

Anatomy of the oropharynx and tongue of the African pied crow (*Corvus albus*)

Udensi M. Igwebuike^{1*}, and Ukamaka U. Eze²

¹Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Nigeria Nsukka, Nigeria

²Department of Veterinary Medicine, Faculty of Veterinary Medicine, University of Nigeria Nsukka, Nigeria

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ABSTRACT

An understanding of the anatomy of components of the digestive tract of the African pied crow would prove useful in relation to the medical, surgical and nutritional management of these birds, especially in captivity. The present study was designed to provide basic data on the morphology of the oropharynx and tongue of the African pied crow. Our results showed that the roof of the oropharyngeal cavity was formed by a cartilaginous hard palate, whose mucous membrane exhibited many caudally directed papillae. The tongue was located in the floor of the oropharyngeal cavity. The rostral and caudal parts of the tongue were demarcated by a transverse row of caudally pointed papillae. The histology of the caudal part of the tongue revealed the presence of many mucous glands that discharge their secretions onto the dorsal surface of the tongue via ducts. Whereas the papillae may serve principally as mechanical obstacles to the involuntary return of food that has passed over them, the secretions of the glands may aid in swallowing by lubricating the caudal part of the oropharyngeal cavity and probably, the initial part of the oesophagus. It was concluded that the anatomical features of the oropharyngeal cavity and tongue of the African pied crow may be adaptations to the bird's mode of food acquisition and feeding habits.

Key words: oropharyngeal cavity, tongue, papillae, mucous glands, African pied crow, *Corvus albus*

Introduction

A large body of knowledge exists on the morphology of the alimentary tract of many birds (KING and McLELLAND, 1984; BAILEY et al., 1997; CASOTTI, 2001; DZIAŁA-SZCZEPAŃCZYK and WESOŁOWSKA, 2008; LAVIN et al., 2008; WANG and PENG, 2008) but, no work has reported on the morphology of the digestive tract of the African pied crow. African pied crows belong to the order Passeriformes and the family Corvidae (JØNSSON and FJELDSÅ, 2006). They are omnivorous birds that feed by scavenging for

*Corresponding author:

Dr. U. M. Igwebuike, Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Nigeria Nsukka, Nigeria, Phone: +234 8038 726 150; Fax: +234 4277 0644, E-mail: abuchi2002@yahoo.com

food in garbage dumps and by foraging on the ground for diet of invertebrates, fruits, vegetables, reptiles, amphibians, small birds and mammals.

Management of African pied crows in captivity is handicapped by a paucity of biomedical data. An understanding of the anatomy of components of the digestive tract of the African pied crow would prove useful in relation to the medical, surgical and nutritional management of these birds, especially in captivity. This is particularly important in the present time when there is increased interest in keeping African pied crows as pets (www.birdtrader.co.uk/birds/BT14696). The present study was designed to provide basic data on the morphology of the oropharynx and tongue of the African pied crow.

Materials and methods

Experimental animals. The ten adult African pied crows used for this study were obtained from the Zoological Garden, University of Nigeria, Nsukka. The birds were sacrificed by euthanasia using an overdose intravenous injection of phenobarbitone.

Gross anatomy. Following death, the digestive tract was dissected and the components of the tract located within the head region were studied in terms of their shape, physical appearance and in-situ topographical relationships. Gross photographs were captured using a Yashica 7.1 mega pixels digital camera.

Histological preparations. Specimens of the tongue were cut and fixed by immersion in Bouin's fluid for 48h. Later, these specimens were dehydrated in graded concentrations of ethanol, cleared in xylene, and embedded in paraffin wax. The 5 µm thick sections were cut, mounted on glass slides, and stained with hematoxylin and eosin (HE) for light microscopy. Photomicrographs were captured using Moticam Images Plus 2.0 digital camera (Motic China Group Ltd. 1999-2004).

Results

Gross anatomy. The oral and pharyngeal cavities in the African pied crow lack demarcation, and so constitute a common cavity known as the oropharynx. The roof of the oropharyngeal cavity (Fig. 1) is formed by a cartilaginous hard palate. Located on the midline of the hard plate there is a longitudinal fissure, the choana. The oral and nasal cavities communicate through this opening. The choana is characterized by a narrow rostral portion and an enlarged caudal portion. On either side of the enlarged caudal part of the choana are mucosal elevations of the palate, the palatine ridges. The mucous membrane of the hard palate exhibit many caudally directed papillae. These papillae are prominent on the palatine ridges and on the edges of the enlarged portion of the choanal slit.

