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ORIGINAL ARTICLE

COMPARATIVE MORPHOLOGICAL DESCRIPTION OF TONGUE BETWEEN TWO DOMESTICATED WATER BIRDS, MALLARD *ANAS PLATYRHYNCHOS* (LINNAEUS, 1758) AND GRAYLAG GOOSE *ANSER ANSER* (LINNAEUS, 1758) (ANSERIFORMES, ANATIDAE)

Ashwaq Ahmed Hussein*, Marwa Khalil Ibrahim and Intidhar Mohammed Mnati
Department of Biology, College of Education for Pure Science/Ibn AlHaitham, University of Baghdad, Baghdad, Iraq.
*Corresponding author: ashwaq.a.h@ihcoedu.uobaghdad.edu.iq

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ABSTRACT

This study is to identify the comparative morphological description of the tongue in two species of domesticated waterbirds, Mallard *Anas platyrhynchos* (Linnaeus,1758) and Graylag Goose *Anser anser* (Linnaeus,1758) (Anseriformes, Anatidae). Four adult male birds (two for each species) were collected from the Iraqi environment and used in the current study by buying them from the AL-Ghezil Market, a local market in Baghdad City. Anaesthetized, dissected, and laboratory work were conducted and visually documented. The results of the study showed that the tongue of both birds was characterized by the appearance of being a narrow-elongated organ divided into three areas represented by the apex, the lingual body, and the root. It was noted that there was a median sulcus, lingual prominence, and conical and filiform papillae of varying numbers and distribution on the dorsal surface of the tongue. While the ventral surface was free of lingual papillae, but it might contain in return a triangular squamous plate called a lingual nail or a bar-shaped structure called a lyssa in proportion to the type and nature of nutrition.

Keywords: Anatidae, Anatomy, Birds, Dorsal lingual surface, Lingual papillae.

INTRODUCTION

The tongue plays an important role for all vertebrates, including birds, where differences have been observed in the size and shape of the tongue in line with the appropriate function for it; these tongue functions in birds are food collection, ingestion, and food processing (Jackowiak and Ludwig, 2008; Jackowiak *et al*., 2011). Tongue of birds also exhibits structural and anatomical variations related to feeding and adapting behaviors to living in different environments (Iwasaki, 2002). The Tongue appears as an elongated triangular organ in the majority of birds (Jackowiak *et al*., 2011; Erdoğan *et al*., 2012), while it is relatively small in other species of birds (Crole and Soley, 2010; Santos *et al*., 2011). There is also observed a difference in the regional distribution of lingual papillae and the structure of the

lingual glands and taste buds in proportion to the mechanism of food intake, type of food, and habitat (Jackowiak and Godynicki, 2005).

Mallards are winter visitors found in the swamps of central and southern Iraq, but they are found to a lesser extent in the northern regions. As for graylag, residents, and winter visitors live in grasslands, agricultural fields near swamps, estuaries, reed fields, islands, and dense sabkha. Mallards are large aquatic birds with a length of about 65 cm and a wingspan of about 95 cm. The male is identified by the yellow beak color, the dark green head color, the brown chest color, the gray body, and the dark blue wing spot surrounded by white, while the female is spotted brown and has a brown spotted belly; both male and females have an iridescent purple blue speculum. Graylag goose is alarge bird with a length of approximately 83cm and a wing span of about 164 cm. It has mottled and barred grey and white plumage, an upper portion greyer than porthion of the body and an orange beak with pink legs (Muzaffar *et al*., 2006).

