Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1679-9283
ISSN on-line: 1807-863X
Doi: 10.4025/actascibiolsci.v35i1.12675

Morphological aspects of the salivary glands of Crab-eating racoon (*Procyon cancrivorus*)

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ABSTRACT. *Procyon cancrivorus* is a wild mammal from the *Procyonidae* family, being one of the least studied Brazilian carnivores. The aim of this study was to describe the morphological aspects of the salivary glands of *Procyon cancrivorus*, and to compare with literature data on the morphology of domestic animals and wilds animals, such as coatis and possums. Three adult animals were collected on highways (roadkilled), fixed 10% formaldehyde aqueous solution and submitted to desiccation. The salivary glands of the crab-eating raccoon are formed by the parotid, mandibular, sublingual and zygomatic glands. The parotid gland shows irregularly triangular shape with its respective duct. The mandible gland shows rounded outline surrounded by a fibrous capsule with its respective duct. The sublingual gland is divided into two parts: the caudal part, located in the occiptomandibular region of the digastric muscle and the rostral part between the tunica mucosa of the mouth and the mylohyoid muscle with its respective duct. The zygomatic gland is small and rounded, located in the rostral part of the pterygopalatine fossa with its respective duct. The morphology of the salivary glands of crab-eating raccoon presents great similarity in shape and arrangement with the glands of dog, cat, coatis and possum.

Keywords: glands, anatomy, carnivores.

Aspectos morfológicos das glândulas salivares do Mão-pelada (*Procyon cancrivorus*)

RESUMO. O *Procyon cancrivorus* é um mamífero silvestre da família *Procyonidae*, sendo um dos carnívoros brasileiros menos estudados. O objetivo deste estudo foi descrever os aspectos morfológicos das glândulas salivares do *Procyon cancrivorus*, e comparar com dados literários sobre a morfologia de animais domésticos e silvestres, como gambás e quatis. Foram utilizados três animais adultos, procedentes de coleta em rodovias (mortos por acidente), fixados em solução aquosa 10% de formaldeído e submetidos à dissecação. As glândulas salivares do mão-pelada são formadas pelas glândulas parótida, mandibular, sublingual e zigomática. A glândula parótida apresenta formato irregularmente triangular com seu respectivo ducto. Na mandibular observa-se contorno arredondado circundada por uma cápsula fibrosa com seu respectivo ducto. A sublingual se divide em duas partes: uma parte caudal que se situa na região occiptomandibular do músculo digástrico e a parte rostral situa-se entre a túnica mucosa da boca e o músculo milo-hióideo com seu respectivo ducto. A glândula zigomática é pequena e arredondada, situada na parte rostral da fossa pterigopalatina com seu respectivo ducto. Observando a morfologia das glândulas salivares do mão-pelada podemos dizer que possuem grande similaridade em forma e disposição com as glândulas de cão, gato, quati e gambá.

Palavras-chave: glândulas, anatomia, carnívoro.

Introduction

Brazil's biodiversity is poorly known, although it is considered the largest in the world. The diversity of mammals in Brazil reaches significant numbers, becoming one of the largest in the world. Until recently, 22 orders of mammals worldwide were known, of which 11 were found in Brazil, represented by 524 species (REIS et al., 2006). *Procyon cancrivorus* (crab-eating raccoon) belongs to the phylum Chordata, class Mammalia, order *Carnivora*, and grouped in the *Procyonidae* family. This family has six genera with at least 13 species, all of the new world. The morphological data of this species are few (MORATO et al., 2004).

Their geographical distribution is wide, and occurs from Central America down to Uruguay, northeastern Argentina and Brazil. In Brazil, its distribution covers all biomes: Atlantic Forest, Caatinga, Amazon, Cerrado, Pantanal and Southern Plains (CÂMARA; MURTA, 2003; REIS et al., 2006). The populations of this species are in decline and threats include hunting for skins, use for target practice, and in some areas of

habitat destruction (MICHALSKI; PERES, 2005). Development projects and the destruction of coastal mangroves contribute regionally to the decline of these populations (REID; HELGEN, 2008).

