Middle-East Journal of Scientific Research 9 (3): 384-389, 2011
ISSN 1990-9233

A Comparative Scanning Electron Microscope Study of the Dorsal Lingual Surface of *Meropes orientalis* (Little Green Bee Eater) and *Meropes epiaster* (European Bee Eater)

Neveen El Said Reda El Bakary

Department of Zoology, Faculty of Science, Mansoura University, New Damietta, Egypt

Abstract: The present study has been carried out to examine comparative macroscopic and microscopic structures of the dorsal lingual surface of two avian species belong to order Coraciiformes; family Meropidae, little green bee eater (*Meropes orientalis*) and European bee eater (*Meropes epiaster*) by using scanning electron microscopy and to compare the present results to those that was held on the previous studies of other birds. Morphological comparison revealed that, the tongue of the studied avian species triangular in the form and filled the whole lower part of the bill. The dorsal lingual surface recognized as three parts; the apex, the body and the root, which are similar to the most of the majority of avian tongue, indicated a close relationship of the lingual form structure with the feeding habitats including food –intake and the type of foods. The result showed that the most obvious features of the bee eaters tongues is the unique structure of the apex of the tongue which has two long and highly keratinized epithelium. Also, the dorsal lingual surface of little green bee eater (*Meropes orientalis*) shows less keratinized than those of European bee eater (*Meropes epiaster*). The distribution patterns of the lingual glands are almost similar in both little green bee eater and European bee eaters, these openings in both species are found around the larynx. In conclusion, tongue morphology varies little within families.

Key words: Comparative · Scanning Electron Microscope Study · Dorsal Lingual Surface · Birds

INTRODUCTION

Morphological studies on the structure of the tongue in birds have been conducted on a small number of species, i.e. chickens, parrot, geese, eagle, cormorant, owl, peregrine falcon, common kestrel, oriental scops owl, zebra finch and hoopoe [1-10].

The avian tongue generally showed the triangular form and filled the whole lower part of the bill. Most of the avian tongues area divided into as three parts, the apex, the body and the root. Morphological and ecological investigations strongly indicated a close relationship of the lingual form, histological structure of the lingual mucosa and skeletal apparatus of the tongue with the feeding habitats including the food-intake and the type of foods [8, 9, 11-14].

Although there are few extensive microscopic studies concerning wild-living birds, very few studies were carried out in this kind of avian species such as African grey parrots [1]; penguins [15] and white tailed eagle [4]. Until the present time, no attention has paid on the morphological and functional aspects of the tongue in the order Coraciiformes. The present study has been carried out to examine the macroscopic and microscopic structures of the tongue in two species of the order Coraciiformes using scanning electron microscopy and to compare the present results to those of the previous studies of other birds.

MATERIALS AND METHODS

The experimental animals of the present study include ten samles of *Meropes orientalis* (Little Green Bee Eater) and *Meropes epiaster* (European Bee Eater) which belong to family Meropidae were collected from Damietta Governorate, Egypt.

The tongues of *Meropes orientalis* and *Meropes epiaster* (bee eater) were used in this study. The tongues were fixed in 10% formalin, post fixed with 1% osmium tetroxide for 1h at pH 7.2. Thereafter, the specimens

Corresponds Author: N.E.R. El-Bakary ,Department of Zoology, Faculty of Science, New Damietta, Egypt.

were dehydrated through graded series of ethanol and critical point dried. To show the three dimensional connective tissue structure of the lamina propria of the mucosa, some samples were washed in distilled water after fixation and macerated in 10% NaOH at room temperature for 4 days. After maceration tissues were washed in several changes of distilled water and post fixed in 1% buffered osmium tetroxide for 1h. After washing three times, the specimens were dehydrated in a series of ethanol and critical point dried [4]. All specimens were mounted on aluminum stubs covered with carbon tabs, sputtered with gold and observed under JEOL scanning electron microscopy (JSM-5300) at an accelerating voltage of 15kv in electron microscopy unit in Faculty of Science at Alexandria University.

RESULTS

In the present study, the length of the tongue of adult little green bee eater is about 2.5cm while that of adult European bee eater is about 3.5 cm long. In the two studied species, the dorsal surface of the tongue are divided to three parts; the apex, the body and the root (Fig. 1). In both little green bee eater and European bee eater, the apex is bifurcated into two branches, each of which is further bifurcated (Fig. 2a, 3a). The dorsal lingual surface of little green bee eater shows less keratinization than those of European bee eater (Fig. 2b; 3b). After sodium hydroxide maceration, the keratinized lingual apexes of little green bee eater and European bee eater are lost (Fig. 2c; 3c). The mucosal surface of the tongue in the apex, body and root of the tongue is flat with no papillae (Figs.2a-f, 3a-f).

