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Lingual Structure of the Domestic Pigeon (Columba Livia Domestica): A Light and Scanning Electron Microscopic Studies

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Abstract: The aim of the present study was to investigate the light and electron microscopic structure of the tongue in pigeon. Six adult domestic pigeon (*Columba livia domestica*) of both sexes were used in this study. Results showed that the tongue is characterized by an elongated triangular format. Three parts are distinguished in the dorsal surface of the tongue: the apex, the body and the root of the tongue. On the dorsal surface of the apex and body of the tongue a median groove is found. Large conical papillae are located symmetrically in the form of the letter U in the marginal region between the body and root of the tongue.The mucosa of the tongue is covered with a thick stratified squamous epithelium which is cornified only on the ventral surface of the organ. The epithelium of the whole dorsal surface of the lingual apex and body presents the lamellar-shaped aspect. The dorsal surface of the root of the tongue, however presented smooth aspect with no densely packed desquamated cells. Microridges can also be seen clearly on the surface epithelium of the lingual root. Gustatory papillae are not found in the epithelium covering the tongue in the domestic pigeon. The PAS positive branched tubuloalveolar lingual salivary glands of the domestic pigeon composed of two laterally situated single strands, which extend from the apex of the tongue to the both sides of laryngeal cleft. The ventral surface of the tongue is devoid of any glandular structure. Neither the morphology nor the dimensions of the tongue show sex-specific differences. It was concluded that the unique features of the tongue in the domestic pigeon were the presence of the large conical papillae with a U-shaped arrangement between the body and the root of the organ and peculiar arrangement of lingual salivary glands.

Key words: Tongue · Salivary glands · Surface epithelium · Lingual mucosa

INTRODUCTION

Studies on the structure of the tongue in birds have been conducted on a small number of avian species, i.e. little tern [1], penguin [2], white tailed eagle [3], cormorant [4], owl [5], falcon and kestrel [6], ostrich [7] and Woodpecker [8]. Morphological studies conducted so far reveal how variations in the morphology and function of the organ might be related to evolutional events and also indicate a close correlation of the shape of the tongue with the method of food intake and the type of food and habitat. Tongues used to manipulate food, such as in piscivorous species, are nonprotruding and covered with stiff, sharp, caudally directed papillae. In birds of prey, the tongue is a rasp-like structure with the rostral portion frequently being very hard and rough. On the tongue of birds that typically strain food particles (e.g. ducks), the rostral portion forms a scoop-like structure with the lateral borders having a double row of overlapping bristles [9]. However, in the available literature, there is a lack of morphological data characterizing the structure of the tongue in the pigeon. The present study was performed to morphologically characterize the tongue of the domestic pigeon using light and scanning electron microscopies, in order to compare results with those of previous reports in other birds.

MATERIALS AND METHODS

Six adult pigeons (3 males and 3 females) donated by the zoological garden of Shahrekord were used to study the morphology of the tongue. No animal was sacrified in this study. The material used in this investigation was

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obtained from animals that died due to different causes, but their tongues were not infected. Samples of the apex, body and root of the tongue were fixed in the 10% buffered paraformaldehyde at room temperature for 48 hours and later submitted to the dehydration process in a series of ethanol at increasing concentrations (70-96%) and embedded in paraplast. Histologic serial sections of 7µm of thickness were obtained and stained routinely with haematoxylin-eosin (H&E) and periodic acid Schiff (PAS) reaction. The morphometric data were obtained using a KS 400 computer morphometry system (ZEISS). Figures were documented under an Axioscope 2 plus light microscope (ZEISS).

For observations under the scanning electron microscope (SEM) the tongues were rinsed with 0.1M phosphate buffer at pH 7.3. Postfixation was made in 1% sodium tetroxide solution for two hours at 4°C. After dehydration through a graded ethanol series and infiltration by hexamethyl disilazin, the dried specimen were mounted on aluminum stubs and coated about 20 s gold-palladinum.

The specimen was observed at various angles under a scanning electron microscope (stereoscan 360, Leica Cambridge Ltd. England). The measurement was provided automatically by the SEM unit.

RESULTS

The tongue of the adult domestic pigeon is characterized by an elongated triangular format for both sexes. Neither the morphology nor the dimensions of the tongue show sex-specific differences. Three parts are distinguished in the dorsal surface of the tongue: the apex, the body and the root of the tongue. On the dorsal surface of the apex and body of the tongue a median groove is found. The groove divides the apex and body of the organ into two symmetrical halves. Large conical papillae are located symmetrically in the form of the letter U in the marginal region between the body and root of the tongue, the apices of which are pointed towards the posterior part of the tongue. Their sizes varied according to their location within the tongue. The lateral papillae are noticeably thicker than the middle ones (Fig. 3). At higher magnification, the epithelial cells on the surface of the papillae presented irregular surface morphologies apparently due to cell sloughing (Fig. 4).

