Scanning electron microscopy of the wild boar and pig lingual papillae

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Summary. Lingual papillae of wild boar and pig were studied by means of scanning electron microscopy (SEM). Vallate papillae appear with the typical circumvallate morphology. Their papillary bodies show conical or fungiform-like and spicule-like pseudopapillae in both animals. Taste pores were seen in the papillary grooves. Microplicae or pits are visible at high magnification. In pig and wild boar similar foliate papillae were observed. Pig has less but wider leaves than wild boar. Taste pores on papillary walls were viewed. At high magnification microplicae were seen. Morphologically, fungiform papillae correspond with their denomination. Taste pores open onto the upper surface and they are easily identifiable by SEM. The rostral and lateral regions contain the major number of fungiform papillae. The lateral papillae of wild boar and pig show a high number of pores per papilla. These regions must be considered important in taste sensitivity. Lateral papillae in both animals could provide a source of taste buds for study. In both animals the fungiform papillary epithelium showed a pitted appearance as a consequence of keratinization by food environmental stress. The filiform papillae can be both simple and compound (with body and hairs). Large conical papillae are located caudally and curved in the same direction. Filiform and conical papillae have a function in food mastication, handling and deglutition.

Key words: Tongue papillae, Scanning electron microscopy, Taste pores ,Wild boar, Pig

Introduction

The surface of the mammalian tongue has a papillary system with two specific functions: gustatory and mechanical. The gustatory papillae show taste buds and

pores, whereas the mechanical papillae play a role in tongue surface protection, food prehension, mastication, etc. Although some general descriptions of the lingual papillae in swine have been made (Nickel et al., 1973; Barone, 1976; for example) a more complete morphological study of the mechanical and gustatory papillae of the pig is lacking. According to these general descriptions the tongue of pig shows soft and flexible filiform papillae on the body and apex. At the root of the tongue these papillae are long, thick, less numerous and directed caudally (towards the pharynx). Interposed among the filiform papillae of the lingual back and apex, as well as on the lateral surfaces, are the fungiform papillae. A complete study of these papillae and their taste pores has been carried out by us in both animals (Chamorro et al., 1993). On the back of the pig tongue there are only two vallate papillae which are located just rostral to the lingual root and have the typical circumvallate morphology. On each lateral border of the tongue, immediately rostral to the palatoglossal arch, there is a foliate papilla. About the papillary endowment of the wild boar and its morphology there are no reports.

SEM provides three-dimensional images at high resolution and allows observation and morphological description of tongue papillae. There are numerous studies of the tongue papillae by means of SEM on various mammals: horse and cow (Steflik et al., 1983; Chamorro et al., 1986; Paz et al., 1988); dog (Chibuzo, 1979; Sing et al., 1980; Holland et al., 1989); cat (Boshell et al., 1982; Chamorro et al., 1987); rabbit (Toyoshima and Shimamura, 1981; Liu and Lee, 1982; Chamorro et al., 1987; Kobayashi, 1992); rat (Liu and Lee, 1982; Iida et al., 1985); and monkey (Arvidson, 1975; Iwasaki et al., 1992).

By means of SEM the surface morphology as well as bacterial flora of the pig lingual surface have also been described (Boshell et al., 1979). Matravers et al. (1982) determine the surface features of several regions of porcine oral mucosa by SEM. These authors analyzed cellular characteristics such as cell shape, cell contacts and type of ridged surface. They used discriminant and

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cluster statistical analyses to determine whether differences in these features were in relation to differences in the degree of keratinization or with specific characteristics of each mucosal region. On this basis, these authors distinguished between keratinized and non-keratinized mucosa.

In this paper we analyze the lingual papillae of the wild boar and pig considering their morphological characteristics by SEM. Such comparative analysis could account for the role of each papillary type in taste, food prehension, etc. in both animals.

