorter than the wide part. Nearly similar findings are recorded by McLelland (1975) who mentioned that the wide part in the chicken is nearly half the narrow part, but in the duck and goose it is longer than the narrow part. This seems to be

different from the results of Hassouna (2002) that the wide part is double the narrow part in the duck.

The edges of the choanal slit in all examined birds are thickened and present a number of caudomedially directed papillae. These papillae are demonstrated only in the narrow part of the choanal slit in the pigeon, but in both parts of the slit in the chicken and goose. In the latter two birds the rostral portion of the narrow part is devoid of papillae. In this respect, McLelland (1975) mentioned that the choanal slit of the duck and goose has thin, pointed caudally directed papillae which are mostly better developed close to the edges of the wide part, while in the chicken, few small papillae are irregularly distributed on the edges of the slit. Unlikely, the present study indicates that in the chicken, the papillae have nearly the same size at both the narrow and wide parts of the slit, while in the goose the papillae are arranged into two rows, they are long, but become thinner and shorter caudalwards.

In consistence with the statement of McLelland (1975), the present work shows that the palate in the chicken and pigeon is characterized by the presence of three longitudinal palatine ridges, one median and two lateral. In most species of birds the palate is ridged both lateral and rostral to the choana (King and McLelland, 1984). The lateral palatine ridges, situated on either side of the choana appear to be relatively common in birds (Goppert, 1903). In some species e.g. *Gallus*, there is also a median ridge in the rostral portion of the palate (McLelland, 1975, 1979). The ridge formation on the palate of the seed eating passerines is highly complex dividing the palate into a series of arch-like grooves. Lateral, intermediate and median palatine ridges occur in this species with a variable number of secondary and tertiary ridges arising from the sides of the intermediate and lateral ridges (Ziswiler, 1965). This specially developed set of palatine ridges, in seed eating passerines, is supposed to remove the shell of the eaten seeds (King and McLelland, 1984).

The current study reveals that the median longitudinal palatine ridge begins 6mm behind the tip of the upper beak in the chicken and 5mm in the goose, then extends caudally to terminate 8mm rostral to the choanal slit in the former bird and 12mm in the latter one. In the pigeon, it begins just caudal to the tip of the beak and terminates at the rostral end of the choanal slit. In the chicken, this ridge is flanked by two small swellings, which unite rostral to the ridge. In this concern, McLelland (1975) reported that the median ridge lies in the rostral third of the palate in the chicken and is weakly developed in the goose as compared to that



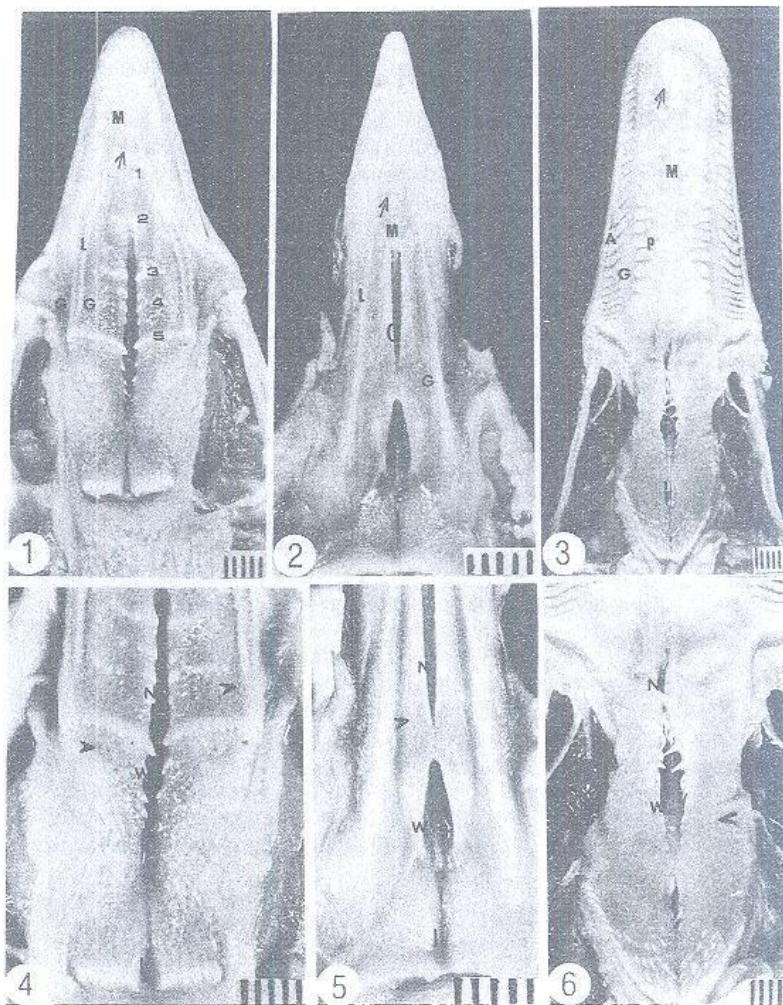
It is concluded that there are morphological differences between the palates of the examined species depending upon the type of the diet. The palate of the chicken, which feeds mainly on mash, is characterized by a pronounced system of caudally directed papillae mostly arranged in rows. These papillae are supposed to move the bolus of feed caudally and prevent its regurgitation. On the other hand, the pigeon depends mainly on grains in its feeding, the palate in this species is characterized by deep longitudinal grooves that may be used as a passage to the fed grains toward the pharynx. In the goose, the rostral part of the palate has several longitudinal rows of papillae in addition to the rostrally located rod-shaped projections and the lamellae of the upper beak. These characters with the aid of the tongue may help in filtering the feed particles from the water and also in cropping grasses. The short and caudally positioned choanal slit in the goose, compared with the chicken and pigeon, may play an important role to prevent the entrance of water in the slit during sieving feed particles from the water.