The mucosa of the tongue is covered with a thick stratified squamous epithelium which is cornified only on the ventral surface of the organ (Figs. 6, 7). The epithelium of the tongue is 330-350 µm, 210-230 µm and 130-140 µm on the dorsal surface of the apex, body and root of the tongue, respectively. In SEM images, the epithelium of the whole dorsal surface of the lingual apex and body presents the lamellar-shaped aspect (Figs. 1, 2). The dorsal surface of the root of the tongue, however presented smooth aspect with no densely packed desquamated cells (Figs. 3, 5). Microridges can also be seen clearly on the surface epithelium of the lingual root (Fig. 5). Gustatory papillae are not found in the epithelium covering the tongue in the domestic pigeon. The tongue is supported by cartilage hyoid apparatus extending from the lingual root to lingual apex (Fig. 6) and enclosed by lingual muscle bundles (Fig. 7).

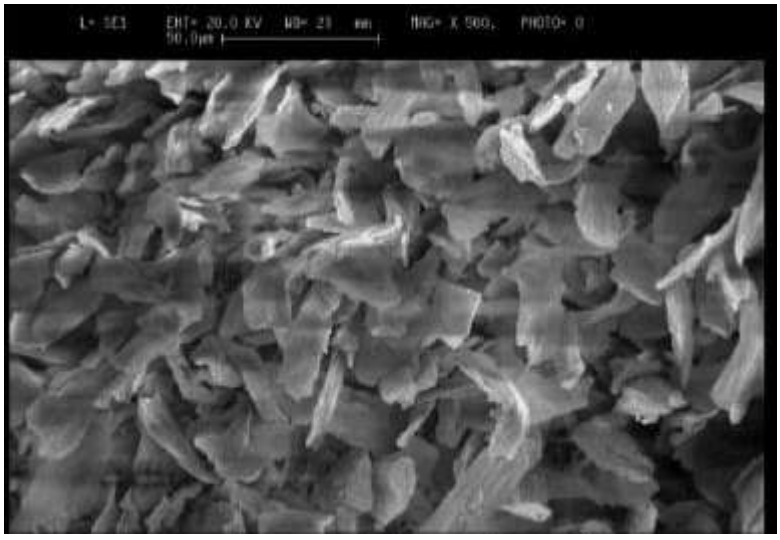

Fig. 1: Scanning electron micrograph showing lamellar shaped epithelium in the lingual apex.

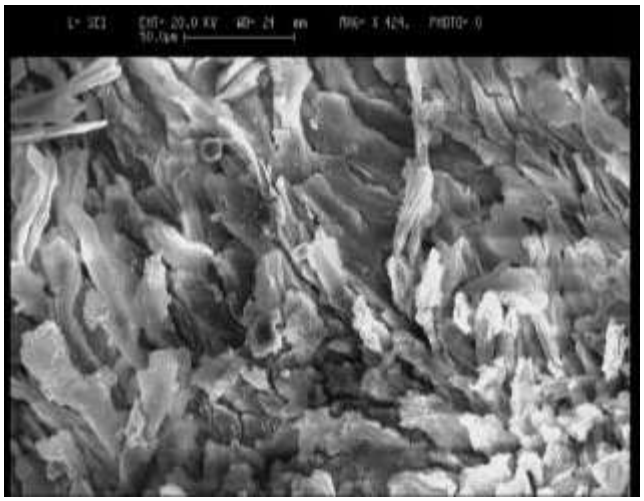

Fig. 2: Scanning electron micrograph of the lingual body with lamellar shaped epithelium similar to that of the lingual apex