The openings of the lingual glands in the little green bee eater (Fig.2 d-f) and European bee eater (Fig.3 d-f) is adjacent to and around larynx opening The fibers of the connective tissue of the lamina propria of the lingual body and root of the little green bee eater form thin rounded interconnected laminae running from the lingual medial groove to the edge of the tongue (Fig. 2 g-i). The fibers of the connective tissue of the lamina propria of the lingual body and root of the bee eater are elongated and parallel to each other (Fig. 3 g-j)

DISCUSSION

All birds are adapted to their habitats; in the air, on land and on and around fresh water and sea water with respect to food sources. Birds have different feeding habits, with corresponding differences in the structure of

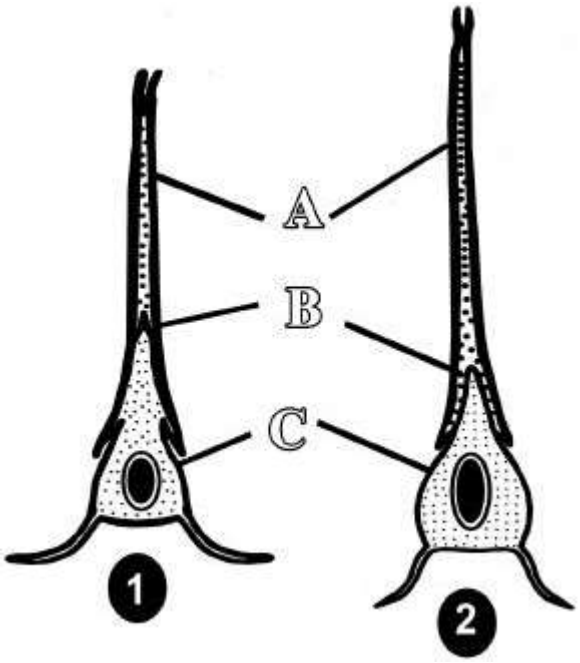

Fig. 1: Diagram showing macroscopic view from the dorsal side of the tongues of (1)-*Meropes orientali* and (2)-*Meropes epiaster* (A: apex, B: body and C: root of the tongue).

their bills and tongues. The structure of the tongue of birds frequently gives some clue to the principal diet and manner of feeding of the species. The tongue of the bird is intimately related with the birds most important problem, that of obtaining food and for this function it must serve as a probe or spear (e.g., woodpecker), a seieve (e.g., ducks), a capillary tube (e.g. sunbirds), a brush (e.g., Trichglossidae), a rasp (e.g. vulture), a barbed organ (e.g. penguin) [11].

In the present study, the tips of the tongues of the little green bee eater and European bee eater were bifid. Similar structures were showed on the Peregrine Falcon and Common Kestrel [7].

The presence of conical papillae varies greatly among the previous studied species and is related to their feeding habits. Firstly, in the marginal region between the anterior and posterior parts of the tongue of the chicken, a close array of giant conical papillae was observed, arranged transversely in a row [2]. Secondly, on the tongue of the goose, giant conical papillae were located in a transverse row between the lingual body and the lingual radix [3]. Thirdly, at a point approximately 2/3 of the length of tongue in the white tailed eagle, between the body and the root of the tongue there were large conical papillae, the apices of