Materials and methods

Tongues from 16 adult pigs and 14 wild boars were used in this study. The pig tongues were obtained immediately upon sacrifice from a local slaughter house. The wild boar tongues were collected from hunted animals and immediately transported in a refrigerated box to the laboratory. The whole tongues were rinsed with 0.1M phosphate buffer (pH 7.4) and samples of each papillary type were chosen for examination as follows: all the vallate and foliate papillae were taken for their study; for conical papillae study five to eight mucosa samples of 1 cm^2 from the lingual region caudal to the vallate papillae were taken in each tongue; mucosa samples (about 1 cm^2) with filiform papillae were taken at random from the tongue dorsum at a number of 10-14 per tongue. To analyze the fungiform papillae each tongue was divided in rostral, medial, caudal and lateral regions. Five to eight samples (1 cm^2) from each region were collected from each tongue.

The pieces were exposed to ultrasonic waves for several minutes and rewashed with 0.1M phosphate buffer to remove the extraneous debris. The samples were fixed in 2% glutaraldehyde in the same buffer, pH 7.4, for 12 hr, post-fixed in 1% osmium tetroxide for 2 hr, dehydrated in ethanol and infiltrated with amyl acetate. Then they were dried by replacing amyl acetate with liquid CO₂ in a critical-point drying apparatus, mounted on aluminium stubs with conducting nickel paint and sputter-coated with gold palladium. The specimens were observed in a JEOL 35 C scanning electron microscope at 20 kV.

Results

Wild boar

Vallate papillae

Two vallate papillae were located rostrally to the lingual root. They marked the boundary between the filiform papillae of the oral part and the conical papillae of the pharyngeal part of the tongue.

SEM showed vallate papillae with the typical appearance of elongated bodies surrounded by deep furrows (Fig. 1a). Their greater diameter was 4 to 7.5 mm and the lesser 3 to 3.5 mm. The papillary groove

was deep and wide (it could be more than 200 μ m) and separated the papilla from the adjacent lingual mucosa which may show abundant filiform papillae or a smooth surface. The dorsal surface of the papillary body was very abrupt, having two types of pseudopapillae (Fig. 1d). A very numerous type of pseudopapillae had a spicule-like aspect, and lengthened perpendicularly to the surface, reaching up to 100 μ m in height. The other fungiform-like pseudopapillae had a circular outline, variable size (from 100 to 500 μ m in diameter and more than 100 μ m in height) and smooth surface with some desquamous cells. These may be up to 10-12 in number. Frequently the papillary body near the groove was practically smooth and without pseudopapillae.

There were few taste pores on the papillary body, but they were more numerous in the papillary groove, having a diameter of about 10 μ m (Fig. 1b, c).

At high magnification the squamous epithelial cells lining the papillary surface had a polygonal shape or irregular outline in some zones. These cells showed branching microplicae (Fig. 1b) or a pitted appearance (Fig. 1c) (according to Kullaa-Mikkonen, 1987).

Foliate papillae

There were two groups of foliate papillae in the wild boar tongue located on the dorsolateral surface, rostrally to the palatoglossal arch. These papillae consisted of four to six papillary leaves separated one from another by a furrow (Fig. 2a). Frequently these furrows were discontinuous, with irregular trajectory and variable depth. Each papillary leaf were 0.5-1.2 mm in width and up to 5 mm in length. Few taste pores with a diameter about 8 µm opened onto the groove walls (Fig. 2b). The lingual mucosa surrounding the foliate papillae was devoid of other papillae. At high magnification the foliate papillae surface showed microplicae (Fig. 2c).

Fungiform papillae

Fungiform papillae were found on the tongue edges, rostral portion and mid-portion of the lingual dorsum, another group being located immediately rostral to the vallate papillae.

The lateral fungiform papillae were very numerous mainly in the caudal area of the lateral regions. They were mushroom-like, flattened in shape (Fig. 3a) and they were surrounded by lingual mucosa without filiform papillae. These papillae had an almost circular morphology with an approximate height of 250 μ m. Their surface was the biggest of all wild boar fungiform papillae. In the lateral regions, the more caudally located papillae had the highest surface. On papillary surfaces numerous taste pores (about 25-30) appeared with 10-20 μ m diameter (Fig. 3b) grouped near the central region of the papilla (Fig. 3a). Occasionally several pores communicated by means of grooves (Fig. 3c). Also occasionally two taste pores opened onto the same crater-like structure (Fig. 3d).





