

Scanning Electron Microscopy Study of the Dorsal Surface of the Tongue of *Dasypus hybridus* (Mammalia, Xenarthra, Dasypodidae)

Estudio al Microscopio Electrónico de Barrido de la Superficie Dorsal de la Lengua de *Dasypus hybridus* (Mammalia, Xenarthra, Dasypodidae)

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SUMMARY: The dorsum of the tongue of *Dasypus hybridus* (Desmarest, 1804) studied by scanning electron microscopy, shows conical and branched filiform, fungiform and vallate papillae. No foliate papillae were seen. Conical filiform papillae are placed in the apex of the tongue and posterior to the vallated ones. Branched papillae are compactly distributed over the entire dorsal surface of the tongue. Fungiform papillae are more abundant on the first third of the tongue and they are distributed between filiform papillae. Only two vallate papillae were observed placed in the posterior third of the tongue, surrounded by a deep groove. The presence of taste buds on fungiform and vallate papillae indicate that both are involved in the sense of taste, while the filiform ones have a mechanical and protective role. The morphological characteristics of the tongue of *Dasypus hybridus* are comparable with those of other species of armadillos.

KEY WORDS: Mammals; Xenarthra; Dasypodidae; Armadillo; Tongue; Lingual papillae; SEM.

INTRODUCTION

The armadillo *Dasypus hybridus* (Desmarest, 1804) (mulita, southern long-nosed armadillo), is an armored digger omnivorous mammal; it belongs to the Superorder Xenarthra, Order Cingulata, family Dasypodidae and inhabit in Argentina, Uruguay, Paraguay, and southern Brazil (Gardner, 2005). Its name possibly makes reference to the seven moveable bands that gave the species the appearance of being a hybrid between *D. novemcinctus* (8-9 bands) and *D. septemcinctus* (6-7 bands) (Braun & Mares, 1995). This species is extremely susceptible to anthropogenic land change and general human activity, both of which have affected its range (Abba *et al.*, 2004). The species is decided as Near Threatened on account of severe hunting and rapid decline (IUCN, 2008). Little is known about its morphology (Cuba Caparo, 1979; Estecondo *et al.*, 1996) and the description of the structure of the dorsal surface of the tongue has not been done.

The morphology of the tongue in vertebrates, and specially the structure of the mucosa with the lingual papillae on the dorsal surface of the tongue, varies between species; also the distribution of the mechanical and gustatory papillae is highly specific (Iwasaki, 2002; Emura *et al.*, 2006), and their development reflects dietary habits and living environment of the animals (Yoshimura *et al.*, 2009).

There are many scanning electron microscopy (SEM) studies of lingual papillae in mammals (Jackowiak & Godynicki, 2007; Kulawik & Godynicki, 2007) and, considering armadillos, *Euphractus sexcinctus* (Morais & Watanabe, 1988), *Dasypus novemcinctus* (Morais *et al.*, 1991, 1994; Watanabe *et al.*, 1992), *Chaetophractus vellerosus* (Estecondo *et al.*, 2001), *Chaetophractus villosus* (Estecondo *et al.*, 2004) and *Zaedyus pichiy* (Ciuccio *et al.*, 2008), were investigated.

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The aim of the present study was to describe with SEM the distribution and three-dimensional structure of lingual papillae of the tongue of *Dasypus hybridus* and their possible morphofunctional correlations.

MATERIAL AND METHOD

Tongues of three mature *Dasypus hybridus* of both sexes captured in Bolivar and Pellegrini localities (Buenos Aires province, Argentina), were used. The whole tongues were fixed in glutaraldehyde 2.5%. Small samples (approximately 2 mm²) of tissue, dissected from some previously established areas (from the tip to the base) of the dorsal tongues were obtained. They were washed in 0.1 M sodium cacodylate buffer (pH 7.4) and treated with 8 N hydrochloric acid at 60 °C for 1 hr, to remove any extracellular mucous substance from the lingual surface; the dehydration was made in increasing series of acetone, critical point dried in Polaron apparatus E-3000 and coated with gold in Ion Sputter model 3 Pelco 91000; the samples were examined and photographed with an Evo 40 XVP scanning microscope (Cambridge, England) at 5-7 kV (Estecondo *et al.*, 2001; Ciuccio *et al.*).