Procyon cancrivorus is characterized by a black mask that extends from the eyes to the base of the mandible. Its color is usually dark gray with yellow spots. It has long and hairy tail, with stripes forming dark rings. The head is short, the ears are semi-rounded and the eyes are round and black (CÂMARA; MURTA, 2003; REIS et al., 2006). They have the forelimbs adapted to hold food, elongated and dark legs, and hands devoid of hair, which gave this species its popular name in Brazil, distinguishing this species from the North American raccoon (*P. lotor*), which has whitish front legs (CUBAS et al., 2006). It can reach 1 m in length, including tail, and weigh up to 10 kg (CARVALHO JÚNIOR; LUZ, 2008).

Nocturnal, they are good climbers and swimmers (EMMONS; FEER, 1997; YANOSKY; MERCOLLI, 1993). The crab-eating raccoon is a solitary animal with its occurrence in forest positively associated with water bodies (MICHALSKI; PERES, 2005). The feeding of this species consists mainly of fruits, insects, amphibians, fish, mollusks and crabs (GATTI et al., 2006; REIS et al., 2006; SANTOS; HARTZ, 1999). Also known as raccoon, washer rat, washer bear or masked, it has the peculiarity of diving into the water everything it eats probably associating to its favorite foods, which are shrimp and frogs (CÂMARA; MURTA, 2003; CUBAS et al., 2006; PEREIRA et al., 2010a, b and c; REIS et al., 2006).

The choice for this wild species was the small number of papers published in Brazilian and international literature about it (LIMA et al., 2010a and b; PEREIRA et al., 2010a, b and c, 2011, 2012; BARCELOS et al., 2012) and the specimens we have in our laboratory from collections on highways, being a major reason for the development of this anatomical study, in addition to the small number of researches on the salivary glands of wild animals.

The salivary glands drain into the mouth cavity secreting saliva, which keeps the inside of the mouth wet. When mixed with the food, it makes chewing and swallowing easier and lubricates the food passage (DYCE et al., 2004). Harvey (1985) and Adams (1988) describe the division of the parotid salivary glands, mandibular, sublingual and zygomatic in dog and cat.

The parotid gland is irregularly triangular in dog and cat, located near the ear between the existing space in the mandible, the atlas wing and the auricular cartilage (ELLENPORT, 1986; DYCE et al., 2004). Macroscopic reports of duct and parotid gland still need a more detailed study, especially with regard to shape and position (GRECO et al., 2010).

In domestic animals, the mandibular gland is long, bright yellow, curved and with concave dorsal margin and surrounded by a fibrous capsule that gives it its final form. It extends from the atlantal fossa to the basihyoid bone so that it is partly covered by the parotid gland (ELLENPORT, 1986; DYCE et al., 2004). This gland is smaller than the parotid, more compact and is near the angle of the jaw in coatis (SANTOS et al., 2010).

The sublingual gland is divided into two parts: the polystomatic gland, which is diffuse, opening up by several small ducts in the mouth and the monostomatic gland, which is compact and drained by a single duct (DYCE et al., 2004).

In dog and cat, the zygomatic gland is located in the orbital cavity and its limits are determined by the zygomatic arch laterally and dorsally by the periorbital cavity, ventrally by the orbital fat and by the pterygoid muscle, and medially by the maxilla, which contains the roots of the last upper molar tooth (PEDINI et al., 1995).

The present study describes the salivary glands of *P. cancrivorus* and the location of their ducts for comparison with data from literature of the salivary glands of domestic and wild carnivores.

Material and methods

Three adult animals were collected on highways (roadkilled) were used in this study according to criteria of the Institutional Ethics Committee (ICVGAN, 2005) and Law in force (Law 1.153/95). The animals were brought to the Laboratory of Anatomy and submitted to fixation in 10% formaldehyde aqueous solution.

We use the method of dissection, removing the skin, and carefully dissect the parotid glands, mandible and zygomatic. The digastric muscle was folded down for better visualization of the sublingual gland and ducts and document the results with camera (Sony α200 10.2 mpx). Then, the results were compared with those of literature on the salivary glands of domestic animals, cats and dogs, and wild animals, according to the international committee on veterinary gross anatomical nomenclature (ICVGAN, 2005).

Results

In *P. cancrivorus*, it was found that the parotid gland shows irregular triangular shape, located right

after the masseter muscle making a slight boundary in its posterior edge (Figure 1).