Fig. 1. a. Wild boar vallate papilla surrounded by a deep papillary furrow (f). Numerous pseudopapillae are seen on the dorsal surface of papillary body. Scale bar= 1 mm. **b.** Taste pore of a vallate papilla. Cell surface surrounding the pore shows microplicae. Scale bar= 10 μ m. **c.** Taste pore surrounded by pitted cells with polygonal surface. Scale bar= 10 μ m. **d.** Stereopair showing the two types of pseudopapillae distinguishable on the vallate papillae: spicule-like (thin arrow) and fungiform-like (asterisk). A very abrupt surface of the papilla is appreciable. Scale bar= 100 μ m.



Fig. 2. a. Wild boar foliate papilla showing irregular furrows. Scale bar= 1 mm. **b.** A taste pore (arrow) on the foliate papilla surface near a papillary furrow (f). Scale bar= 10 µm. c. Microplicae on the foliate papillary surface. Scale bar= 10 µm.

The rostral fungiform papillae were very abundant, taller than the lateral ones and were finger-like in shape. Filiform papillae surrounded the fungiform papillae of this tongue region. Their surface was lesser than that of the lateral papillae. The number of pores per papilla was low (1-3).

In the medial third, the fungiform papillae were

mushroom-like, not flattened in shape and surrounded by abundant filiform papillae (Fig. 3e). They had a greater height than lateral and rostral papillae (up to 300-400 μ m). Medial fungiform papillae were less abundant than rostral ones. The number of pores (about 4) was greater than in rostral papillae and much lower than in lateral papillae.



Fig. 3. a. A flattened fungiform papilla of wild boar that shows numerous taste pores (arrows). This papilla arises from the lateral tongue region being surrounded by mucosa without filiform papillae. Scale bar= 100 µm. **b.** Fungiform taste pore. A practically smooth or pitted surface surrounds this pore. Scale bar= 1 µm. **c.** Surface of a fungiform papilla. Some grooves communicate taste pores. The cell boundaries of the polygonal epithelial cells are visible. Scale bar= 10 µm. **d.** Two taste pores are seen opening onto the same crater-like structure. Scale bar= 1 µm. **e.** Fungiform papilla of the medial region surrounded by abundant filiform papillae. Scale bar= 100 µm.

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A few numerous group of caudal fungiform papillae was located immediately rostral to the vallate papillae. This papillary group was surrounded by a lower number of filiform papillae than medial and rostral fungiform ones. Their morphology was intermediate between lateral and medial fungiform papillae. These caudal papillae also showed a number of intermediate pores.

At low magnification the fungiform papillary surface was relatively smooth. At high magnification it was observed smooth or with a pitted appearance.

Filiform papillae

According to the morphology and location of the mechanical papillae we have considered separately the filiform and conical papillae. Filiform papillae covered the dorsum of the tongue and were densely distributed at the apex and mid-portion, being less numerous in the caudal region.

SEM showed two types of filiform papillae: compound and simple (Fig. 4). The compound filiform papillae can be divided into two parts: body and hairs (Kullaa-Mikkonen and Sorvari, 1985). The body was 30 to 80 μ m in diameter and 100 to 350 μ m in length. The hairs protruded upwards from the cylindrical body. 2 to 10 hairs with a variable diameter (10 to 3 μ m) protruded from each papillary body and were progressively acuminated with a sharp end. Simple filiform papillae had a greater diameter, from 15 to 45 μ m, and were up to 500 μ m in length.

The free surface of the filiform papillae was devoid of

distinguishable microplicae and it appeared smooth at high magnification.