RESULTS

The tongue of *D. Dasypus hybridus* has a triangular shape, elongated in anteroposterior direction, with a sharp apex (Fig. 1). The apex and body of the tongue is covered by three kinds of papillae: filiform, fungiform and vallate. No foliate papillae were found.

Filiform papillae are the most abundant and are placed covering the entire surface of the tongue. They are simple (conical) or branched. The conical ones have a wide base and are narrowed to a thin apex (Fig. 2). The branched ones show a basally concave central area surrounded by several pointed filamentous processes. All of them are curved principally towards the pharynx (Fig. 3).

Conical papillae are placed in the tip of the tongue, where they are prominent in size (Fig. 2) and posterior to the vallated ones (Fig. 6). Filiform branched papillae lie in rows and are compactly distributed over the entire dorsal surface (Fig. 4). The length and number of the accessory processes vary throughout the surface of the tongue. They have two accessory processes from the apex to the posterior third of the tongue, finding three processes in the second third of the tongue (Fig. 4). In the posterior third the length

of the processes decreases and the number of branches reduces to two, or the filiform branched become simple conical papillae.

Dome shape fungiform papillae are observed over the entire surface, between the filiform ones, surrounded by a continuous furrow (Fig. 3-5). They are more abundant on the first third of the tongue where we can find them in clusters of two or three papillae (Fig. 1). They are shorter in length and larger in diameter when compared with filiform papillae. Their dorsal surface shows open test pores between squamous epithelia (Fig. 5).

Two oval and elongated vallate papillae are founded on the dorsal-posterior area of the tongue. They are placed symmetrically and obliquely to the median line of the tongue. The surface of these papillae is convex and the body is delimited by a deep circular groove (Fig 6). Both papillae are surrounded by filiform ones. Each one shows visible taste pores on their surface. At high magnification, on the interpapillar areas and places without any papillae, a network of microridges can be observed.

DISCUSSION

Scanning electron microscopic studies have identified some level of structural variation, particularly in size and shape of the lingual papillae on the surface of the tongue of vertebrates (Iwasaki; Jackowiak & Godynicki, 2007). Concerning armadillos, the general morphological pattern and distribution of lingual papillae in *Dasypus hybridus* is comparable to the observed in other species previously studied (Morais & Watanabe, 1988; Morais *et al.*; Estecondo *et al.*, 2001, 2004; Ciuccio *et al.*). The presence of only three kind of papillae is a characteristic also observed in the majority of the other Xenarthrans, but differ of the structure showed by many other mammals as, for example, silver fox (Jackowiak & Godynicki, 2004), raccoon dog and fox (Emura *et al.*, 2006), american beaver (Shindo *et al.*, 2006) or bactrian camel (Peng *et al.*, 2008).

Conical papillae were included with filiform ones because their characteristics, particularly size and morphology would suggest not to consider them as a separate group, opposite to the case observed in other species like lambs (Tadjally & Pazhooman, 2004), goat (Kurtul & Atalgin, 2008) or giant panda (Pastor *et al.*, 2008), where they are clearly differentiated. The morphology of the filiform papillae only differs in size and number of branches from that of the other armadillos previously studied. Those differences may be related with