These two species, Mallard *Anas platyrhynchos* Linnaeus, 1758, and Graylag goose *Anser anser* Linnaeus, 1758, belong to the family Antidae (Order, Anseriformes), which is a large and complex group of approximately 150 species that shows great variation in wildlife (Livezey, 1998). *Anas platyrhynchos* is a waterbird whose diet in spring and summer consists mainly of animal matter such as insects, while its main food is aquatic plants, crops, and seeds in winter (Kear, 2005), while *Anser anser* cuts the vegetable parts of plants to and eats seeds (Kear, 1966). Several studies, such us: AL-Jumaily *et al*. (2013), Kadhim *et al*. (2014), Mnati *et al*. (2014), AL-Fartwsy *et al*. (2016), Ibrahim and AL-Jumaily (2020), Jabur *et al*. (2023), and Hussein and Ibrahim (2023), described the morphological traits of the tongue in different vertebrates. However, the anatomical study related to the avifauna of Iraq was poorly addressed.

The purpose of the current study is to identify comparative morphological characteristics of between the tongue in the *A. platyrhynchos* and *A.anser* to compare these results with the results of previous studies that dealt with different species of birds related to their feeding habits.

MATERIALS AND METHODS

Four adult males and healthy animals (two specimens for each species) bought from the local markets of Baghdad City, AL-Ghezil Market and its suburbs were used; the birds were collected during winter 2022, based on their availability in the market, and then these birds were taken in cages to the Advanced Comparative Anatomy Laboratory in the Department of Biology, College of Education for Pure Sciences- Ibn Al-Haitham, University of Baghdad. The birds were anesthetized using chloroform, and the head was separated off the neck area and the heads were left with a 10% formalin solution for 48 hours after fixation, the head were washed with tap water and the mouths were opend carefully, where the tongue was photographed in its location to show the location of the frenulum, and then the tongue was removed from the floor of the oral cavity by cutting the surrounding tissue (Buamel *et al*., 1993). For easy identification of the lingual papillae, the tongue was stained with Methylene

blue at a concentration of 1%, which was prepared according to the method of Kiernan (1999), and after staining, the tongue was studied and examined with a dissecting microscope with different magnification powers and photographed with a mobile camera of 64 megapixels and corrected directly, then adding scale bars to the image by using Image J software.

RESULTS

Morphological description of the tongue in *Anas platyrhynchos* (Linnaeus, 1758)

The results of the morphological description of the bird subject of the current study showed that the tongue appeared as an elongated and narrow organ and reached a length of 7 cm and occupies the proboscis portion of the floor of the oropharyngeal cavity without extending to the free apex of the bottom of the lower beak (Pls. 1, 2), to which the tongue is connected by a membranous fold called the frenulum (Pl. 3). The dorsal surface of the tongue contains lingual papillae, while the ventral surface is free of these papillae, and in return, the structure of the bar appears at the ventral surface of the tongue extending from the apex to the area of the lingual body and extending to the lingual frenulum called lyssa (Pl. 4). The tongue of this species appeared to consist of three parts represented by the apex, lingual body and root) with a free tip. The apex appears smooth and non-papillary in its dorsal surface, separated from the body, and takes on an oblong shape similar to a shovel (Pls. 1, 2). The body of the tongue is in contact with the lower jaw by a wide frenulum and has a deep central groove in its dorsal surface that divides the apex and the body (passing through the lingual prominence) into two equal parts, as it was found that there are two prominence on both sides of the lingual groove, forming a spindle shape that merges with the lingual prominence (Pls. 2, 6, 7). It appears on the apex of these two prominences, short filiform papillae whose free and pointed ends are directed outward and increase in size as we would progress towards the root (Pls. 1, 2).

The current study showed that the sides of the lingual body contain 11 short conical papillae, followed by 6 giant conical papillae, and between these papillae are distributed hairy structures (Pl. 4). The lingual prominence appears in a butterfly-like triangle shape lined with conical papillae positioned at its base with 2-3 protrusion, while the papillae located on the sides appear with only one protrusion, and these papillae appear arranged in two rows, numbering up to 24 papillae (Pls. 5, 6). As for the lingual root region, its location can be distinguished between the lingual prominence and the epiglottis and is characterized on both sides by two bulges, each with a group of conical papillae (Pl. 7).