Conical papillae

The conical papillae were located on the dorsum of the caudal portion of the tongue, caudally to the vallate papillae and curved towards the pharynx. Conical papillae stood on a base (0.8-2 mm thick) and narrowed to a thin apex (Fig. 5). They were from 1.5 to 4 mm long. At high magnification the papillary surface showed microplicae or a smooth appearance in some zones.

Pig

Vallate papillae

Two vallate papillae were located on the caudal third of the dorsum tongue. Each papilla showed an ellipsoidal papillary body surrounded by a papillary groove and an annular pad (Fig. 6). The body had a maximum diameter of 4-5 mm and a minimum of 2.5-3.5 mm. The papillary groove was deep and was from 100 to 200 μ m in width. The annular pad frequently had a caudal broad zone (up to 1 mm) and a rostral thin zone (up to 300 μ m). This pad may show abundant papillae with filiform aspect.

The papillary body surface generally showed 4-5 conical-like pseudopapillae with variable dimensions (250-700 μ m in diameter on the base and 200-400 μ m in height). Moreover, there were other spicule-like



Fig. 4. Filiform papillae of the wild boar tongue. Simple (s) and compound (c) filiform papillae are seen. The compound filiform papillae show a body (b) and several hairs (h). Scale bar= 100 µm.

Fig. 5. Conical papillae with a wide base and a thin apex. Scale bar= 1 mm.



Fig. 6. Pig vallate papilla surrounded by a papillary groove (g) and an outermost pad (p). Several pseudopapillae (arrows) with a conical shape are visible on the papillary body. Scale bar= 1mm.

pseudopapillae types on the papillary body that were 90-100 μ m in height.

Secondary grooves could also be present in variable number on the body. Some taste pores with a diameter from 8 to 12 μ m were only located on the papillary groove. At high magnification the cell surfaces showed branched microplicae.

Foliate papillae

The foliate papillae were composed of two groups of papillary leaves with a location similar to the wild boar ones. These papillae had three to five papillary leaves separated by furrows (Fig. 7a). Exceptionally, some papillae could appear with one leaf only. Leaf dimensions varied from 0.5 to 2 mm in width and up to 5 mm in length. Occasionally we viewed foliate papillae with numerous grooves (up to 12) having variable dimensions and irregular disposition (Fig. 7b). Rounded pseudopapillary formations of 200-700 μ m in diameter appeared on the papillary leaves near the grooves (Fig. 7a).



Fig. 7. a. Pig foliate papilla with papillary leaves separated by wide furrows (f). The papillary leaves have pseudopapillae (asterisks) on their edges. Scale bar= 1mm. **b.** Foliate papillae of the pig showing an irregular disposition of its grooves and leaves. Scale bar= 1mm. **c.** High magnification of the upper papillary surface showing microplicae. Scale bar= 10 μm. **d.** Internal view of a papillary leaf with several taste pores. Scale bar= 10 μm.

Some taste pores (5-10 μ m in diameter) were observed on the surface of these pseudopapillae. Internal faces of the leaves showed numerous pores (Fig. 7d) with similar diameters.

At high magnification, surface structure of the papillary superficial cells showed branched microplicae (Fig. 7b), whereas the pseudopapillae one had a pitted appearance.

Fungiform papillae

The lateral fungiform papillae had an almost circular outline and a flattened aspect, being only 250 μm in



Fig. 8. a. Lateral fungiform papillae of the pig. This papilla is located near the upper lingual surface. Numerous taste pores are present (arrows). Scale bar= 100 μ m. **b.** Medial fungiform papilla of the pig. Abundant filiform papillae surround this papilla which is higher than lateral fungiform papillae. Scale bar= 10 μ m.

height (Fig. 8a). These papillae were surrounded by no, or very scarce, filiform papillae. The papillary body could show several shallow grooves. The surface of the pig lateral fungiform papillae was the greatest of all fungiform papillae of both animals. Both the papillae number and the papillary surface were higher in the medial third of the lateral regions. The number of pores was high (about 12). The taste pores had an approximate diameter of 10-15 μ m.