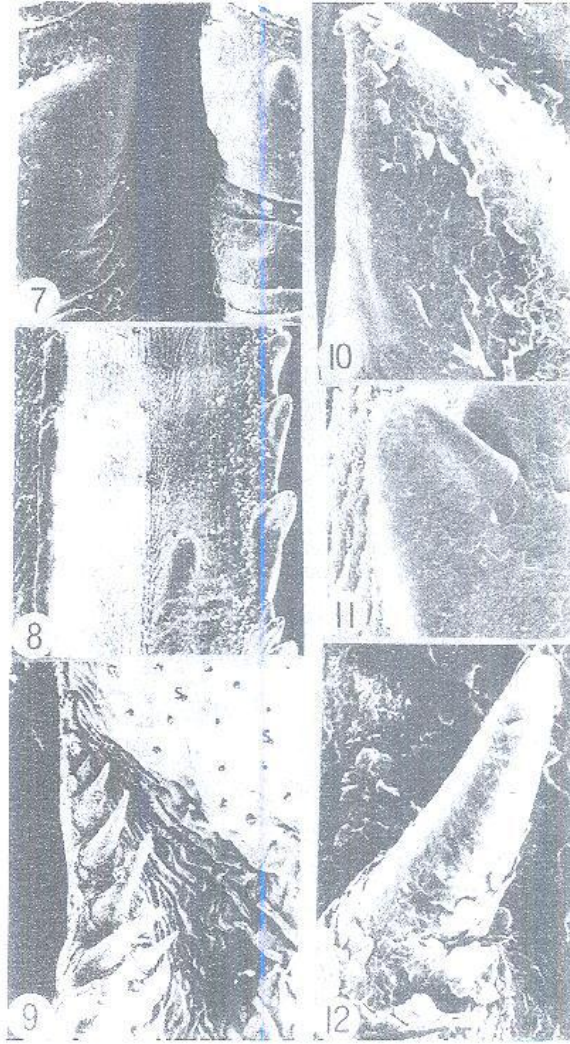
REFERENCES

- Dyce, K.M.; W.O. Sack and G.J.C. Wensing (1996):* Textbook of veterinary anatomy, 2nd edition. W.B. Saunders Company, Philadelphia, London, Toronto, Montreal, Sydney, Tokyo.
- Feder, F.H. (1969):* Beitrag zur makroskopischen Anatomie des Verdauungsapparats beim Wellensittich (*Melopsittacus undulatus*). Anat. Anz., 125: 233-255.
- Gardner, L.L. (1926):* The adaptive modification and taxonomic value of the tongue in birds. Proc. U.S. Natn., Mus., 67: Art. 19.
- Gardner, L.L. (1927):* The tongue in birds. Ibis, 3: 185-196.
- Goppert, E. (1903):* Die Bedeutung der Zunge für den sekundären Gaumen und den Ductus naso-pharyngeus. Morphol. Jahrb., 31: 311-359.
- Hamilton, H.L. (1952):* In: Lillie's "Development of the chick". 3rd edition. New York, Henry Holt and Comp. INC.
- Hassouna, E.M.A. (2002):* Morphological studies on the pharyngeal cavity of duck (*Anas boschius domesticus*). Assiut Vet. Med. J. Vol.47, No.94: 21-41.
- Heidrich, H. (1908):* Die Mund- und Schlundkopfhöhle der Vogel und ihre Drüsen. Morphol. Jahrb., 37: 10-69.
- Hoäges, R.D. (1974):* The digestive system. In "The histology of the fowl". Academic Press INC. London, LTD.