Morphological description of the tongue in *Anser anser* (Linnaeus, 1758)

The results of the current study of the tongue in this bird, the subject of the current study, showed that it is a long and narrow organ and ranges in length 6.5 cm, and occupies the entire base of the oropharyngeal cavity, and is linked to the bottom of the lower part of the beak by a membranous fold called the frenulum (Pls. 8, 9). The dorsal surface of the tongue contains lingual papillae, while the ventral surface is free of these papillae, and in contrast, it was observed at the ventral surface of the apex of the tongue the presence of a triangular white squamous plate called the lingual nail (Pl. 10).

Comparative morphological description

In this bird, the tongue was divided into three parts: the apex, lingual body, and root. The apex appears round, free of papillae and with smooth edges, and has a shallow and narrow medial groove at the dorsal surface of the tongue, dividing the apex and body into two equal parts passing through the lingual prominence (Pls. 9, 11). The results showed the presence of eleven pairs of giant conical papillae on both sides of the body of the tongue, which were characterized by their pointed lingual prominence, and is directed laterally and slightly backward. There were filiform papillae distributed between the giant conical papillae, which look similar to hair organized in the form of 3-4 long rows and single and curved ends (Pl. 11).

The lingual prominence is located in the *A.anser* above the body of the tongue, taking the structure of a triangular shape whose base is facing the root of the tongue, and it was also noted that there are four pairs of giant conical papillae located at the back of the tongue body whose lingual prominence were directed towards the back, and the last row of them is located near the lingual prominence, and these papillae are of two different types in size, represented by large lateral papillae, while the middle papillae are small in size (Pls.8, 9, 11). Also on either side of the lingual root 6–15 are papillae with sharp, pointed tips with a small end with free edges outward orientation and conical papillae (Pl.12).

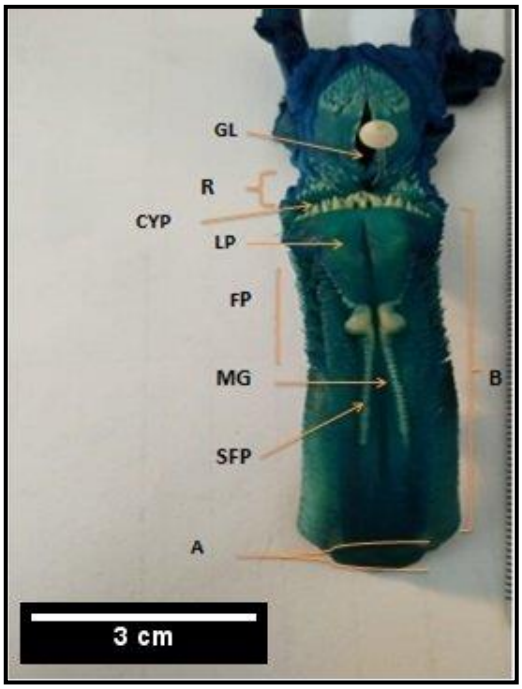

Plate (1) : The dorsal surface of the *A. platyrhynchos* tongue shows the general appearance; (A) Apex, (B) Body, (R) Root, (Mg) Medial groove, (LP) Lingual prominence, (Gl) Glottis, (Cyp) Conical papillae, (SFP) Small filiform papillae (Methylene blue satin).

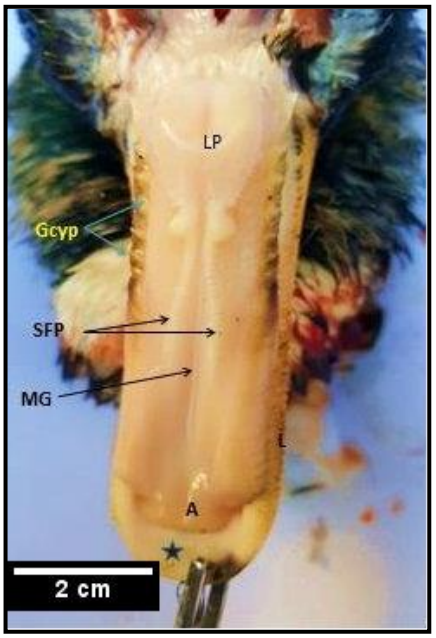

Plate (2): Location of the tongue within the lower jaw of the beak in *A. platyrhynchos*; (star) Free end of the lower jaw, (A) Apex, (MG) Medial groove (LP) Lingual prominence, (Gcyp) Giant conical papillae, (SFP) Small filiform papillae.