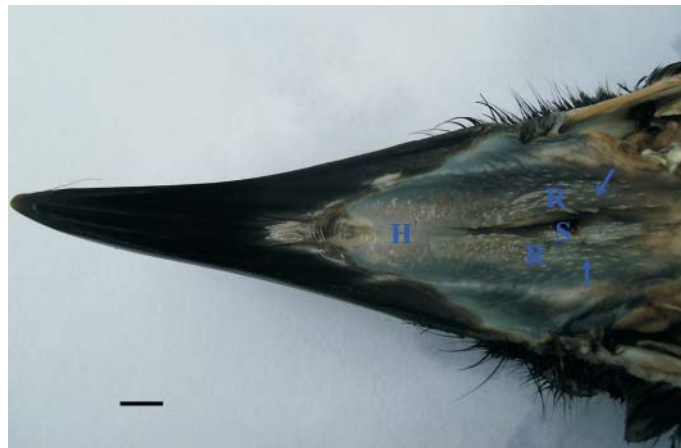


Fig. 1. Roof of the oropharynx of an African pied crow showing the hard palate (H), the choanal slit (S), the palatine ridges (R) and the caudally directed papillae (arrows). Scale bar = 1 cm.

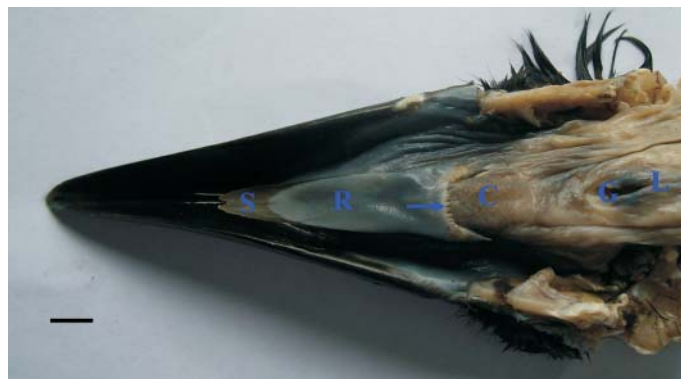


Fig. 2. Floor of the oropharynx of an African pied crow showing the rostral part of the tongue (R) and the caudal part of the tongue (C), demarcated by a transverse row of caudally directed papillae (arrow). A cornified structure (S) that covered the ventral surface of the tongue extended rostrally beyond the tip of the organ. Note the glottis (G) and the laryngeal mound (L). Scale bar = 1 cm.

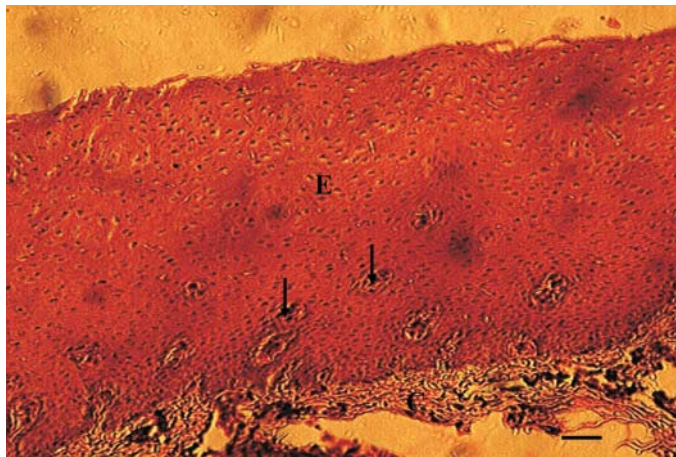


Fig. 3. Photomicrograph of the rostral part of the tongue of an African pied crow showing non-keratinized stratified squamous epithelium (E) on the dorsal surface of the tongue. Note the intraepithelial taste buds (arrows) and sub-epithelial connective tissue (C). H&E; $\times 20$; scale bar = 30 μm .

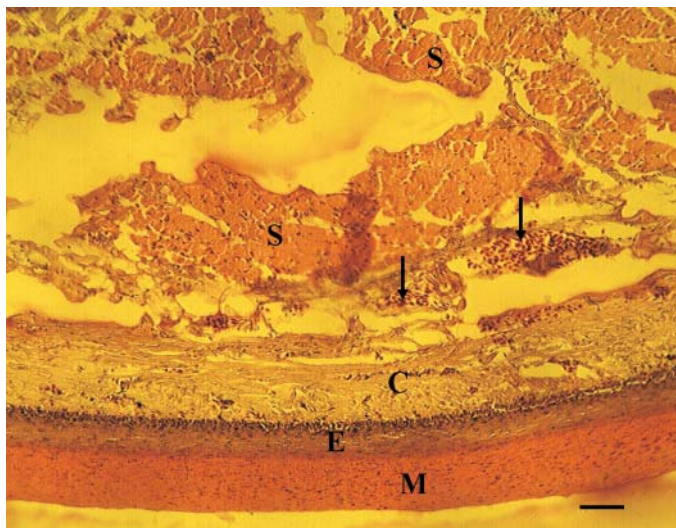


Fig. 4. Photomicrograph of the rostral part of the tongue of an African pied crow showing the epithelium on the ventral surface (E), covered by cornified squamous cells (M). Note the sub-epithelial connective tissue (C), transversely sectioned skeletal muscles (S) and blood vessels (arrows). H&E; $\times 10$; scale bar = 60 μm .