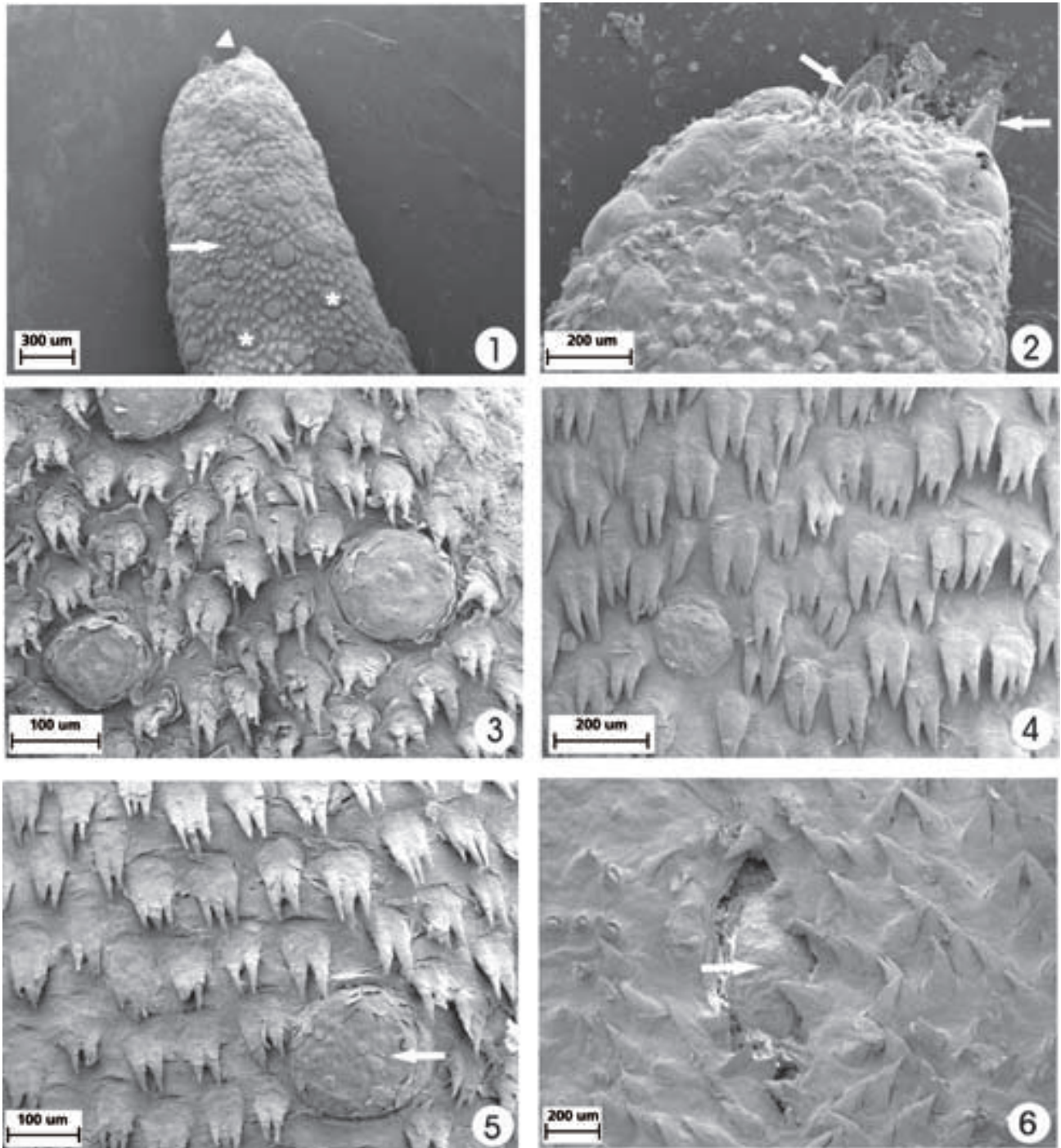


Fig. 1. SEM of lingual apex of *Dasypus hybridus* tongue showing fungiform (*), simple conical (\square) and branched (\Rightarrow) filiform papillae. 300X.

Fig. 2. Apex of the tongue with prominent simple conical filiform papillae (\Rightarrow). 200X.

Fig. 3. Branched filiform and fungiform papillae covering the dorsal surface of the medial third of the tongue. 100X.

Fig. 4. Filiform papillae with two and three branches on medial third of the tongue. 200X.

Fig. 5. Fungiform papillae, placed between filiform ones, rounded by a deep groove with deciduous epithelium and openings of taste buds (\Rightarrow). 100X.

Fig. 6. Vallate papillae with openings of taste buds (\Rightarrow), surrounded by a deep groove and several protective filiform papillae. 200X.

masticatory methods and dietary habits, as was proposed for other mammals (Okada & Schraufnagel, 2005; Yoshimura *et al.*, 2009).

The disposition of the filiform papillae in *Dasybus hybridus*, covering the entire dorsal surface of the tongue, with the number of branches increasing to the middle third of the organ, was also observed in other armadillos like *Euphractus sexcinctus* (Morais & Watanabe), *Dasybus novemcinctus* (Morais *et al.*, 1994), *C. vellerosus* (Estecondo *et al.*, 2001), *C. villosus* (Estecondo *et al.*, 2004) and *Z. pichiy* (Ciuccio *et al.*). The fact that no taste pores were detected added to their dimensions and positions indicate that their function would be mechanical, probably increasing the friction produced by the tongue during grooming and rasping food, as was stated in other mammals (Pastor *et al.*). Their abundance and distribution suggest a possible participation in the protection of the dorsal surface as well as a functional role increasing the adhesion of food to the surface of the tongue, as proposed for bat (Jackowiak *et al.*, 2009).