The rostral papillae were the most abundant and the smallest fungiform papillae of the pig tongue. They were surrounded by filiform papillae and their surface had abundant desquamous cells. These papillae could show circular grooves on the external border and were higher than the lateral ones. Few taste pores opened onto their surface (about 3).

The medial fungiform papillae was not located on the rudimentary *torus linguae* but on the more rostral and lateral portions of this third and were surrounded by filiform papillae.

A small number of caudal fungiform papillae was grouped rostrally to the vallate papillae. These papillae could show a typical fungiform morphology or a conical-like aspect (Fig. 8b). Conical-like fungiform papillae were 500 to 700 μ m in height. Caudal mushroom-shaped fungiform papillae had more taste pores than conical-like papillae. The surface of squamous epithelial cells of fungiform papillae from any region had a pitted appearance.

Filiform papillae

The filiform papillae were located on the dorsum of the tongue. SEM analysis showed two types of papillae: compound and simple. The compound papillae had a body and a variable number (two to ten) of papillary hairs (Fig. 9). The body had a diameter from 70 μ m (for bodies with few hairs) to 120 µm (for bodies with numerous hairs) and a length from 200 to 400 µm. The total length of the papilla was about 350-550 µm. The simple filiform papillae had a typical filiform morphology of 10-60 µm in diameter and up to 600 µm in length. Those filiform papillae located on the rudimentary torus linguae increased their length reaching 700 µm for the simple papillae. In the same zone the body of compound filiform papillae thickened to 200 µm. At high magnification these papillae showed a smooth surface or micropits. Some papillae showed microplicae, especially in papillary surface regions nearest to the lingual surface.

Conical papillae

Caudally to the vallate papillae were found the conical ones. They presented a typical conical morphology of 1-2 mm in diameter on the base and from 2 to 7 mm in height. These papillae were directed caudally ending in a point and they could present one or two apices (Fig. 10). In SEM micrographs microplicae

could be seen.

Discussion

Vallate papillae

The wild boar and pig, as the horse, have only one pair of vallate papillae. In both animals they appear with a typical circumvallate morphology, being slightly bigger in wild boar than in pig. The papillary body in both animals has pseudopapillae, more numerous in wild boar than in pig. These pseudopapillae can be of two types: conical- or fungiform-like and spicule-like in shape. The presence of pseudopapillae in the vallate papillae has also been reported in other species such as opossum (Krause and Cutts, 1982), dog (Chibuzo, 1979) and cat (Chamorro et al., 1987), the significance of which is unknown.

Some deep secondary grooves are seen in the body of pig vallate papillae, whereas the wild boar ones do not have furrows. Similar grooves have also been seen by us in horse (Chamorro et al., 1986). Taste pores are seen in vallate papillae of both animals, but their number is low, although taste pores are more frequently found in pig vallate papillae. These pores are located in the walls of the papillary groove. Secondary grooves of pig vallate papillae show no taste pores.

At high magnification the cellular surface of vallate papillae in both animals shows ridges which are branched to a varying degree according to the descriptions of Appleton and Heaney (1977) for bucal mucosa. These folds are discussed under various names (Kullaa-Mikkonen, 1987; Arvidson et al. 1988), such as cytoplasmic folds (Whittaker and Adams, 1971), microridges (Sperry and Wassersug, 1976), microplicae (Kullaa-Mikkonen and Sorvari, 1985, for example) or microrugae (Banoczy et al., 1980). According to Kullaa-Mikkonen (1987) the term microplicae has gained wide acceptance.

Nair and Schroeder (1981) pointed out several hypothetical functions for microplicae such as: intercellular interdigitation for cell adhesion; protective function by reducing the surface area of contact and aiding the laminar flow of surface protecting and lubricating secretions. Fahrenbach and Knutson (1975) presumed that microplicae represented an adaptation of the structure of the epithelium to friction, whereas Sperry and Wassersug (1976) indicated that microplicae might play a role in the retention of mucus, and appeared to facilitate the spread of the same. Iwasaki and Miyata (1985) have pointed out that microplicae do not necessarily occur in the adaptation to friction suggesting that microplicae could appear in the course of keratinization of epithelial cells to fasten neighbouring cells together and that these structures may disappear when the keratinization has increased beyond a certain degree.

