

## Scanning Electron Microscopy of the Tongue in the Golden Eagle *Aquila chrysaetos* (Aves: Falconiformes: Accipitridae)

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**Abstract:** The aim of this study was to investigate the scanning electron microscopic structure of the tongue in golden eagle. Three adult golden eagle were used in the present study. The tongue of the Golden Eagle *Aquila chrysaetos* (Aves: Falconiformes: Accipitridae) has a total length of 30 mm and a clear median longitudinal groove being of uniform width along the dorsal surface. A single row of large conical papillae is observed between the body and root of the organ, the apices of which are pointed towards the posterior part of the tongue. The lateral parts of the dorsal surface of the lingual body is covered by the slim filiform papillae. The remaining of the body of the tongue is covered by desquamating cells of the surface epithelium with a typical conical arrangement. A unique feature in the caudal of the golden eagle's lingual body is the presence of well developed circumvallate papillae. No one has described the presence of filiform or circumvallate papillae in the tongues of species of birds that have been examined so far. The lingual papillae are not found on the lingual root. Numerous, wide orifices of lingual glands are located evenly on the whole dorsal surface of the lingual root.

**Key words:** Tongue • Lingual papilla • Surface epithelium

### INTRODUCTION

The tongue, which plays a very important role in food intake by vertebrates, exhibits significant morphological variations that appear to represent adaptation to the current environmental conditions of each respective habitat [1].

There are three distinguishable anatomical parts in the tongue of birds: the apex, the body and the root. The body and the root of the organ are demarcated externally by a single or double crest composed of mechanical conical papillae [2, 3]. Birds live in the air, on land and on and around fresh water and sea water. However, keratinization of the lingual epithelium is a common feature [4-6].

Histological structure of the tongue has been described in a number of avian species such as cormorants [7]; domestic chickens [8]; little tern [9]; goose [5]; white tailed eagle [10]; Penguin [6] and ostrich [11].

The results obtained from these studies show a close relationship of the shape of the tongue with the method of food intake and the type of food and habitat. The golden eagle is a cosmopolitan species, distributed throughout the Northern Hemisphere [12]. However in available literature, there is a lack of morphological data characterizing the histological structure of the tongue in this species.

The aim of this study was to morphologically describe the tongue of the golden eagle with special reference to the lingual papillae at scanning electron microscopic levels and to compare the results with data obtained from other vertebrates.

### MATERIALS AND METHODS

The tongue of three adult female golden eagle (*Aquila chrysaetos*) donated by the Zoological garden of Shahrekord was used in the present study. No animal was



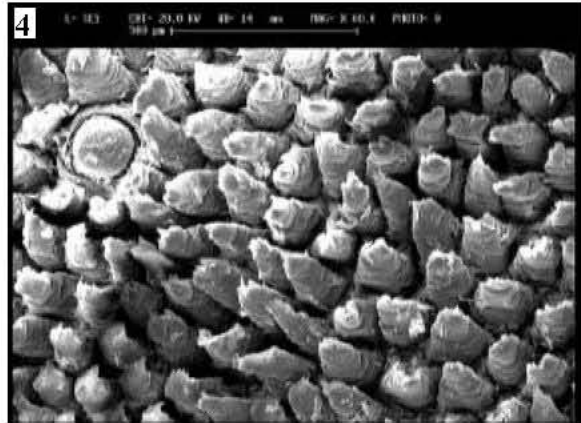


Fig. 4: Scanning electron micrograph of the middle part of the dorsal surface of the lingual body covered by desquamating surface cells. Note the conical arrangement of the desquamating cells and the presence of a circumvallate papilla among the conical-shaped papillae.

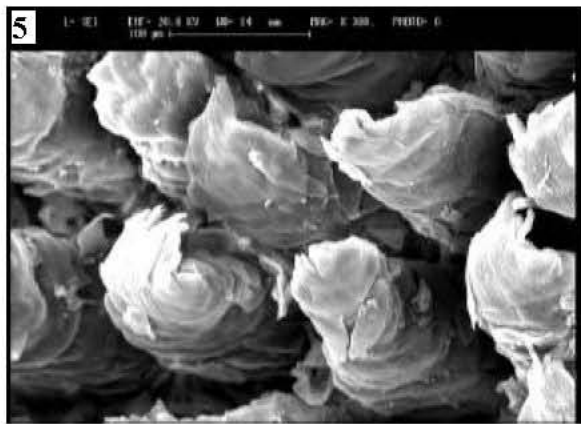


Fig. 5: A higher magnification of the desquamating cells showing stratified scales on the surfaces of them.