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- Figs. 4-6:** Photographs showing the choanal slit and its surrounding area in the palate of the chicken (Fig. 4), pigeon (Fig. 5) and goose (Fig. 6). The choanal slit has a narrow rostral part (N) and a wide caudal part (W). Note the openings of the palatine salivary glands (arrow heads).
- Fig. 7:** SEM showing the rostral portion of the narrow part of the choanal slit in the chicken which is free of papillae. x75
- Fig. 8:** SEM showing caudomedially directed papillae on the edge of the choanal slit in pigeon. x35
- Fig. 9:** SEM demonstrating two rows of caudomedially directed papillae on the slit edge in the goose which become shorter caudalwards, in addition to the openings of the palatine salivary glands (S) arranged in rows. x15
- Figs. 10-12:** SEM showing the shape of the papillae of the choanal slit which are tongue-shaped with wide base in the chicken (Fig. 10) and pigeon (Fig. 11), but in the goose (Fig. 12) they are conical in shape with concentric scales. x200.
- Fig. 13:** SEM of the rostral end of the palate in the goose demonstrating rod-shaped branched projections (P) with intervening spaces. Note the presence of several openings of the maxillary gland on both sides of the median ridge (M). x15.
- Fig. 14:** SEM of the rostral end of the palate in the goose showing rose-shaped papillae lying between the above mentioned rod-shaped projections and the tip of the upper beak. X100.
- Fig. 15:** SEM demonstrating the papillae of the lateral paramedian row (P) in the goose which is separated from the lamellae (L) of the upper beak by a longitudinal groove (G). x15.
- Fig.16:** SEM showing a higher magnification to one of the openings of the maxillary salivary glands in the goose. x1000.
- Figs. 17-19:** SEM illustrating the openings of the palatine salivary glands in the chicken (Fig.17, x1000), pigeon (Fig. 18, x1500) and goose (Fig. 19, x500). Note the presence of secretory droplets and some desquamated cells on the edges of the openings.





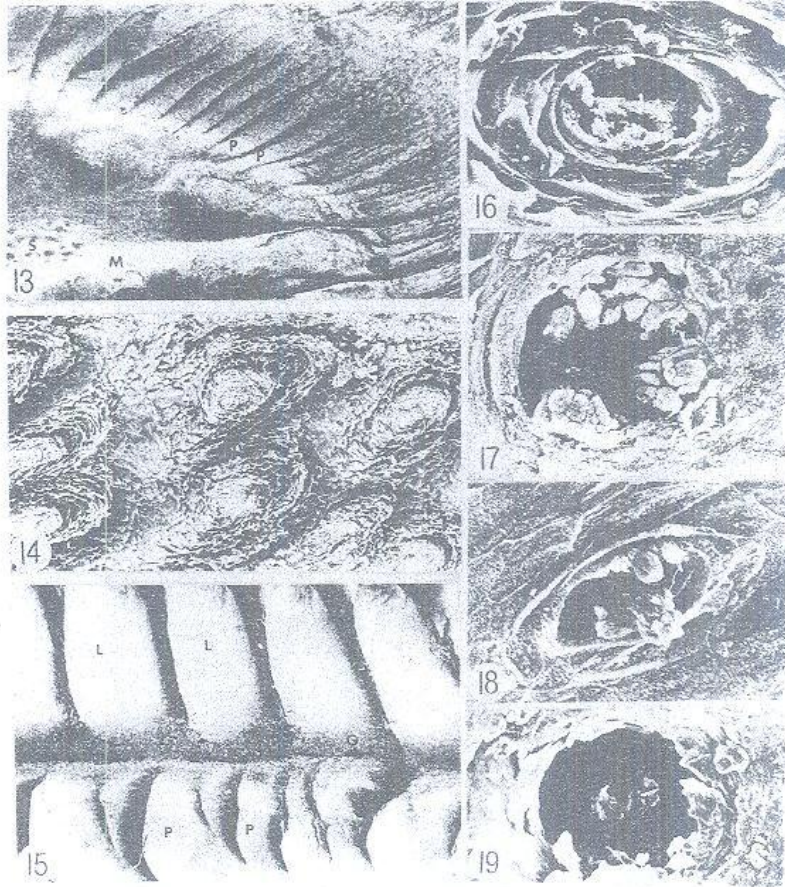


Fig.20: The length percentage of the palate to the oropharynx in examined birds

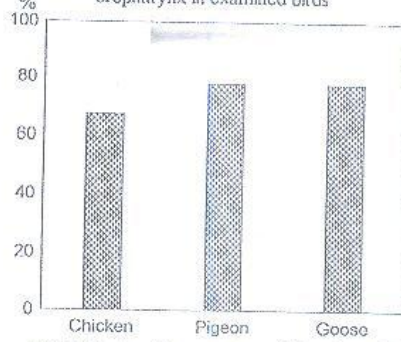


Fig.21: The length percentage of the choanal slit to the palate in examined birds.

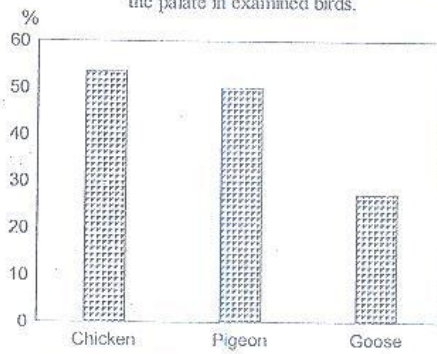


Fig.22: The length percentage of the narrow and wide parts of the choanal slit in examined birds.