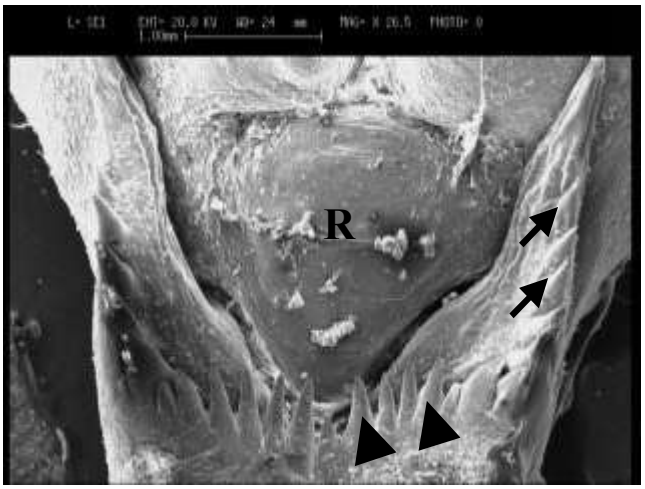

Fig. 3: Scanning electron micrograph of the surface of large conical papillae between the body and root of the tongue. Note the U-shaped arrangement of the conical papillae. The lateral papillae (arrows) are noticeably thicker than the middle ones (arrowheads). Lingual root (R).

Fig. 4: A higher magnification of conical papillae with characteristic aspect of the stratified scales

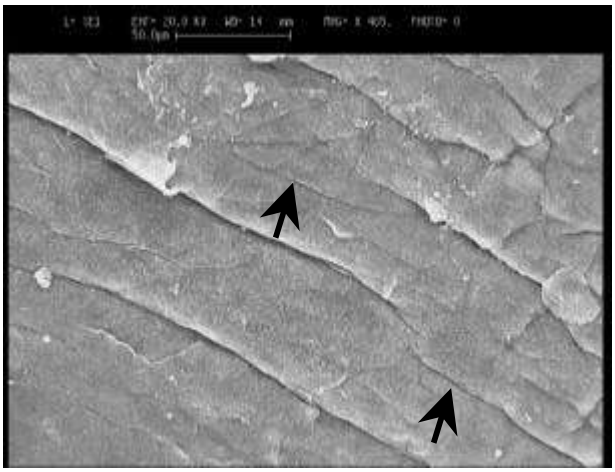

Fig. 5: Scanning electron micrograph of the dorsal surface of the lingual root showing smooth aspect with no papillae. Note the presence of microridges (arrows) on the surface epithelium.

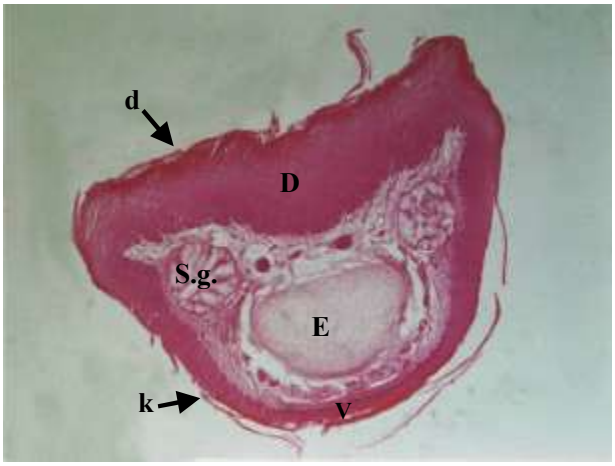

Fig. 6: Cross-section of the lingual apex in the domestic pigeon; light photomicrograph, × 40, HandE staining. Entoglossal bone (cartilaginous) (E), dorsal (D) and ventral surface (V) of the tongue, lingual salivary glands (S.g.). Note the presence of desquamated epithelial cells (d) of the dorsal and keratinized layer (k) of the ventral lingual mucosa.

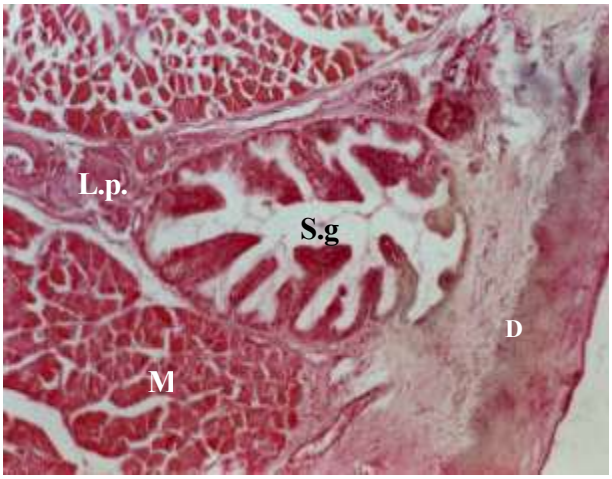

Fig. 7: The lingual salivary gland (S.g.) in the body of tongue. × 100, PAS staining. Dorsal surface (D) of the tongue, lingual muscle bundles (M), lamina propria (L.p.).