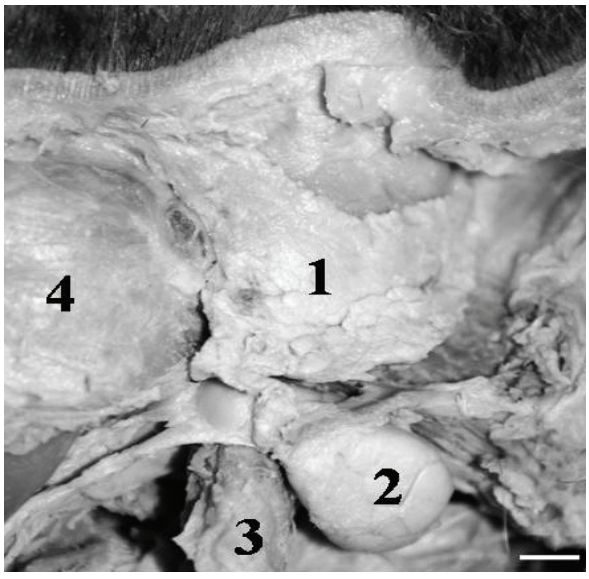

Figure 1. 1) Parotid Gland, 2) Mandibular Gland, 3) Digastric Muscle, 4) Masseter Muscle. Bar: 1 cm

The mandibular gland shows a rounded contour and its duct crosses along the occiptomandibular face of the digastric muscle and styloglossus muscle and opens in the mouth on the sublingual caruncle near the frenulum (Figure 1 and 2).

The sublingual gland is divided into two parts: the caudal part that is located in the occiptomandibular region of the digastric muscle and the rostral part between the tunica mucosa of the mouth and the mylohyoid muscle. The larger one follows the mandibular duct and opens beside it (Figure 2).

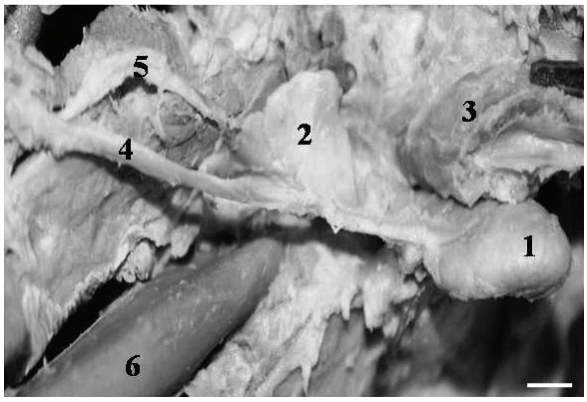

Figure 2. 1) Mandibular Gland, 2) Sublingual Gland, 3) Digastric Muscle, 4) Mandibular Duct, 5) Sublingual Duct, 6) Mandible Bone. Bar: 1 cm

The zygomatic gland is small and rounded, located in the rostral part of the pterygopalatine fossa (Figure 3).

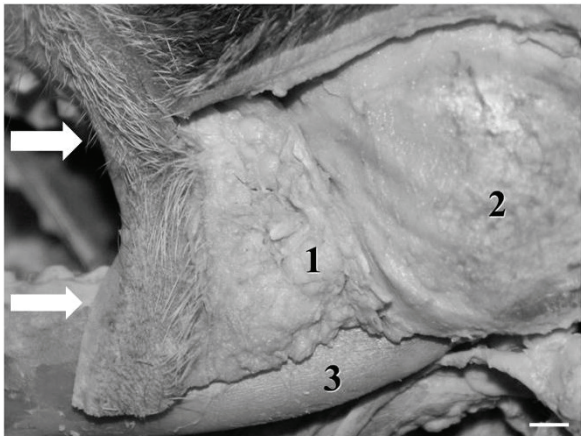

Figure 3. 1) Zygomatic Gland, 2) Masseter Muscle, 3) Mandibular Bone; Arrows: Upper and Lower Lip. Bar: 1 cm

Discussion

The salivary glands of mammals have been documented in numerous studies (CANGUSSU et al., 2002; ESTECONDO et al., 2005; LENTLE et al., 2002; WATANABE et al., 1996). However, the family of *Procyonidae*, little is known about the morphology of the salivary glands. Only Santos et al. (2010) studied the morphology of the mandibular glands of raccoons and so due to lack of information on these glands in raccoon, we were interested to investigate their morphology.