Two circumvallate papillae, measured  $160 \times 180 \mu\text{m}$  were found in the posterior part of the lingual body, immediately in front of the lingual root among the desquamating cells of surface epithelium. Each circumvallate papilla which was visibly elevated from the lingual surface had a center doughnut-shaped region with apparent taste pores on its dorsal convex surface and a continuous outer circular trough. The central region and the outer trough were completely independent from each other and from surrounding parts of the tongue. There was a deep sulcus around the central region of the papilla which seems to enhance the accessibility of food to the taste buds. At high magnification, desquamated epithelial

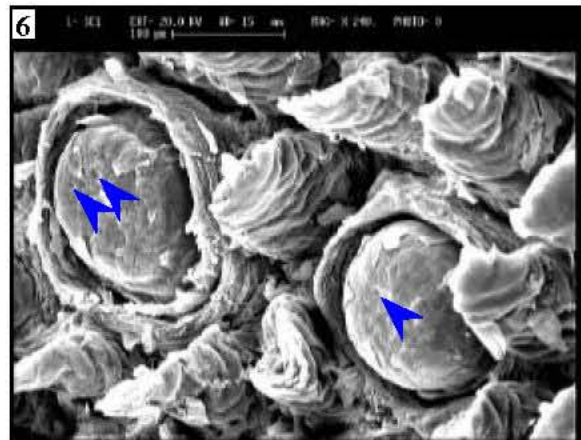


Fig. 6: Scanning electron micrograph showing two circumvallate papillae with a central doughnut-shaped region surrounded by a deep sulcus and a circular trough. Note the characteristic aspect of the stratified scales and the presence of taste pores (arrows) on the dorsal convex surfaces of the papillae.

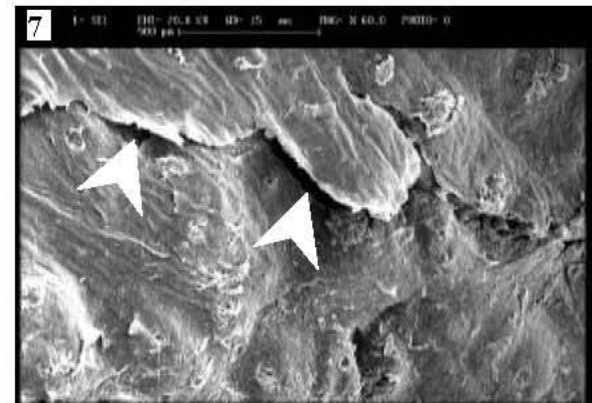


Fig. 7: Scanning electron micrograph of the surface of the lingual root. The lingual papillae are not found on the lingual root and clusters of horny cells desquamate as thin compact plaques (arrowheads).

cells can be seen irregularly superimposed on the surfaces of the circumvallate papillae (Fig. 6).

The lingual papillae were not found on the lingual root so that the lingual surface was flat and clusters of horny cells desquamate as thin compact plaques (Fig. 7). The large conical papillae between the body and root of the organ also showed a flat surface (Fig. 8). Numerous, wide orifices of lingual glands, with diameters reaching  $150 \mu\text{m}$ , were located evenly on the whole dorsal surface of the lingual root (Figs. 8, 9).



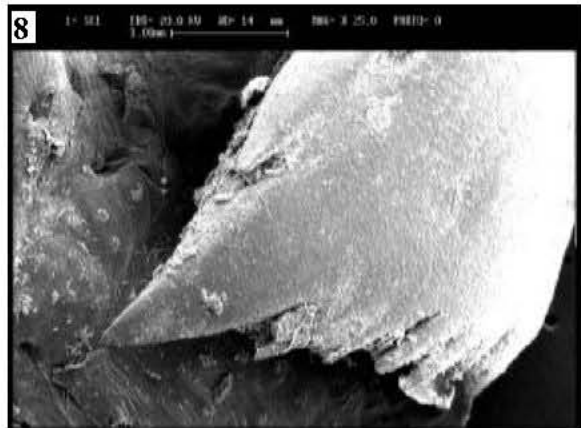


Fig. 8: Scanning electron micrograph of the surface of lingual root. Note the presence of large conical papillae between the body and root of the tongue.



Fig. 9: A higher magnification of the wide openings of the lingual glands in the lingual root.

## DISCUSSION

In the elongated tongue of the golden eagle the characteristic feature is a distinct median groove which divides the apex and body of the tongue 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, 6, 10, 13-15]. 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 [7]. In the anterior part of the tongue in the little tern, there is a median line and the apex of the tongue is slightly bifurcated [9]. Jackowiak and Godynicki [10] stated that in the white

tailed eagle, the median lingual groove expands gradually towards the back of the lingual body. Results obtained from the present study however showed that in golden eagle the median lingual groove is uniform in its width throughout the length.

Regarding the lingual papillae, the tongue of golden eagle showed considerable differences in comparison with the tongues of species of birds that have been examined so far. In most of the species of birds examined, the tongue except for its apical part, is covered by flat, stratified, keratinized epithelium. However two types of papillae i.e. filiform and circumvallate papillae can be found on the dorsal surface of the tongue in golden eagle.

Results obtained from the present study showed that many processes are observed densely distributed over the entire lingual apex of the dorsal surface. Each epithelial cell presents the leaf-shaped aspect.

