

Morphometric characterization of Long-Legged Buzzard (*Buteo rufinus*)

Tongue and Heart Caracterización

Morfométrica de la lengua y el corazón del buitre pata larga (*Buteo rufinus*)Saime Betül Baygeldi* , Yeşim Aslan Kanmaz 

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ABSTRACT

Morphometric and scanning electron microscopic evaluations reveal limitations in long-legged buzzards (*Buteo rufinus*), are particularly limited when it comes to the detailed morphological characteristics of the tongue and heart. The aim of our study is to present these data in detail and to contribute to the anatomical formation of wild animals, which are particularly difficult to study. Four Long-Legged Buzzard (*Buteo rufinus*) belonging to the Accipitridae family were used in this study. The tongues and hearts of the animals were dissected and macro and micrometric analyses were performed. The tongue of the Long-Legged Buzzard was distinctly elongated, terminating in an oval-shaped apex. The tongue widths were 3.83 ± 0.03 mm at the apex lingua, 7.64 ± 0.07 mm at the corpus lingua and 9.09 ± 0.04 mm at the papillary apex. The total length of the tongue from the radix to the apex was 29.30 ± 0.50 mm and the greatest thickness of the corpus was 2.89 ± 0.16 mm. The length of the Long-Legged Buzzard heart from the apex to the base was 30.05 ± 0.05 mm, the thickness of the base cordis was 25.03 ± 0.16 mm and the thickness of the apex cordis was 10.95 ± 0.09 mm.

Key words: Heart, Long-Legged Buzzard; morphometric; SEM, tongue

RESUMEN

Las evaluaciones morfométricas con microscopio electrónico de barrido son limitadas en los buitres de patas largas (*Buteo rufinus*), especialmente en los aspectos morfológicos detallados de la lengua y el corazón. El objetivo de nuestro estudio es presentar estos datos en detalle y contribuir a la formación anatómica de los animales salvajes, que son particularmente difíciles de estudiar. En este estudio se utilizaron cuatro buitres pata larga (*Buteo rufinus*) pertenecientes a la familia Accipitridae. La lengua buitre pata larga los corazones de los animales se estudiaron mediante disección simple. Se realizaron exámenes y mediciones macro y micrométricas. La lengua del Buitre pata larga era bastante larga y terminaba en un ápice ovalado. La anchura de la lengua era de $3,83 \pm 0,03$ mm en el ápice lingual, $7,64 \pm 0,07$ mm en el cuerpo lingual y $9,09 \pm 0,04$ mm en el ápice papilar. La longitud total de la lengua desde el a la raíz y hasta el ápice era de $29,30 \pm 0,50$ mm y el mayor grosor del cuerpo fue de $2,89 \pm 0,16$ mm. La longitud del corazón del Buitre pata larga desde el ápice hasta la base fue de $30,05 \pm 0,05$ mm, el grosor de la base corazón fue de $25,03 \pm 0,16$ mm y el grosor del ápice corazón fue de $10,95 \pm 0,09$ mm.

Palabras clave: Corazón, Ratónero común; Lengua, Morfometría; MEB

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INTRODUCTION

Anatomical research on the avian tongue has primarily concentrated on the examination of tongue morphology, the classification and structural characteristics of papillae, and the association between surface anatomy and feeding behaviors, including the types of food consumed. These investigations have been conducted in domestic birds [1, 2], birds of prey [3, 4, 5], waterfowl [6, 7] as well as in rodents [8, 9, 10, 11].

Research on the tongue includes macroscopic [8, 9, 10, 11, 12, 13, 14], scanning electron microscopic (SEM) [15, 16, 17, 18, 19, 20] and light microscopic evaluations [11, 21, 22, 23]. The tongue anatomy and SEM imaging of the Long-Legged Buzzards are scarce [24, 25].