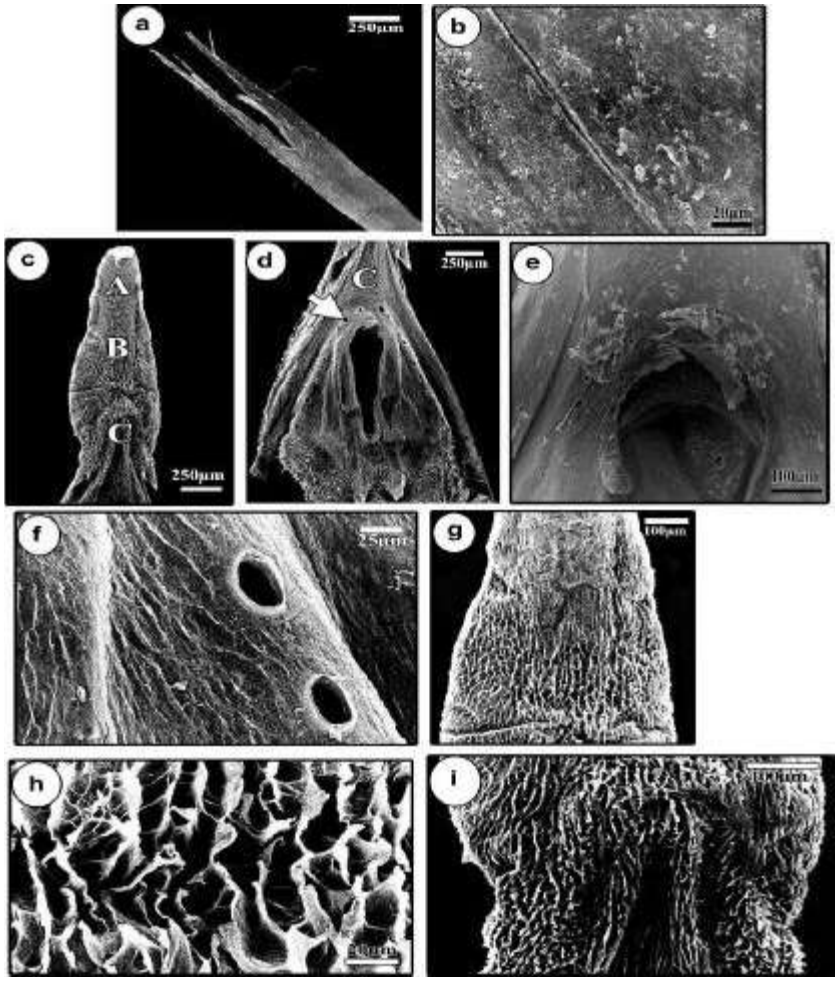

Fig. 2: Scanning electron micrograph of the dorsal lingual surface of *Meropes orientalis* (little green bee eater). a,b-well keratinized epithelium covering tip of the tongue. c-apex (A) body (B) and root (C) of the tongue (sodium hyroxide macerated sample). D-th root of the tongue (C) and the openings of the lingual glands around the larynx opening. E,f the lingual root and openings of the lingual glands before (e) and after (f) sodium hydroxide maceration. g,h-dorsal subepithelial surface of the lamina propria of the lingual mucosa of the body (sodium hydroxide macerated sample) i-dorsals subepithelial surface of the lamina propria of the lingual mucosa of the root (sodium hyroxide macerated sample).

which were pointed towards the posterior part of the tongue [4]. Furthermore, in the white tailed eagle, the crest of the conical papillae found in the lingual body was sites aiding in the transfer of the swallowed food towards the esophagus and at the same time preventing its regurgitation [4]. In the peregrine falcon and common kestrel [7], there were observed not only the crest but also the many conical papillae on the lingual body. Finally, in the dorsal surface of the Hoopoe tongue, large conical papillae are found at the posterior border of the lingual apex and small and large conical papillae are found between the body and the root of the tongue [10]. The presence of papillae in these regions facilitates pushing food to the lingual glands which are found in the region posterior to the conical papillae directly. The present results show that these species of birds has no any conical papillae.

Distribution of lingual glands on a few bird species make it possible to distinguish anterior and posterior lingual glands [13, 16-18] The orifices of the anterior lingual glands of the birds are located on the edges of the lingual body or occasionally on the lateral surfaces of the tongue, whereas the orifices of the posterior lingual glands are located on the dorsal surface of the root of the tongue.