The size and number of fungiform papillae also vary according to animal species (Yoshimura *et al.*, 2008; Takemura *et al.*, 2009). In *Dasybus hybridus*, they show the same morphology and distribution observed in other Dasypodidae. Particularly their distribution, mainly concentrated in the apex of the tongue, and the arrangement in clusters of three or four papillae, resembles *D. novemcinctus* (Morais *et al.*, 1994) and other armadillos (Estecondo *et al.*, 2001, 2004; Ciuccio *et al.*). Their gustatory function is clear in view of the multiple taste pores on their surface. The distribution of filiform papillae surrounding the fungiform ones, suggests a protective role.

It is well known that the number and morphology

of vallate papillae varied between species, from absent, as in cape hyrax, to abundant, as in ruminants (Yoshimura *et al.*, 2008) and rhinoceros (Emura *et al.*, 2000). The presence of only two vallated papillae in the posterior third of the tongue in *Dasybus hybridus* was also reported by Cuba Caparo; furthermore, this feature was observed in the armadillos *E. sexcinctus* (Morais & Watanabe), *D. novemcinctus* (Morais *et al.*, 1991, 1994; Watanabe *et al.*), *C. vellerosus* (Estecondo *et al.*, 2001), *C. villosus* (Estecondo *et al.*, 2004) and *Z. pichiy* (Ciuccio *et al.*) and in some other mammals as rabbit (Kulawik & Godynicki), ferret (Takemura *et al.*) and badgers (Yoshimura *et al.*, 2009).

Concerning foliate papillae, their absence in *Dasybus hybridus* was also recorded for other armadillos as *C. vellerosus* (Estecondo *et al.*, 2001), *C. villosus* (Estecondo *et al.*, 2004), *Dasybus novemcinctus* (Morais *et al.*, 1991) and *Z. pichiy* (Ciuccio *et al.*) as well as in other Xenarthra genus like *Myrmecophaga*, *Tamandua* and *Bradypus* (Sonntag, 1923; Benetti *et al.*, 2009). Nevertheless, they were observed in *Euphractus sexcinctus* (Morais & Watanabe). Even if the development of foliate papillae was suggested in relation to the feeding method, their evolution remains unclear (Okada & Schraufnagel; Shindo *et al.*).

Finally, morphological and histological features of mammalian tongues reveal the differences between lifestyles and taxonomic position of animals. Such evolution has probably occurred due to characteristic masticator and gustatory needs and functions of the different species. The comparison of the morphology of the tongue of *D. hybridus*, particularly the distribution and the structure of the lingual papillae, with that of the other species of armadillos previously studied, indicate a general similarity of features within the family Dasypodidae.

CIUCCIO, M.; ESTECONDO, S. & CASANAVE, E. B. Estudio al microscópico electrónico de barrido de la superficie dorsal de la lengua de *Dasybus hybridus* (Mammalia, Xenarthra, Dasypodidae). *Int. J. Morphol.*, 28(2):379-384, 2010.

RESUMEN: La superficie dorsal de la lengua de *Dasybus hybridus* (Desmarest, 1804) estudiada a través de microscopía electrónica de barrido, muestra papilas filiformes cónicas y ramificadas, fungiformes y caliciformes. No se observaron papilas foliadas. Las papilas filiformes cónicas se observan en el ápice de la lengua, en los bordes laterales y posteriormente a las papilas caliciformes. Las filiformes ramificadas se encuentran distribuidas en forma compacta sobre toda la superficie dorsal de la lengua. Las papilas fungiformes se localizan entre las filiformes ramificadas y son más numerosas en el tercio anterior de la lengua. Sólo dos papilas caliciformes fueron encontradas ubicadas en el tercio posterior de la lengua, rodeadas por un surco profundo. La presencia de poros gustativos en las papilas fungiformes y caliciformes indica que ambas se encuentran involucradas en el sentido del gusto, mientras que las filiformes poseen un rol mecánico y de protección. Las características morfológicas de la lengua de *Dasybus hybridus* son comparables con las de otras especies de armadillos.

PALABRAS CLAVE: Mamíferos; Xenarthra; Dasypodidae; Armadillo; Lengua; Papilas linguales; SEM.

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