In poultry, the heart is a conical organ positioned in the cranial part of the axis of the thoracoabdominal cavity [26]. In poultry, the heart has distinct surfaces: the sternal (cranioventral), hepatic (caudodorsal), and pulmonary surfaces [26, 27]. In birds, the heart consists of a base (basis cordis) and an apex (apex cordis); the base is formed by the right and left atriums [26]. The heart is also shaped like a cone with a pointed tip in birds. In birds, the heart is located between the fifth and sixth ribs. Anatomically the heart is not directly related to the cervical diverticula, clavicle, or cranial thoracic air sacs. These structures are part of the respiratory system in some species, like birds, and while they interact with the circulatory system, they do not have direct anatomical fixed to the heart [28]. Also in birds, the heart is connected to the sternum by lig. sternopericardiaca [26].

The Long-Legged Buzzard (*Buteo Rufinus*) is a bird belonging to the family Accipitridae in the order Falconiformes. The tip of the beak is curved downwards like a hook and the upper jaw edges are quite sharp. Its feet are usually adapted for grasping, and its nails are curved and pointed. Their sense of sight and hearing are very well developed. This bird species also feeds on animal foods [29, 30].

Studies utilizing morphometric and scanning electron microscopy are scarce in this species, particularly in relation to the detailed morphological features of the tongue and heart. The aim of this study is to present these data in detail and to contribute to the anatomical formation of wild animals, which are particularly difficult to study.

MATERIALS AND METHODS

For this study, permission was obtained from both Firat University Local Ethics Committee for Animal Experiments (12.06.2023-16677) and Ministry of Agriculture and Forestry General Directorate of Nature Conservation and National Parks (E-21264211-288.04-14206693).

In this study, 4 (3 males and 1 female) adult Long-legged Vultures (*Buteo rufinus*) belonging to the Accipitridae family were used. The tongues and hearts of the animals were examined and identified using standard dissection techniques. The length and diameter of the organs were measured with digital calipers (Koodmax Caliper Digital LCD Display Carbon Fiber Precision/Turkiye).

The samples intended for scanning electron microscopy (SEM) analysis were first washed twice with a 0.1 M phosphate buffer solution (pH 7.4) and then fixed in a 2.5% glutaraldehyde solution for 48 hours (h). The tissues were then fixed in 1% osmium tetroxide (OsO₄) for one hour. After fixation, the tissues were subjected to a series of successive acetone rinses and dehydrated using critical point drying.

The gold-palladium coated specimens were examined under a scanning electron microscope (Leica, Leo S440/Germany) at various magnifications (X 85-X25000). Macroanatomical photographs were taken with an Olympus (Japan) C-5060 digital camera. Morphometric data were recorded with a Mitutoyo Digital Caliper. Morphometric data for the tongue and heart are presented as mean \pm SD. Nomina Anatomica Avium was used for descriptions [31].

RESULTS AND DISCUSSION

Tongue findings

Anatomically, the tongue is divided into three distinct parts: the apex lingua, the corpus lingua, and the radix lingua. The tongue of the Long-Legged Buzzard was distinctly elongated, terminating in an oval apex. The tongue widths were 3.83 ± 0.03 mm at the apex lingua, 7.64 ± 0.07 mm at the corpus lingua and 9.09 ± 0.04 mm at the papillary apex.

The total length of the tongue from the radix to the apex was 29.30 ± 0.50 mm and the greatest thickness of the corpus was 2.89 ± 0.16 mm. The sulcus lingua mediana extending from the apex to the radix of the tongue was prominent on the surface (FIG. 1). At the apex of the tongue, scale-like projections were present instead of the typical mechanical papillae.



FIGURE 1. Dorsal view of the lingua. Apex lingua (a), Corpus lingua (b), Conical papilla (c), Radix lingua (d), Pharyngeal conical papillae caudal to glottis (e), os hyoideum (f), Papiller crest (star), sulcus lingua mediana (--)

The continuity of these structures along the tongue's body midline was also observed. Under higher magnification, micro-protrusions were detected on the surface of the papillae situated in both the apex lingua and the corpus lingua (FIG. 2).