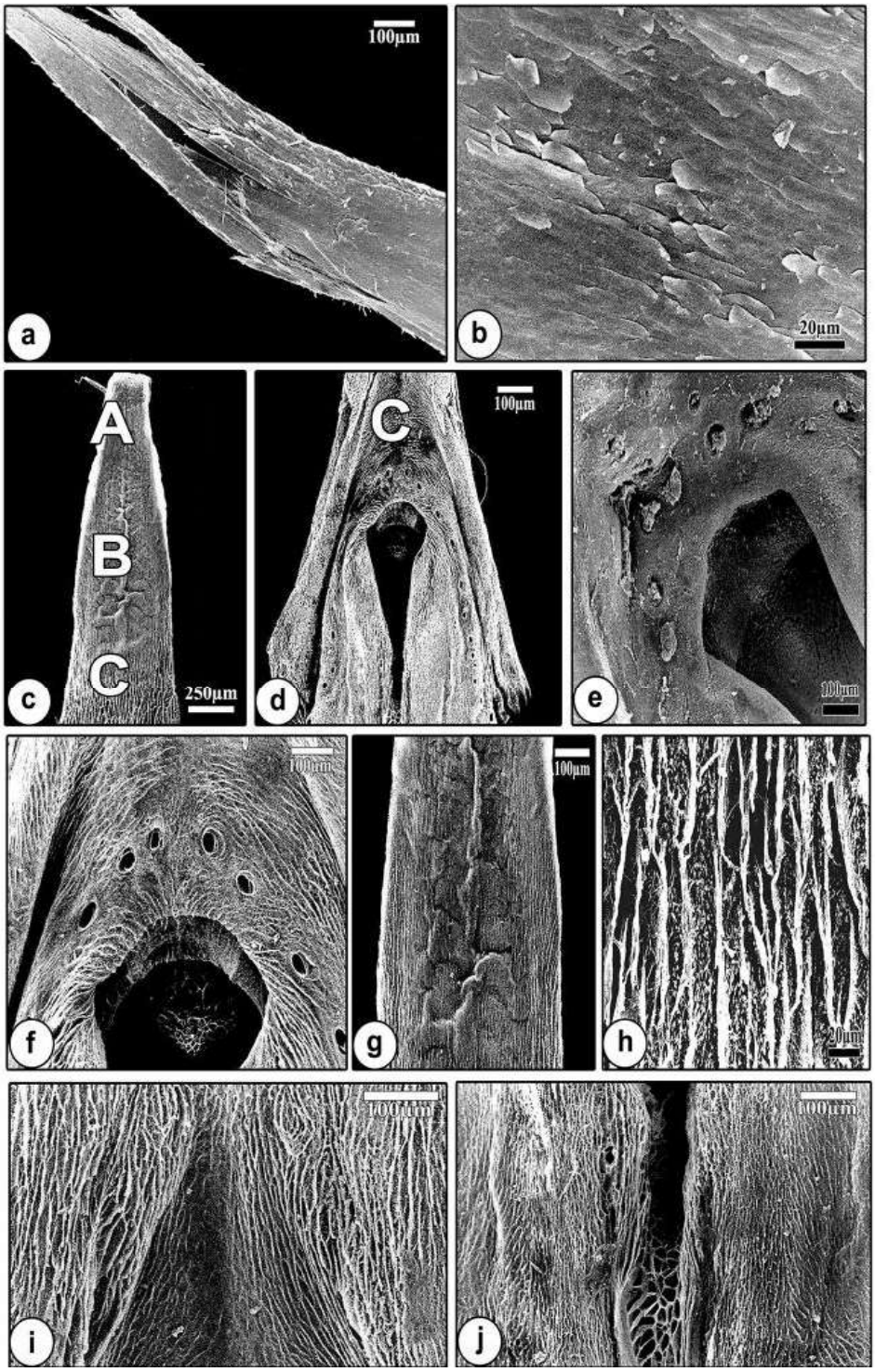

Fig. 3: Scanning electron micrograph of the dorsal lingual surface of *Meropes epiaster* (bee eater). a,b keratinized epithelium covering tip of the tongue. c-apex (A), body (B) and root (C) of the tongue (sodium hydroxide macerated sample). d- the root of the tongue (C) and the openings of the lingual glands around the larynx opening. e,f- openings of the lingual glands before (e) and after (f) sodium hydroxide maceration. g,h- dorsal subepithelial surface of the lamina propria of the lingual mucosa of the lamina propria of the linguall mucosa of the root (sodium hyroxide macerated sample). j-dorsal lingual surface back to larynx opening.

A different distribution of glands was found in Hoopoe where the anterior lingual glands are located on the entire part of the body of the tongue and the posterior lingual glands are located on the entire part of the root of the tongue and numerous than that of the anterior one. These glands may help in lubrication of food before pushing it to the esophagus [10]. In this study, the distribution of the lingual glands in the bee eaters is around the larynx opening may indicate that food needs more lubrication.

The secretion of these glands may be collected in the subepithelial chamber, whereas wide orifices of the glands provide effective evacuation of the produced glutinous mucus which may act as inhibitors of some bacterial enzymes [19].

The white tailed eagle feeds mostly on fish and the peregrine falcon and common kestrel feeds on small animal. The hoopoe feeds on large insects, their larvae and pupae, also small vertebrates: lizards and geckos. The bee eater is almost exclusively aerial hunters of insect prey. Prey is caught either while in continuous flight or more commonly from an exposed perch where the bee- eater watches for prey. Before swallowing prey, a bee eater removes stings and breaks the exoskeleton of the prey by repeated thrashing it on the perch.

Therefore, the differences in the structures of the tongues in the white tailed eagle, peregrine and common kestrel, hoopoe, little green Bee eater, European bee eater may be reason of the differences in the feeding habits.

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