Iran. J. Ichthyol. (Special Issue 1, 2022): 116-122

P-ISSN: 2383-1561; E-ISSN: 2383-0964
http://www.ijichthyol.org

Research Article

Histomorphological study of the tongue in adult starling birds (*Sturnus valguris*)

Suhaib A.H. AL-TAAI*, Azhar Saleem KHALAF

Department of Anatomy & Histology, College of Veterinary Medicine, University of Baghdad, Iraq.

Email: dr.suhaibaltaai@gmail.com

Abstract

The study aimed to describe the morphology of the starling tongue, as well as its histological structures. The tongue was elongated triangular in shape locating the lower part of the beak cavity, between upper and lower beak. The tongue has two surfaces, dorsal and ventral, and two borders, lateral and medial. The dorsal face was divided into three regions, apex (tip), body, and root. The frontal portion of the dorsal face was included the median groove which it is ends the tongue body. The lingual papillae were presented on the dorsal view of the tongue only. There are conical lingual papillae found between body and root, which lie inside the concave transverse row V-shape. The study showed a variety of lingual papillae whence the location, size, and shape. Where the pharyngeal papillae are closed from the laryngeal cleft. The histological structure showed the mucosa of the tongue formed by the stratified squamous epithelia keratinize which lined the lateral border of the dorsal surface, while the medial border was lined by non-keratinize stratified squamous epithelia. The ratio of keratin thickness is less toward the antero-posterior end until the tongue. Lingual salivary glands are included in two groups, anterior and posterior under epithelia layer. These glands were characterized by aggregations that increase toward the lingual root. The secretory units of glands were characteristic of a tubuloalveolar type and their ducts open toward the dorsal surface directly. These glands consist of a group of mucous cells characterized tall columnar with basal nuclei in position. In a histochemical reaction by periodic acid Schiff stain with mucous secretion of these cells showed negative reaction. The lingual muscles were observed to represent the circular axis at the root region.

Keywords: Tongue, Starling, Lingual glands, Histology, Morphology.

Citation: Al-Taai, S.A.H. & Khalaf, A.S. 2022. Histomorphological study of the tongue in adult starling birds (*Sturnus valguris*). Iranian Journal of Ichthyology 9(ICAB Special issue 2022): 116-122.

Introduction

The starling bird *Sturnus valguris* is a seasonal wild bird found in western and eastern Asia and in Iraq is seen during winter. In addition, they are reported from Western Europe, central Asia, Iceland, north India, southern Australia, South Africa, and Jamaica (Purcell et al. 2002; AL-Taai & Nsiaf 2020). There are many studies on the tongue structures of birds (Homberger & Brush 1986), such as *Gallus domesticus* (McLelland 1975; Iwasaki & Kobayashi 1986; Homberger & Meyers 1989), little tern (Iwasaki 1992), Red jungle fowl tongue (Kadhim et al. 2011), and Peregrine falcon *Falco peregrinus* (Al-Nefeiy 2022).

Birds have been adapted to different environments for life, leading to different morphological structures in their tongue. The tongue is divided into apex (tip), body, and root (Komarek et al. 1986; Iwasak 2002). The lingual papillae of the birds are found almost in each bird, functioning to crushed hard foods (grain), using as teeth, and they hold diet on the dorsal surfaces of the tongue (Iwasaki et al. 1997). Lingual salivary glands are found in almost all birds and may be absent in other birds such as pelicans. Some birds

are different in food consumption, and intake of diet affects the shape of tongue epithelia (Jackowiak & Godynicki 2005; Jackowiak & Ludwig 2008; Tivane 2008; Taki-El-Deen 2017; Al-Nefeiy 2022). The bird's tongue is covered by keratinize or non-keratinize stratified squamous epithelia, according to food intake habits. The keratinize thickness of epithelium in the lateral border of the tongue during domestic birds is less (Erdoğan et al. 2012b). The salivary glands are well-developed during granivorous and insectivorous, either the birds are consumed soft food such as piscivorous, will be less developed (Iwasaki 1992). This study aimed to investigate the morphological and histological structure of the starling bird *S. valguris*.