According to Ellenport (1986) the parotid gland in dog and cat is irregularly triangular. Constantinescu (2005) describes the parotid gland of lunate shape. It has yellowish-gray color and is surrounded by a fibrous capsule. Its dorsal end is wide and is divided into two parts by a deep groove that receives the base of the ear. It extends towards the masseter muscle rostrally, ventrally to the mandibular angle and caudally towards the atlas fossa. Its ventral edge is small and overlaps with the mandibular gland. In cats, it has a shape a little rounder but with the same characteristics and location of dogs. The parotid duct leaves the gland at the bottom of the rostral edge, crosses the masseter muscle, and opens in the mouth, oppositely to the third or fourth upper premolar tooth in dogs and the second premolar in cats (DYCE et al., 2004; ELLENPORT, 1986).

In *P. cancrivorus*, the gland and the outlet of its duct in the fourth upper premolar shows similarity to the domestic carnivorous dog. In studies such as Santos et al. (2001), maned wolf (*Chrysocyon brachyrus*) showed the opening of the parotid duct at the level of the lateral line of the first upper molar tooth. Through the results, one must consider the existence of topographic variations in relation to the

point of confluence of the parotid duct in other individuals of the same species.

Santos et al. (2010) observed that the mandibular gland is brown in coatis. In all samples are at the junction of the jaw angle and veins línguofacial, similar to dogs and cats (DONE et al., 2002). In armadillos, Estecondo et al. (2005) report that this press has a rounded, smaller than the parotid coatis as well as *Procyon*.

In domestic animals dog and cat, the mandibular duct leaves the deep surface of the gland, crossing along the face of the occipitomandibular part of the digastric and styloglossus muscles, and opens at the sublingual caruncle in the mouth, little evident and near the frenulum (ELLENPORT, 1986; SCHALLER et al., 1999). In coatis, Santos et al. (2010) describe the duct of this gland is similar to the dog, cat and possum, as observed in raccoon.

The sublingual gland is pink and divided into two parts. In domestic animals such as cats and dogs, the caudal part is located at the occiptomandibular region of the digastric muscle and in close relation with the mandibular gland, which is easily separable after the removal of the common fibrous capsule. It has a sharp rostral process. The largest sublingual duct follows the mandibular duct and opens beside it, or unites with it. The rostral part is long and narrow, located between the tunica mucosa of the mouth and the mylohyoid muscle, dorsally to the styloglossus muscle. It has several small ducts, the minor sublingual ducts, some of which open directly into the mouth, while others join the main duct (CONSTANTINESCU, 2005; ELLENPORT, 1986; SCHALLER et al., 1999).

The zygomatic gland is only found in carnivores (CONSTANTINESCU, 2005; ELLENPORT, 1986; SCHALLER et al., 1999). Located in the orbital cavity, its limits are determined by the zygomatic arch laterally and dorsally by the periorbital cavity, ventrally by the orbital fat and by the pterygoid muscle, and medially by the maxilla. It has four or five ducts that open to the side mucosa next to the last upper molar tooth, which contain its roots, the larger duct is almost as big as the parotid duct, the others are small (DYCE et al., 2004; PEDINI et al., 1995).

The anatomical features mentioned above of domestic animals such as cats and dogs, on the zygomatic and sublingual glands and their ducts, found in literature, are similar with our findings in the wild carnivore *P. cancrivorus*, noting that the anatomical features resemble more dogs than cats and maned wolf.

The data from this study corroborate the findings of (LIMA et al., 2010a and b; PEREIRA et al., 2010a b and c, 2011, 2012; BARCELOS et al., 2012) on the anatomical similarities between *P. cancrivorus* and animals such as cats, dogs, coatis e possum.

Conclusion

It was found that although few studies on *P. cancrivorus* were conducted, a great analogy in the morphology of the salivary glands of this wild carnivore with domestic carnivores such as dogs and cats and wilds animals, such as coatis and possums were found. This study showed the characteristics of an animal of difficult access, showing its similarity to a well-studied animal such as dog, thus contributing for the knowledge on wild animals of the fauna and for future studies on the general biology of this species.

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Received on February 3, 2011.
Accepted on October 17, 2011.