Many processes were observed densely distributed over the entire anterior 2/3 of the lingual dorsal surface in the chicken tongue [15], over the entire lingual apex of the dorsal surface, except in the tip of the apex in the owl [16] and over the entire lingual apex in the peregrine falcon and common kestrel [17]. Results obtained from the present study regarding the leaf-like processes on the dorsal surface of lingual apex in golden eagle was the same as that of the lingual apex in the owl, falcon, kestrel and chicken. However, each papilla of the chicken presented a flattened and slightly twisted aspect [15], that of the owl a thread-shaped appearance [16] and that of the falcon and kestrel a carpet-shaped aspect [17].

Our results also showed that two types of lingual papillae were observed on the dorsal surface of the body of tongue in golden eagle. The lateral parts of the dorsal surface of the lingual body were covered by the slim filiform papillae. The middle part of the body of the tongue however was covered by desquamating cells of surface epithelium with a typical conical arrangement.

The presence of various forms of filiform papillae has been well documented in the bat [18], rodents [19, 20] and mammals [21]. However, information about the scanning electron microscopic structure of filiform papillae in birds is limited.

Emura *et al.* [22] stated that in Pygmy woodpecker, the dorsal surface of the lingual body presents smooth aspect. In penguins, the whole dorsal lingual surface is covered by long conical papillae that help to hold ingested food [6].

Our finding regarding the presence of two types of lingual papillae in golden eagle may indicate that different tongue regions in birds can be selectively modulated during swallowing tasks. However more research needs to be undertaken to augment the finding.

Our findings also revealed that the apices of filiform papillae are bent toward the posterior part of the tongue. In mammals the anterior regions of filiform papillae are softer than their posterior regions. Therefore the papillae are easily bent in the direction of the radix but not in the opposite direction. This property facilitates retention of food on the dorsal surface of the tongue [4, 23, 24].

A unique feature observed in the caudal part of the golden eagle's lingual body is the presence of well developed circumvallate papillae. The presence of taste pores on the dorsal convex surface of papilla clearly suggests that they are gustatory papillae.

Many mammals of both terrestrial and aquatic species possess circumvallate papillae and their distribution varies depending on the species [1]. However, no one has described the presence of these papillae in the tongues of species of birds that have been examined so far. The circumvallate papillae of mammals are submerged into the surface of the tongue, so that the outer ring of the papilla is integrated with the surrounding part of the tongue [25-28]. Results obtained from the present study showed that unlike in mammals, the circumvallate papilla in golden eagle apparently raise over the level of tongue's mucus membrane so that the outer trough of the papilla is completely separated from the surrounding part of the tongue. Jackowiak and Godiyacki [10] stated that gustatory papillae were not found in the epithelium covering the tongue in the white tailed eagle.

Our results showed that a single row of large conical papillae is present in the posterior part of the lingual body, the apices of which are pointed towards the posterior part of the tongue. In the marginal region between the anterior and posterior part of the tongue of the chicken, a close array of giant conical papillae was observed, arranged transversely in a row [15]. At a point approximately 2/3 of the length of the tongues in the white tailed eagle and black kite and between the body and the root of the tongue there were large conical papillae, the apices of which were pointed towards the posterior part of the tongue [10, 17, 29]. In the tongues of the peregrine falcon, common kestrel and owl the conical region between the lingual apex and lingual root is very wide area [16, 17]. In the Japanese Pygmy Woodpecker and ostrich, the large conical papillae were not observed between the lingual body and root [11, 22].

The crest of the conical papillae found in the lingual body was sites aiding in the transfer of the swallowed food towards the oesophagus and at the same time preventing its regurgitation [10]. Therefore this crest is well developed in birds such as white tailed eagle, golden eagle and owl which feed on fish or small animals and is absent in birds such as woodpecker and ostrich which feeds on insect or plants.

Our results showed that no lingual papillae were seen on the lingual root. Similar SEM finding has been reported on the lingual root of the owl and white tailed eagle [10, 16]. In the Japanese Pygmy Woodpecker, needle processes are observed on the dorsal surface of the lingual root [22].

Results obtained from the present study also showed that many openings of lingual salivary glands were situated on the dorsal surface of the lingual root. In the tongue of the Japanese Pygmy Woodpecker, a pair of openings of the lingual glands was observed in both lateral sides of the root of the lingual body [22]. In the tongues of the peregrine falcon, common kestrel and owl the many openings of the lingual glands existed in the entire surfaces of the lingual body and lingual root [16, 17]. Jackowiak *et al.* [7] stated that the lingual glands are absent in the mucosa of the tongue in cormorants. In the Ostrich, 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 [11].

In conclusion, results of the current work showed that the unique features in the tongue of golden eagle were the presence of two types of well developed lingual papillae i.e. filiform and circumvallate papillae.

#### ACKNOWLEDGEMENT

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