Materials and methods

Experimental design: Ten adult birds were used in this study, all purchased from the Gazzel market, Baghdad. Then the birds were put on board stage for the dissecting after anesthesia. The weights of birds were measured by electronic balance. They were in good health conditions, birds tongue incised at oral cavity after the dissection. The samples were fixed in 10% formalin for 48 hours. Then they were washed under tap water. The histological techniques were used by dehydration of the samples in alcohol series each 2 hours (70, 80, 90, and 100 %), then, the specimens were cleared by xylene for 1 hour, and embedded inside paraffin wax for preparing block and cutting serially (6 µm) by a microtome. The final step was staining by Hematoxylin and eosin (H&E), and Masson's trichrome stain for diagnostic collagen fibers and Periodic Acid Schiff (PAS) stain to detect polysaccharides (Luna 1968).

Results

Macroscopic examinations: The examination of the tongue showed that it is elongated triangular in shape and is located on the lower part of the beak cavity between the upper and lower beak. Its dorsal surface is divided into apex (tip), body and root. The free part of the tongue was pointed, having narrow dorsal with ventrolateral surface and clefts to left and right parts. The rostral portion of the dorsal surface of the tongue includes a median groove that continually ends the tongue body (Figs. 1ab, 2). The dorsal surface of tongue consists of two borders known lateral and medial borders at two sides (Fig. 2). The region situated between body and root lies inside the concave transverse row of the conical lingual papillae. In addition, a short flat plate arch-like extends from two sides of the tongue angle (Fig. 3a). The lingual papillae in birds vary in shape, location, and size, and the smallest papillae are located at the midline. The large conical lingual papillae were extended caudally toward the transverse row. The transverse row of the conical papillae is concavity V-like, and pharyngeal lingual papillae are situated at the rear of the conical row of lingual papillae close to the laryngeal cleft (Figs. 3b, 4).

Histological features: In the dorsal surface, it is formed two borders, lateral and medial. The mucosa is formed of the stratified squamous epithelia keratinize which lined lateral border of the dorsal surface, while the medial borderlines by non-keratinize stratified squamous epithelia (Fig. 5ab). The ratio of the keratinized layer decreases toward antero-posterior end until the tongue root. After epithelia, the lamina properia is positioned with loose connective tissue which is rich in blood vessels and supported cartilage tissue (Figs. 6, 7b). The bird tongue skeleton is the hyaline cartilage at the entoglossal bone which extended from root to tongue apex (Fig. 6). The lingual salivary glands are found in the lamina properia beneath the lingual epithelium. The lingual salivary glands consist of two groups viz. anterior and posterior groups. These lingual glands were characterized by aggregations that increase toward the tongue root. The location of these glands is different in the tongue tissue. The lingual salivary glands are extended from the mid tongue body to the ending root (Fig. 5a, 7b). The tip of the tongue was clearly identified from glandular structures. The posterior glands are located between the dorsal face of the epithelia and extrinsic circular axis muscles