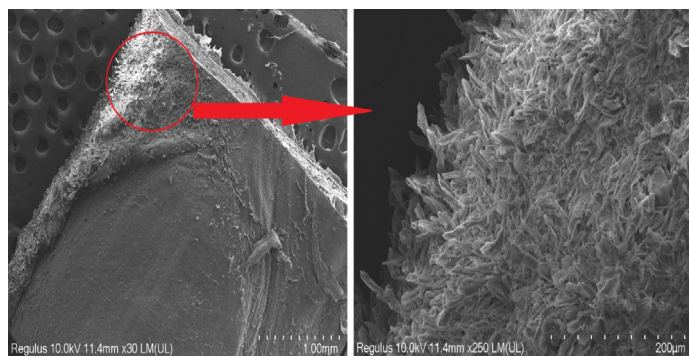


FIGURE 2. Scale-like projections on the dorsal surface of the lingual. Scale bars=1.00 µm and 200 µm

On both sides of the dorsal surface of the corpus lingua, there were very long and curved filiform papillae that bordered both sides of the median sulcus and were not found anywhere without a lingual body surface.

Moreover, a series of conical papillae, termed the papillary crest, was observed on the surface of the posterior half of the tongue, positioned between the body and the root. These papillae had pointed tips that tapered towards the posterior region of the tongue. The conical papillae on the lateral border of this row were more prominent in height compared to those along the midline (FIG. 1). The structure of each conical papilla was observed to have a simple structure and a smooth surface. In addition, taste papillae were not found on the entire surface of the Long-Legged Buzzard's tongue.

In the radix linguae, in contrast to the apex and body of the tongue, there are no scale-like or thread-like projections, nor conical papillae. However, openings for the ducts of the posterior salivary glands were detected.

The morphology of the tongue varies significantly among bird species. In the European magpie, for instance, the tongue is generally triangular in shape, it can also be oval in raven [24], white-tailed eagle [21], stork [32], quail chicken [28] and Japanese pygmy woodpecker [19, 20, 33] and oval in waterfowl [12, 34], equilateral triangle in penguin [35], mushroom-shaped in cormorant [21]. As in the study by Erdoğan [24], the tongue of the Long-Legged Buzzard is shovel-shaped.

The presence of sulcus linguae is consistent with studies reported in the black kite [3, 17, 18], Egyptian goose [11], Middendorf bean goose [34], nutcracker [21] and Long-legged Eagle [24]. The bifurcation of the apex linguae, marked by a fissure, has been observed in multiple species, including the peregrine falcon and kestrel [19], owl [20], little tern [34], European magpie and raven [24]. In this study, apex linguae bifurcation was absent in the Long-Legged Buzzard.

In the Long-Legged Buzzard, scale-like projections are observed at the tip of the tongue, as opposed to the prominent or robust mechanical papillae. Recent studies have documented the presence of needle-like magpie [24] and Japanese pygmy woodpecker [19] rigid mechanical projections at the tongue's tip have been reported in species, including the raven. It is hypothesized that birds of prey, such as vultures, which exclusively consume meat, do not necessitate strong mechanical action at the tip of the tongue for food manipulation.

In magpie [24], peregrine falcon and kestrel [18], owl [20] and little tern [34], the top of the tongue is forked with a fissure. Such a fissure, which is seen in some birds, has not been fully identified in the Long-Legged Buzzard.

Heart findings

This study revealed that the heart of the Long-Legged Buzzard includes both an apex cordis and a basis cordis. The apex cordis of the heart was seen to be in the shape of a pointed cone (FIG. 3).



FIGURE 3. View of the heart of a long leg buzzard (*Buteo rufinus*). apex cordis (1); auricula sinistra (2); margo ventricularis sinister (3); margo ventricularis dexter (4); sulcus coronarius (5); sulcus interventricularis subsinuus (6); aorta (7); Truncus pulmonalis (8); A. brachiocephalicus (9).

The length of the Long-Legged Buzzard heart from the apex to the base was 30.05 ± 0.05 mm, the thickness of the base cordis was 25.03 ± 0.16 mm and the thickness of the apex cordis was 10.95 ± 0.09 mm.