In wild boar vallate papillae we have also observed some zones with a pitted appearance. This appearance had already been observed in keratinized epithelium of different buccal regions (Appleton and Heaney, 1977; Matravers et al., 1982; Kullaa-Mikkonen, 1987). Presence of some surface areas with microplicae and other areas with pitted appearance in the same papilla, that is to say non-keratinized epithelium and keratinized epithelium, has already been described by Kullaa-Mikkonen and Sorvari (1985) for human fungiform papillae. Microplicae, together with mucus, may protect the epithelium; either the microplicae hold mucus on the cell surface or reduce the surface area available for environmental contact.

When the mechanical stress due to contact of cell



Fig. 9. Pig filiform papillae. Simple papillae (small arrows) and compound papillae (large arrows) with several hairs can be seen. Scale bar= 100 μm.
Fig. 10. Conical papillae of pig. One papilla has two apexes (arrows). Scale bar= 1 mm.

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surface with food is great enough, the epithelium of upper surface of wild boar vallate papillae becomes keratinized in some areas, appearing pitted as a reaction to this environmental stress (Kullaa-Mikkonen and Sorvari, 1985). In pig vallate papillae the above mentioned environmental stress is lower than in wild boar because the food diet is compounded by prepared food whereas the latter is fed with wild food and thus the pig vallate papillae surface appears with microplicae.

Foliate papillae

Both wild boar and pig have two groups of foliate papillae with the same location and similar morphology as that described in other species (Svejda and Janota, 1974; Chibuzo, 1979; Liu and Lee, 1982; Chamorro et al., 1986; Chamorro et al., 1987; Kobayashi, 1992). The dimensions are also similar in both animals, except that the wild boar can have more papillary leaves than pig but each one being slightly narrower. Total dimensions are 4 to 7 mm in length and 2 to 5 mm in width in both animals. The number of papillary leaves, 4 to 6 for wild boar and 3 to 5 for pig, is similar to that described for rat (5-6), greater than in mouse (2-3) (Liu and Lee, 1982) and lower than foliate papillae of rabbit (15-19) (Liu and Lee, 1982; Chamorro et al., 1987; Kobayashi, 1992). Papillary furrows are not as deep and pronounced as in human foliate papillae (Svejda and Janota, 1974).

As for taste pores, they appear more frequently in the wall of the furrows in pig foliate papillae than in wild boar ones. Foliate papillae have never been associated with taste sensitivity except in cow (Chamorro et al., 1986) and cat (Boshell et al., 1982; Chamorro et al., 1987). Presence of taste pores in foliate papillae of wild boar and pig corroborate for these animals their gustatory significance. Nevertheless, this quantitative gustatory importance could be reduced bearing in mind the number of fungiform papillae and their taste pore endowment (see below and Chamorro et al., 1993).

At high magnification the surface of foliate papillae in both animals shows microplicae, that is to say nonkeratinized epithelium. Absence of keratinization has already been observed in the foliate papillae of man by Svejda and Janota (1974). Nevertheless, pseudopapillae of pig foliate papillae show a pitted surface. According to what has been discussed for vallate papillae, this fact could be due to a greater erosion by food since these pseudopapillae are more prominent on lingual surface than the remaining surface of the foliate papillae.

Fungiform papillae

A complete analysis of these papillae and their taste pores has been carried out by us (Chamorro et al., 1993) in the same animals. Fungiform papillae of pig and wild boar are morphologically similar. The mushroom appearance of these papillae is relatively alike to the one described by us for other species (horse: Chamorro et al., 1986; cat and rabbit: Chamorro et al., 1987) but fungiform papillae from other species have been described with spherical shapes (cow: Chamorro et al., 1986; human: Kullaa-Mikkonen and Sorvari, 1985). However, the lateral papillae of pig and wild boar are flattened in shape, whereas those papillae located on the rostral and medial lingual surface are higher.