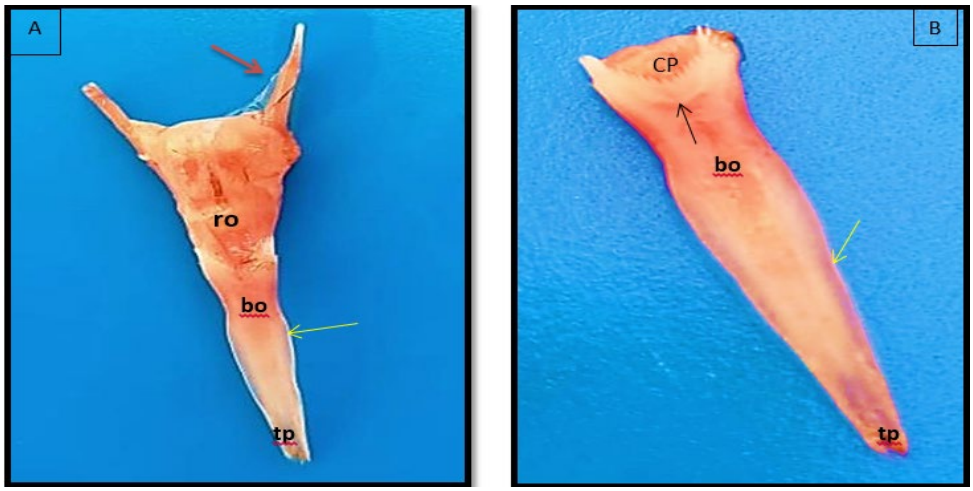

Fig.1. A, B, Macrophotographs of the dorsal surface of the tongue of the starling bird. The arrangement of the conical papillae (CP), in concave transverse row and a short flat plate-like fold (Black arrows) between the body (bo) and the root (ro) and hyoid bone (red arrow), lateral border (yellow arrow) of the tongue are shown.

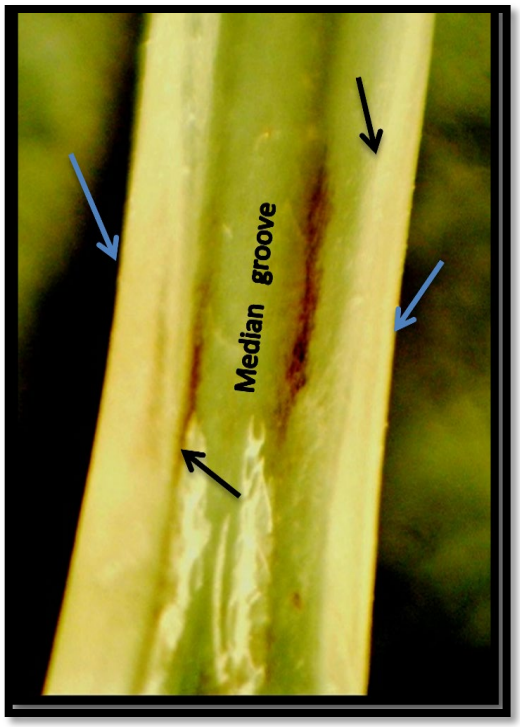

Fig.2. Macrophotograph of the dorsal surface of the tongue body of the starling bird showed (median groove) of tongue, lateral border (blue arrow), medial border (black arrow).

dorso-lateral to the basihyal bone (Fig. 7b). The lingual glands were characteristic by a tubuloalveolar type that its ducts open in the dorsal surface directly. The secretory cell units of these glands consist of mucous cells, characterizing the tall columnar with basal nuclei. In histochemical reaction using periodic acid Schiff stain with mucous secretion, these cells showed a negative reaction. The lingual muscles had a circular axis at the root region (Figs. 5ab, 6, 7ab).

Discussion

The tongue is an important part of the digestive system positioned inside the beak cavity. They were considerably showing the adaption for the bird nutrition. The present study showed a type of arrangement of lingual papillae similar to many birds (Hill 1971; Iwasaki & Kobayashi 1986). However, Iwasaki et al. (1997) and Hassan et al. (2010) pointed out that tongue had only giant conical lingual glands. Jackowiak & Godynicki (2005) mentioned that in eagle, the conical lingual papillae are arranged posterior to a single crest at the tongue body extending toward the anterior lingual root. Our study showed that the pharyngeal lingual papillae in starling birds are situated close to the laryngeal cleft.

The study also showed the structure of the tongue divided into three parts viz. apex, body and root. The results corresponded with findings of AI-Jumaily et al. (2013) and Kadhim et al. (2011) that shown in pigeon *Columba livia* and red jungle fowl tongue, respectively, similar morphology. The starling tongue is composed of the mucosa, with first layer as epithelia formed of the stratified squamous epithelia keratinize which lined lateral border of the dorsal face, while the medial border is lined by non-