The lingual salivary glands of the domestic pigeon composed of two laterally situated single strands, are located in the lamina propria of the dorsal lingual plate and extend from the apex of the tongue to the both sides of the laryngeal cleft (Figs. 6, 7). The glands are of branched tubuloalveolar type and consist of secretory endpieces composed of tall columnar cells with extensive vesicular cytoplasm resting at a delicate basement membrane. The ventral surface of the tongue is devoid of any glandular structure. All the lingual salivary glands in domestic pigeon show strongly PAS positive reaction (Fig. 7).

DISCUSSION

Owing to their different lifestyles, birds show considerable differences in the structures of their bills and tongues. In many species of birds, the tongue is a triangular organ that fills the whole lower part of the bill [10-13]. It is an elongated tubular organ in woodpeckers [8] and elongated flat in geese and ducks [13-14]. The tongue of the cormorant is only a small, mushroom-shaped connective tissue structure joined with the hyoid cartilage and the lingual root are non present [4]. Macroscopic features of the tongue in ostrich, such as the proportion of its size to the beak and its shape, indicate a morphological reduction of this organ [7]. Results obtained from the present study show that the tongue of the domestic pigeon like that of many other birds is a well developed triangular organ with three distinct anatomical parts, i.e. apex, body and root.

Data obtained from the present study also showed that a distinct median groove divides the apex and body of the tongue of the domestic pigeon into two symmetrical halves. The median groove is a characteristic feature found on the tongue of white tailed eagle, ducks and geese, whereas it is absent on the tongue of chickens and penguins [2, 3, 10, 12, 13, 15, 16]. On the dorsal surface of the short tongue of the cormorant, in the midline a crest is found, resembling a ridge, reaching both ends of the organ [4]. Iwasaki [1] stated that, there is a median line in the anterior part of the tongue in the little tern and the apex of the tongue is slightly bifurcated .

The conical papillae found between the body and root of the tongue show considerable differences in their distribution and development among the different avian species. The papillae are well developed in the white tailed eagle, black kite, northern goshawk, goose, [3, 14, 17,18]; are distributed in a very wide area between the lingual apex and lingual root in the peregrine falcon, common kestrel and owl [5,6] and are absent in the tongue of the Japanese Pygmy Woodpecker and ostrich [7, 8]. The anatomical arrangement of the papillae shows also variability in birds. They are arranged in a transverse row in chicken and goose [14, 16], in the form of the letter V converging in the median line in white tailed eagle [3]. Our results showed that a unique feature of the tongue in domestic pigeon is the U-shaped arrangement of well developed conical papillae in the posterior part of the lingual body. No one has described this peculiar papillary arrangement in the tongues of species of birds that have been examined so far. These differences in the structures of the tongues may be due to the different feeding habits. It seems that the papillae aid in the transfer of the food towards the alimentary canal and prevent its regurgitation.

Results obtained from the present study also showed that the mucosa of lingual apex, body and root is covered with squamous stratified nonkeratinized epithelium. This finding is similar to those documented by Jackowiak and Godynicki [3] in the white tailed eagle and by Jackowiak and Ludwig [7] in the ostrich. In most of the other species of birds examined, the whole dorsal surface of the tongue up to conical papillae is covered by horny epithelium, whereas the stratified epithelium without the horny layer usually covers a part of the root of the tongue [10, 16, 19]. The microridges present on the lingual root in the domestic pigeon may enhance the transportation of seed through the lingual surface and act as sites for retention of the mucous produced by the salivary glands of the lingual root.

Salivary glands also show considerable species variation in birds. While salivary glands are generally well developed in granivorous species, they are less developed in birds of prey, poorly developed in piscivores and absent in the Anhinga and Great Cormorant [9]. Our results showed that the salivary glands of the domestic pigeon form two single continuous strands extended from the apex to the root of tongue. In many other birds so far studied, the salivary glands have been considered as anterior and posterior lingual glands without any anatomical continuity between them. Exceptional cases include e.g. the lingual salivary glands in the Ostrich in which the lamina propria of the lingual mucosa is filled with mucous glands whose openings are found on both the dorsal and ventral surface of the tongue [7]. The secretory cells of the lingual salivary glands shows strongly positive reaction to PAS reaction, indicating that the saliva of the domestic pigeon similar to that of other birds is rich in glycoproteins. The saliva may lubricate ingested food for ease of swallowing, protect the mucous membrane of the upper digestive tract.

It was concluded that the unique features of the tongue in the domestic pigeon were the presence of the large conical papillae with a U-shaped arrangement between the body and the root of the organ and peculiar arrangement of lingual salivary glands.

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