Plate (3): The ventral surface of the tongue and the lower beak of *A. platyrhynchos*; (Fr) Frenulum, (L) Lamellae of the bill, (star) Free end of the lower beak.

Comparative morphological description

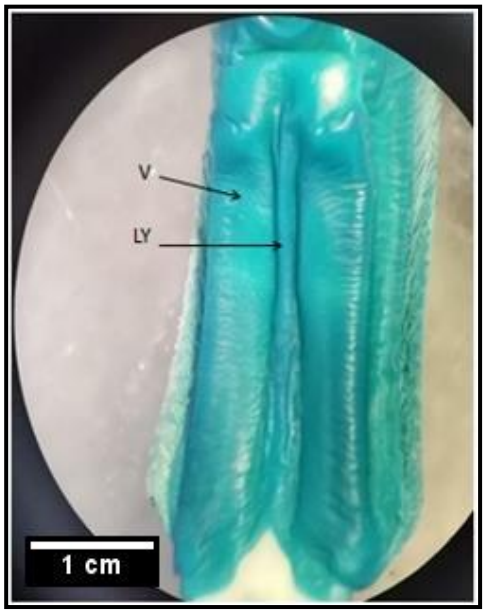

Plate (4): (V) Ventral surface of the *A. platyrhynchos* tongue, (Ly) Lyssa (Methyleneblue satin).

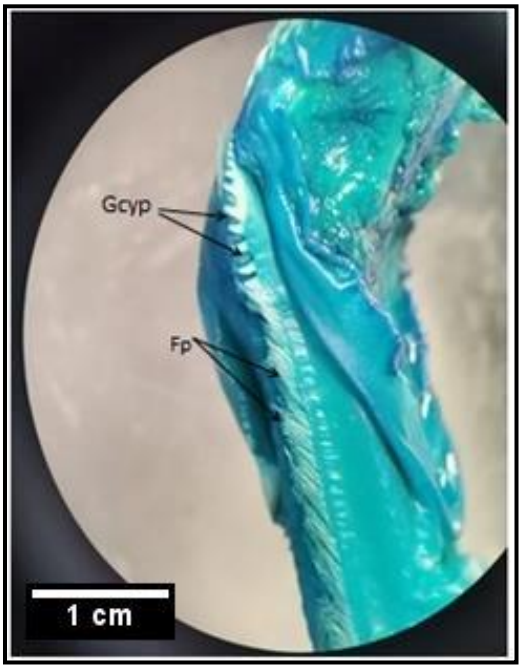

Plate (5): Lateral view of the *Anas platyrhynchos* tongue showing; (Gcyp) Giant conical papillae, (FP) Filiform papillae (Methylene blue stain).