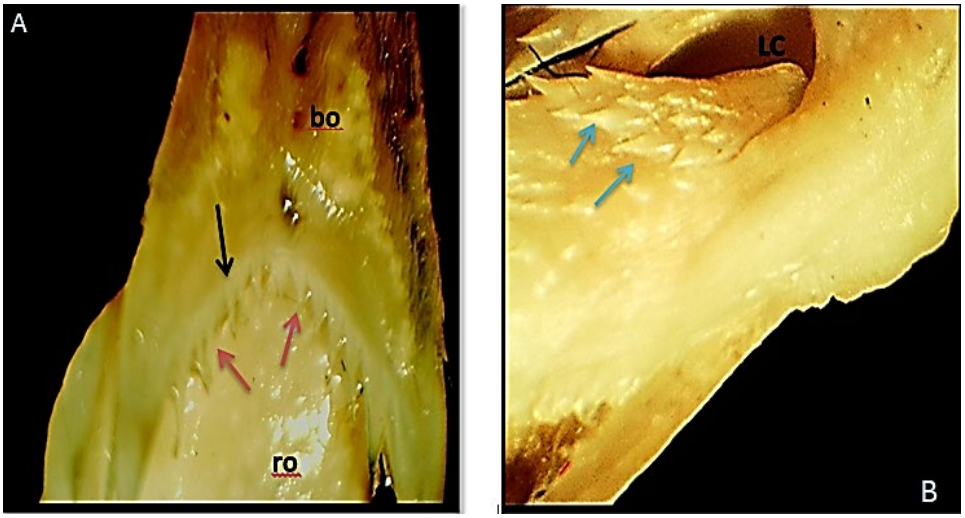

Fig.3. A, B. Macrophotographs of the dorsal surface of the tongue of starling bird showed pharyngeal papillae (blue arrow) and laryngeal cleft (LC), conical lingual papillae (red arrow), in concave transverse row and a short flat plate-like fold (Black arrows) between the body (bo)and root (ro) are shown.

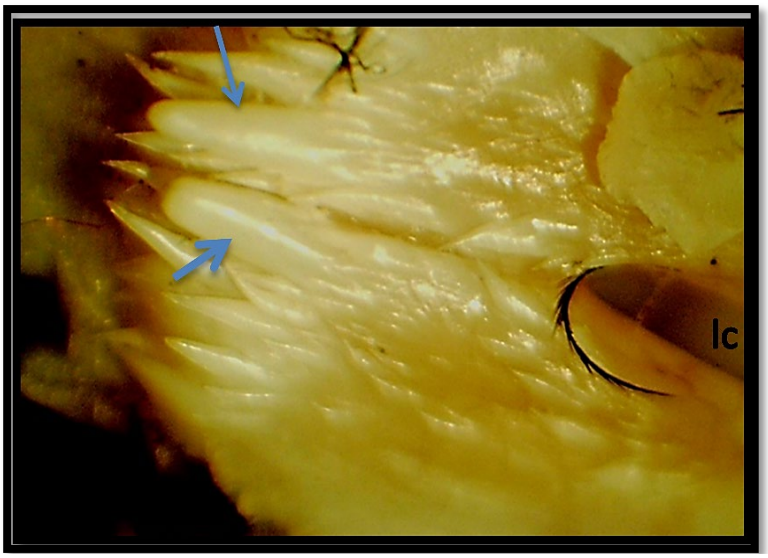

Fig.4. Macrophotograph of the pharyngeal papillae of the tongue of starling bird showed the arrangement of single row of pharyngeal papillae (blue arrows) and laryngeal cleft (LC) are shown.

keratinize stratified squamous epithelia. Also, the ratio of the keratinize was less toward anteroposterior end of the tongue root. Similar to *Acridotheres tristis* (Kadhim et al. 2013). However, in Falco peregrinus (Al-Nefeiy 2022), the tongue epithelia include non-keratinize stratified squamous is lined the dorsal, lateral and ventral surfaces. Susi (1969), Iwasaki (1992) and Jackowiak & Ludwing (2008) pointed out that the keratinize epithelia are in herbivorous and granivorous species. Iwasaki (2002) and Jackowiak et al. (2006) mentioned that keratinized epithelia developed in less degree in water birds. This study also showed that the lamina properia is positioned beneath the epithelia, which included loose connective tissue and supported cartilages. Lingual muscles appeared only during tongue root, representing circular axis, however, (Al-Nefeiy 2022) showed that lingual muscles in Falco peregrinus are bundles of longitudinal axis extended along with the tongue.