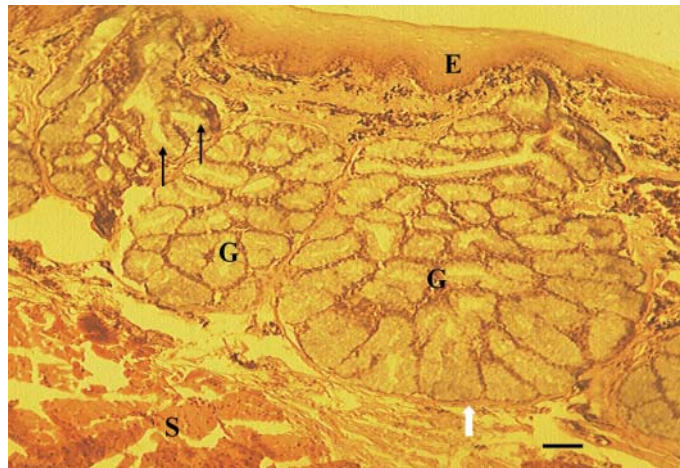


Fig. 5. Photomicrograph of the caudal part of the tongue of an African pied crow showing keratinized epithelium (E) on its dorsal surface, subepithelial mucous glands (G), which are branched tubular glands (black arrows). Note the connective tissue sheath around the glandular acinus (white arrow), and presence of skeletal muscles (S). H&E; $\times 10$; scale bar = 60 μm .

The tongue of the African pied crow lies on the floor of the oropharyngeal cavity (Fig. 2). The tongue, which could be protruded, is arrow shaped. It appears demarcated into two parts; a rostral part that forms the tip and body of the organ, and a caudal part that is the base of the tongue. The line of demarcation between the rostral and caudal parts of the tongue of the African pied crow is marked by a transverse row of caudally pointed papillae. It was observed that a cornified, horny material covers the ventral surface of the rostral part of the tongue. This cornified material extends rostrally beyond the tip of the tongue as a bluntly triangular structure that tapers at its rostral terminus to a bifurcated tip (Fig. 2). The bifurcated tip of the cornified structure is located rostral to the tip of the tongue. The caudal part of the tongue is attached to the floor of the oropharyngeal cavity by the frenulum linguae, while the rostral part and the cornified structure associated with it are free and could protrude out of the cavity. Caudal to the tongue of the African pied crow is the laryngeal mound, a mucosal elevation located on the midline (Fig. 2). The glottis is present on the rostral surface of the laryngeal mound, and is situated directly ventral to the enlarged caudal portion of the choanal slit. The caudally directed papillae are evident on the mucous membrane of the laryngeal mound.

Histology. The histology of the tongue of the African pied crow showed that the organ is lined by stratified squamous epithelium on both the dorsal (Fig. 3) and the ventral (Fig. 4) surfaces. The epithelium on the ventral surface of the rostral part of the tongue appears keratinized, and is covered by many layers of cornified squamous cells, while a

non-keratinized epithelium is apparent on the dorsal surface of this part of the tongue. A common feature of both surfaces of the tongue is the presence of richly vascularized connective tissues just beneath the epithelial layers. Intraepithelial taste buds may be seen within the epithelium on the dorsal surface of the rostral part of the tongue (Fig. 3). The core of this part of the tongue contains bone, and many skeletal muscle cells. All the skeletal muscle fibres seen in a cross section of the tongue are transversely sectioned, indicating that the orientation of these muscles is parallel to the long axis of the tongue (Fig. 4). Histology of the base (caudal part) of the tongue of the African pied crow revealed the presence of many mucous glands (Fig. 5). These lingual glands are located within the connective tissue just beneath the keratinized stratified squamous epithelium on the dorsal surface of the caudal part of the tongue. A longitudinal section of the mucous glands showed that they are simple branched tubular glands. Each glandular acinus is surrounded by a connective tissue sheath, and the ducts of these lingual glands open onto the dorsal surface of the tongue. Bone and skeletal muscles are present within the core of the caudal part of the tongue.