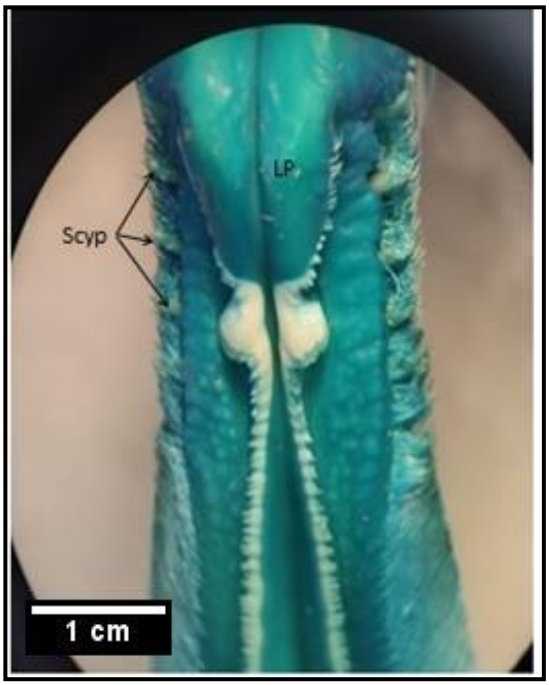

Plate (6): The dorsal and lateral surface of the *A. platyrhynchos* tongue shows; (Scyp) Small conical papillae, (LP) Lingual prominence (Methylene blue stain).

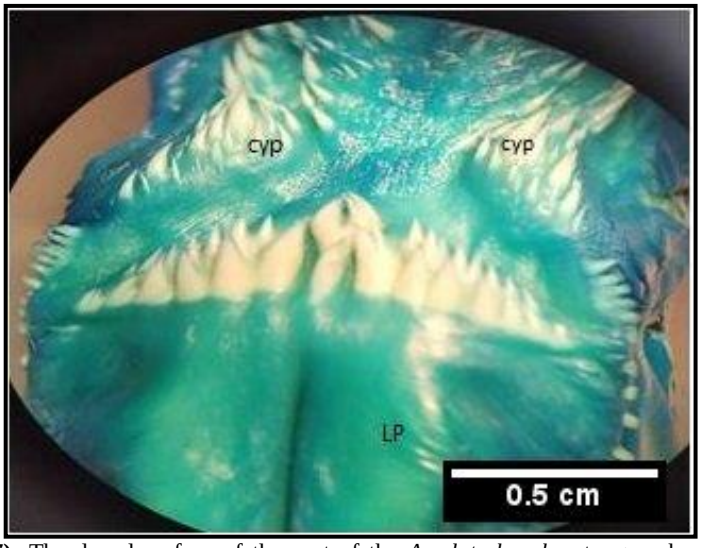

Plate (7): The dorsal surface of the root of the *A. platyrhynchos* tongue shows; (cyp) Conical papillae, (LP) Lingual prominence (Methylene blue stain).

Comparative morphological description

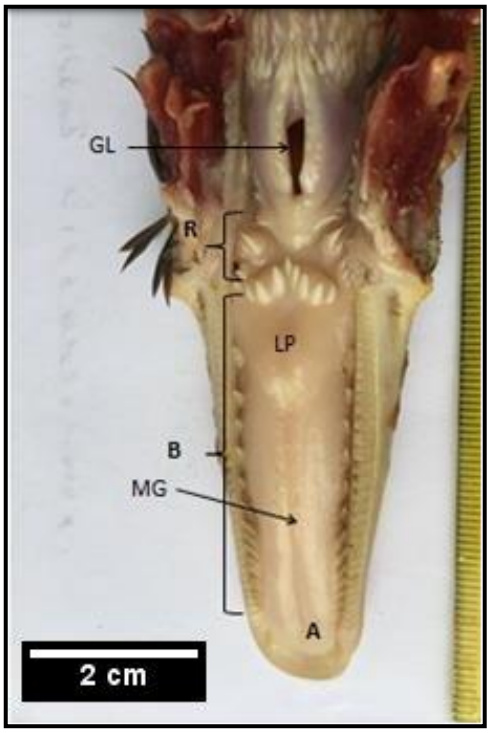

Plate (8): Location of the tongue within the lower beak in *A. anser*; (A) Apex, (B) Body, (R) Root, (Mg) Median groove, (Lp) Lingual prominence, (Gl) Glottis.

Plate (9): The ventral surface of the tongue and the lower beak in *A. anser* show; (Fr) Frenulum, (L) Lamellae of the bill, (Lp) Lingual prominence.

Plate (10): (V) Ventral surface of the *A. anser* tongue, (LN) Lingual nail.