It was determined that the heart extends transversally to the body axis in the Long-Legged Buzzard. In the thoracoabdominal region, the heart was attached to the columna vertebralis by the aorta, to the apertura thoracis by the cava cranialis sinistra and cava cranialis dextra, and to the sternum by the cava caudalis and ligament sternopericardiaca.

It was noticed that the heart is structured with three separate layers. The three layers are the epicardium, myocardium, and endocardium. The epicardium was found to be formed by the lamina visceralis of the pericardium serosum and was also seen to surround the heart, including around the vessels entering and leaving the heart.

It was also discovered that the epicardium gave transparency to the heart., shine and lubricity. Myocardium was found to be the thickest layer of the heart. The endocardium was found to be the thinnest layer of the heart and adhered tightly to the myocardium (FIG. 4).

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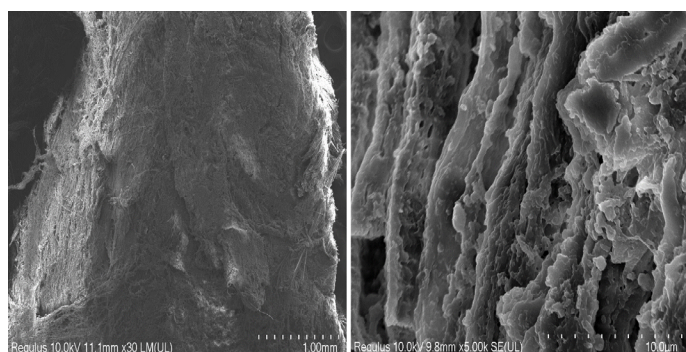


FIGURE 4. SEM view of the layers of the heart. On the left is the endothelium layer. Myocardium and bands in the picture on the right. Scale bars= 1.00µm and 10.0 µm

Baumel [31] found that the apex cordis of the chicken heart has the shape of an elongated pointed cone, this study revealed that the apex of the Long-Legged Buzzard's heart is conical in shape, tapering to a point.

In the present study, it was found that the heart of the Long-Legged Buzzard is suspended within the cavum thoracoabdominalis, oriented cranially and located caudoventrally. Baumel [31] found that the heart in birds is located in the thoracoabdominalis, similar to the location of the heart in the Long-Legged Buzzard. Nickel *et al.* [28] mentioned that the heart of birds lies in the anterior half of the thoracoabdominale. It was also reported that the heart is located in the median line of the thoracic cavity in poultry. Dursun [26] reported that the heart in birds is located cranial to the cavum thoracoabdominalis.

In humans, the heart was reported to be located in the chest cavity, in the mediastinum medius, between the anterior lower parts of the two lungs and above the diaphragm [36]. The findings regarding the location of the heart in the present study are similar to the literature data reported for poultry [26, 27].

Scanning electron microscopy (SEM) examination of the Long-Legged Buzzard heart revealed that it consists of 3 layers: epicardium, myocardium and endocardium from the outside to the inside, in accordance with the reports of Gálfiová *et al.* [37] and Varga *et al.* [38].

Scanning electron microscopy studies in humans have demonstrated that the endocardium, which covers the innermost surface of the heart and heart valves, consists of three layers: the endothelium, subendothelium, and subendocardium [37, 38]. These three layers were also observed in the present study (FIG 4).

CONCLUSIONS

This study provided a detailed analysis of the macroanatomical structure of the tongue and heart in the Long-Legged Buzzard. Moreover, morphometric analyses of the anatomical structures on both the external and internal surfaces of the tongue and heart were systematically compared across different species.

In general, the long-legged buzzard has similar characteristics and similar findings to the white-tailed eagle. The anatomy of

these organs in the long-legged hawk and white-tailed eagle, members of the same Accipitridae family, shows very high similarity.

We believe that the findings of this study, which is thought to contribute to the Veterinary anatomy literature, will be helpful for future researchers who will work on the subject in the future.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

Data information availability can be obtained from the author if requested.

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