Discussion

The structural characteristics of components of the avian digestive tract are largely determined by the kind of diet consumed by the particular species (MOSS, 1972). Furthermore, adaptation of a bird to its habitat, mode of food acquisition and feeding habits may be an important determinant of the anatomy of the oropharynx and tongue. The rostral part of the tongue of the African pied crow is free and can protrude out of the oropharyngeal cavity. This differs from what was observed in domestic fowls (KING and McLELLAND, 1984) and bustards (BAILEY et al., 1997). The ability of the African pied crow to protrude its tongue may be a necessary adaptation for collecting food materials. The African pied crow feeds by scavenging for food in garbage dumps and by foraging on the ground for diet of invertebrates, fruits, vegetables, reptiles, amphibians, small birds and mammals. Whereas the bone found in the core of the tongue may serve to provide for firmness, the longitudinally oriented skeletal muscles of the tongue in these birds may enable voluntary control of lingual protrusion, as well as movement of the bolus of food within the oropharynx and during swallowing.

The presence of well developed caudally directed papillae on the tongue and the mucous membranes of the hard palate and laryngeal mound of the African pied crow is similar to what has been reported in bustards (BAILEY et al., 1997). These papillae may serve principally as mechanical obstacles to the involuntary return of food that has passed over them. In addition, the papillae may assist with swallowing by ensuring that the bolus of food is moved in only one direction, towards the oesophagus, and prevent regurgitation (McLELLAND, 1979). Intramural mucous glands found within the caudal part of the tongue

secrete through ducts onto the dorsal surface of the tongue. The secretions of these glands may aid in swallowing by lubricating the caudal part of the oropharyngeal cavity and probably, the initial part of the oesophagus. Such lubrication is important because birds lack teeth and are unable to masticate their food.

Keratinization of lingual epithelium is a common feature in avian species (IWASAKI, 1992; IWASAKI et al., 1997; KOBAYASHI et al., 1998). This is especially prominent on the ventral surface of the tongue of the African pied crow. The cornified structure that covered the ventral surface of the tongue, and extended rostrally beyond the tip of the tongue of the African pied crow may be a type of the 'lingual nail' that has been described in the tongues of other avian species (SUSI, 1969; HOMBERGER and BRUSH, 1986). The lack of keratin in the epithelium on the dorsal surface of the rostral part of the tongue of the African pied crow is not similar to what has been reported in other birds (CARVER and SAWYER, 1989). However, a relationship between the extent of lingual epithelial keratinization and avian habitat and type of food has been demonstrated (IWASAKI, 2002). The occurrence of intraepithelial taste buds in the tongue of the African pied crow suggests that the crow may be capable of taste discrimination, which may play a role in food selection. Taste buds are variously developed in birds, and their anatomical location may vary among different species. In most birds, there are a few taste buds at the caudal end of the tongue and in the mucosal wall of the upper and lower beaks (GANCHROW et al., 1986). In Mallards, taste buds are absent in the caudal part of the tongue, but are found on the roof of the oropharynx, while parrots have taste buds on either side of the choanal opening, and just rostral to the laryngeal mound (COLES, 2007). The acuity of taste may also vary between species. Generally, bitter and salt tasting substances are rejected (COLES, 2007), and this may be important when administering therapeutic drugs via the oral route.

In conclusion, our study has shown that the anatomical features of the oropharyngeal cavity and tongue of the African pied crow may be adaptations to the bird's mode of food acquisition and feeding habits.

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SAŽETAK

Proučavanje anatomije probavnoga sustava afričke crnobijele vrane potrebno je radi njezina liječenja, pravilnoga načina hranidbe i kirurških zahvata što je od posebnoga značenja kad se ona drži u zatočeništvu. Ovo istraživanje provedeno je u svrhu prikupljanja temeljnih podataka o morfologiji orofarinksa i jezika afričke crnobijele vrane. Polučeni rezultati pokazali da je krov njezine orofaringealne šupljine građen od tvrdoga hrskavičnoga nepca na čijoj se sluznici nalazi mnoštvo kaudalno usmjerenih papila. Jezik je smješten na dnu orofaringealne šupljine. Rostralni i kaudalni dijelovi jezika odijeljeni su poprječnim redom kaudalno usmjerenih papila. U kaudalnom dijelu jezika nalazi se mnoštvo sluznih žlijezda koje svoje sekrete izlučuju na dorzalnu površinu jezika putem kanalića. Dok papile prvenstveno služe kao mehanička prepreka za povratak hrane, lučevine žlijezda mogu pomoći pri gutanju podmazivanjem kaudalnoga dijela orofaringealne šupljine, i, vjerojatno, početnoga dijela jednjaka. Može se zaključiti da je anatomska građa orofaringealne šupljine i jezika afričke crnobijele vrane prilagođena hranidbenim navikama i načinu uzimanja hrane.

Ključne riječi: orofaringealna šupljina, jezik, sluzne žlijezde, afrička crnobijela vrana, *Corvus albus*