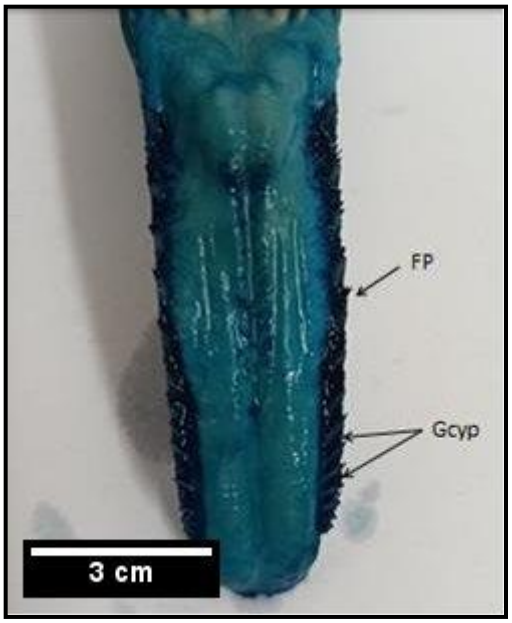

Plate (11): Dorsal surface of the *A. anser* tongue; (Gcyp) Giant conical Papillae, (FP) Filiform papillae (Methylene blue stain).

Comparative morphological description

Plate (12): The dorsal surface of the *A. anser* tongue shows; (LP) lingual prominence , (Gcyp) Giant conical papillae, (cyp) conical papillae (Methylene blue stain).

DISCUSSION

The results of the current study showed that the tongue of both birds was elongated and narrow, and this result corresponded to a study by Mohamed (2019), which indicated that the tongue of Mnscovy duck *Cairina moschata* (Linnaeus, 1758) was elongated and narrow, while Al- Nefeiy (2015) indicated that the tongue of the laughing dove was triangular in shape with a thin end, and the tongue of the Magpie bird had an elongated tongue with an oval shape and a cleft apex (Erdoğan and Alan, 2012).

The tongue of the *Bubulcus ibis* (Linnaeus, 1758) is long with a blunt end, while the tongue of the domestic chicken *Gallus gallus* (Linnaeus, 1758) is short with a triangular shape and flat base (Khadhim *et al*., 2011), and the tongue shape of these two birds under study is probably adapted to capture and transport food. The tongue occupies the proboscis portion of the oropharyngeal cavity floor without extending to the free apex of the bottom of the lower beak in *A. platyrhynchos* and this result is consistent with a study of Mohamed (2019). While the current study showed that the tongue of *A. anser* occupied the entire floor of the oropharyngeal cavity, this result was contrary to the results of other studies dealing with different species of birds, such as the study of Abd El- Fatah *et al*. (2000) in Turkey bird and the study of Abdall *et al*. (2011) in ducks.

The results of the present study showed that the tongue in both birds, *A. platyrhynchos* and *A. anser*, consists of a lingual apex and body, and a lingual root area, and a lingual prominence. The apex appeared in the tongue of *Anas platyrhynchos* separated from the

lingual body area and oblong in shape, while the apex area in *A. anser* appeared round with smooth and continuous edges with the lingual body area, and it seems that the structure of the tongue in birds has a relationship with feeding behaviors and lifestyle in different environments (Emura *et al*., 2008). The tongue may be adapted to pick up or swallow, filter, and treat food (Baussart *et al*., 2009; Erdoğan and Iwasaki, 2014).