The lingual salivary glands are presented in the lamina properia beneath the lingual epithelium. They

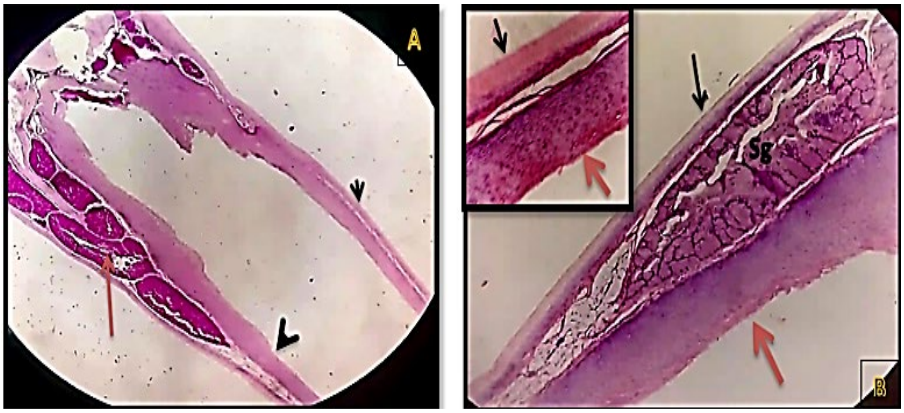

Fig.5. A: longitudinal section of the anterior part of dorsal part of the tongue of starling bird showed the dorsum surface with lateral and medial part (arrowhead), anterior lingual salivary glands (red arrow), H & E stain x40. B: magnified section showed stratified squamous epithelium keratinize of lateral border (black arrow), non-keratinize stratified squamous epithelium of medial border (red arrow), H & E stain 100x.

Fig.6. Longitudinal section of dorsal surface of tongue root of starling bird showed non- keratinize stratified squamous epithelium (red arrow), lingual salivary glands (sg), Lamina properia (LP), supported connective tissue (cartilage), (blue arrow), H & E stain 100x.

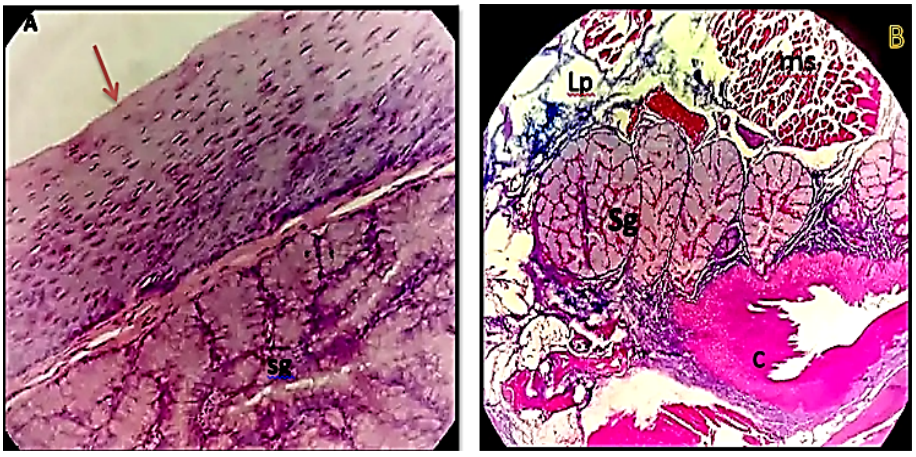

Fig.7. A: longitudinal section of dorsal surface of tongue of starling bird showed non- keratinize stratified squamous epithelium (red arrow), secretory units of lingual salivary glands with basal nuclei (sg), PAS stain 100x B: in Root of tongue showed Lamina properia (LP), supported connective tissue (cartilage), (C): posterior lingual salivary glands (Sg), muscles fibers (ms), masson's trichrom stain 100 x.

consist of two groups, anterior and posterior, characterized aggregations that increase toward the tongue root. The location of lingual glands is different in the tongue tissue. They are characterized as tubuloalveolar type, with the ducts open toward the dorsal surface directly. These results are in

agreement with reports of Kadhim et al. (2011) and AI-Jumaily et al. (2013). However, Toryu et al. (1960) reported differences between anterior and posterior groups in chicken.

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