Van der Leeuw *et al*. (2003), and Baussart and Bels (2011) indicated that members of the order Anseriformes have three methods of feeding: pecking, grazing, and filter feeding. The results of the current study showed that the apex of the tongue, *A. anser* was a white squamous triangular plate called the lingual nail, and perhaps the benefit of the nail lies in the support of the tongue, since the nail has a kind of hardness that may help in the process of capturing food and pushing it to the pharynx. The nail works as a spoon to pick up food, this result was consistent with the study of Jackowiak *et al*. (2011) in domestic geese and the study of Shieresz and Jackowiak, 2016) in domestic ducks. The absence of the lingual nail in Mallard, which plays a role in transporting grain, may explain why Mallard relies less on pecking mechanisms for feeding. While there is no lingual nail in *A. platyrhynchos*, it was noted that there is a bar-shaped structure called the lyssa located at the ventral surface of the apex and the body of the tongue up to the frenulum area. This result corresponded with the study of Kadhim *et al*. (2014) in black francolin and is contrary to the results of our current study, which confirms the absence of the ventral surface of the *A. anser* from lyssa. The presence or absence of this structure may be due to the urgent need for it, and the environment of the bird, and feeding behaviors because the lyssa is a muscular structure that helps in supporting the tongue and thus facilitates the feeding process.

Many studies that dealt with the anatomical and macroscopic description of the tongue in different species of birds reported the presence of a medial groove on the dorsal surface of the lingual body, and from these studies, our current study, showed the presence of a deep median groove, and on both sides of which, there are two lingual prominences that take a spindle shape in the *A. platyrhynchos* bird, while the middle groove is shallow and narrow in the *A. anser*.

These results were consistent with Abd Elmohdy (1993), which showed that Hawk's tongue has a shallow median groove, while these results differed from the results of other studies such as Santos *et al.* (2011) and Mohamed (2019), which confirmed that the tongue is free from the median groove in both Rhea Americana and Muscovy duck, respectively.

The results of the present study showed that the tongue of *A. platyrhynchos* has a triangular lingual prominence resembling a butterfly, while the lingual prominence in *A. anser* is located above the area of the lingual body, taking the structure of a triangle whose base is facing the root of the tongue.These results were identical to Sridevi *et al*. (2018) that study on the tongue of Mute swan, which confirmed that the base of the tongue is formed by a unique dorsal height, which is called lingual prominence and perhaps that the movement of lingual prominence with the palate may help in the process of ingestion by pulling food in the caudal direction.

Comparative morphological description

The results of this study showed a difference in the regional distribution of the lingual papillae and that their function depends on their locations. It was noted that the papillae located on the lateral edges of the tongue were of two types, short and giant conical papillae, and there are filiform papillae similar to hair. These papillae can work together with the plates on the lateral edges of the upper and lower beak as a filter for food minutes immersed in the water. These results were identical to those of Akbari *et al*., (2018). The study by Taki-El-Deen (2017) confirmed that the tongue is free of lingual papillae in Whimbrel birds, which contradicts.

The results of the current study showed that the tongue of *A. platyrhynchos* has two rows of conical papillae lined up on the base of the lingual prominences, and these papillae are located from 2-3 lingual prominences. Further, the papillae located on the sides have one lingual prominence, while the study showed that the tongue of. *A. anser* has a lingual prominenc lined with four pairs of giant conical papillae, which also appear varying in size.

This was consistent with the results of Mohamed (2019), which showed that the tongue of the Muscovy duck has a lingual prominence on which giant conical papillae are organized in two rows, while these papillae took a V-shaped shape in the white-tailed falcon *Haliaeetus albicilla* (Jackowiak and Godynicki, 2005) and a U-shape in domestic pigeons *Columbia livia domestica* (Igwebuike *et al*., 2013), while the caudal papillae are lost in the ostrich (El morsi *et al*., 2002).

Studies have indicated that the conical papillae located between the body area and the lingual root can serve the function of transporting and swallowing food and preventing the return of food outside the mouth, and these studies were identical with the results of our current study and the results of many studies such as (Abdall *et al*., 2011; Igwebuike *et al*. , 2013).

It appears that the phenotypic structures associated with grazing in Mallard are the giant conical papillae, which have the shape of a cone and are directed towards the root of the tongue. They are also united in the caudal lateral part of the lingual body, where they correspond to plates at the bottom of the tongue and work to cut plant parts. As for the small conical papillae, they are plate-shaped, and go to the bottom of the tongue, and do not contribute to grazing, This may be attributed to the fact that grazing is not the primary mechanism in Mallard nutrition.It appears that the filtration efficiency of the giant conical papillae is less than that of the small conical papillae, and the reason may be attributed to the shape of the papilla and its caudal orientation. As for the filiform papillae, which act as a brush, trapping even the smallest particles of food, this is an adaptation of the filtration device. Mallard feed mainly on food immersed in water using a filter feeding mechanism (Skieresz- Szewczyk and Jackowiak , 2016).

It seems that the structures that are directly related to the process of pecking in graylag goose are the giant and small conical papillae of the body of the tongue, which are located in the lateral parts and correspond to the plates at the bottom of the tongue, where they help in

cutting plants. The apex of the lingual prominence, which changes its position, contributes to transporting food to the esophagus, while the lingual nail acts like a spoon to raise grains, this may explain its good growth in Bewick's Swan.The movement of the tongue prominence causes water to be expelled from the oral cavity, while small parts of food dissolve inward. The filiform papillae contribute to this process, as they fill the spaces between the conical papillae, where food is captured (Jackowiak *et al*., 2011).

CONCLUSIONS

The current study, which dealt with the comparative morphological description between the tongue of *Anas platyrhynchos* and *A. anser*, showed that it possesses specialized morphological characteristics such as lingual nail, filiform and conical mechanical papillae that suit the type of nutrition of both birds, Mallard rely primarily on the filter feeding mechanism for their nutrition, in addition to other terrestrial activities such as pecking and grazing. As for Graylag Geese, they are considered more adapted to the terrestrial lifestyle than the aquatic lifestyle, and for their terrestrial livelihood, they are not specialized for filter feeding like Mallard.

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CONFLIT OF INTERSET STATEMENT

The authors have no conflicts of interest to declare. We "the authors" have followed and signed the scientific research ethics and animal welfare guidelines announced by the journal.

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الوصف المظهري المقارن للسان بين اثنين من الطيور المائية المستأنسة، طائر الخضيري (Linnaeus, 1758) *Anas platyrhynchos* والوزه الرداء(Linnaeus,) 1758 *Anser anser* (Anseriformes, Anatidae)

اشواق احمد حسين، مروة خليل ابراهيم و انتظار محمد مناتي
قسم علوم الحياة، كلية التربيه للعلوم الصرفة (ابن الهيثم)، جامعة بغداد، العراق.

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الخلاصة

قدمت هذه الدراسة وصفاً مظهرياً مقارناً للسان في نوعين من الطيور المائية المستأنسة طائري الخضيري Mallard *Anas platyrhynchos* (Linnaeus, 1758) والوزه الرداء Graylag goose *Anser anser* (Linnaeus, 1758) تعود الى رتبة Anseriformes و عائلة Anatidae. جمعت أربعة طيور ذكور بالغة (اثنان لكل نوع) من البيئة العراقية واستخدمها في الدراسة الحالية عن طريق شرائها من سوق الغزل (سوق محلي في مدينة بغداد). تم إجري التخدير والتشريح والعمل المختبري وتوثيقه بصريًا.

أظهرت نتائج الدراسة أن لسان كلا الطائرين تميز بمظهر كونه عضواً متطاولاً-ضيقاً مقسماً إلى ثلاث مناطق تتمثل بالقمة والجسم اللساني والجذر. ولوحظ ان هناك اخدود وسطي وبروز لساني وحليمات مخروطية وخيطية متفاوتة الاعداد والتوزيع على السطح الظهري للسان، في حين ان السطح البطني خالٍ من الحليمات اللسانية، الا انه قد يحتوي في المقابل على صفيحة حرشفية مثلثة يسمى الظفر اللساني أو تركيب على شكل شريط يسمى Lyssa بما يتناسب مع نوع وطبيعة التغذية.