Most of all the fungiform papillae in both animals are located in the rostral and lateral regions of the tongue. The caudal fungiform papillae represent only a small percentage and the medial papillae the rest. The tongue lateral area contains the largest papillae.

As for taste pores, their location near central papillary region was observed in both animals. This fact could be related to the genesis of taste buds and papillary development. Presence of grooves communicating several pores was seen in wild boar and pig but their origin and significance is unclear.

The lateral papillae of wild boar show the highest number of taste pores in all cases. Also, the highest taste pore number in the pig fungiform papillae are found in the lateral region (Chamorro et al., 1993). These data may be related to the fact that the lateral region also has the largest papillae. In this sense Davies et al. (1979) pointed out that the larger fungiform papillae of the bovine tongue contained more taste buds.

Both wild boar and pig fungiform papillae show numerous taste pores and for this reason these animals may be used in studies of taste buds of domestic and wild species.

In both animals, the epithelium of fungiform papillae was keratinized showing a pitted appearance at high magnification, which is similar to that described by Kullaa-Mikkonen and Sorvari (1985) for human fungiform papillae. According to these authors, because of the contact of the upper surface of fungiform papillae with food, the epithelium becomes keratinized as a reaction to the environmental stress.

Filiform papillae

The filiform mechanical papillae are distributed on the tongue dorsum in both animals being less numerous in the caudal third. The rudimentary *torus linguae* of the pig tongue show greater filiform papillae than the remaining tongue surface.

In mammals, there are marked variations in the structure of the dorsal surface of the tongue, especially in size and shape of the filiform papillae (Kullaa-Mikkonen et al., 1987). Apparently, the differences between the tongue surface of various mammals depend on dissimilarities in diet, feeding habits, mastication and handling of the food in the mouth. Mechanical stress might modify both the surface structure of the superficial cells (Kullaa-Mikkonen and Sorvari, 1985) and different parts of the oral mucosa (Kullaa-Mikkonen, 1986a).

Morphologically, the filiform papillae of both animals were very similar. In both animals two types of filiform papillae are seen: simple and compound, although in previous reports about pig tongue, simple filiform papillae are not mentioned (Kullaa-Mikkonen et al., 1987). Simple filiform papillae are similar to the ones described by us in horse (Paz et al., 1988).

Compound filiform papillae have body and hairs. These papillae have already been described by several authors in different species: man (Kullaa-Mikkonen and Sorvari, 1985; Kullaa-Mikkonen, 1986b); pig (Kullaa-Mikkonen et al., 1987); musk shrew (Iwasaki et al., 1987a); and squirrel monkey (Iwasaki et al., 1988). In dog (Sing et al., 1980) and guinea pig (Iwasaki and Miyata, 1985) a similar type of filiform papillae with ramifications have been described. Presence of simple and compound filiform papillae in the same tongue has also been shown in opposum by Krause and Cutts (1982). These authors pointed out that the function of this form of papilla is unknown. Nevertheless, other species do not show compound filiform papillae, only simple: horse and cow (Paz et al., 1986); rat (Iwasaki et al., 1987a); and rabbit (Chamorro et al., 1987). The reason why species like man, monkey, pig, wild boar, guinea pig, cat and musk shrew have compound filiform papillae whereas others like horse, cow, rabbit and rat do not show them is unclear. According to Kullaa-Mikkonen and Sorvari (1985) this fact must be related to diet, feeding, mastication and handling of the food in the mouth. Thus, the hairs form a mildly rough surface which enables careful mastication and handling of food before and during swallowing. On the other hand, it is possible that this fact could be related to the important role of these papillae in somatosensation that some investigations attribute to them (Sato et al., 1988).

At high magnification the wild boar filiform papillae appear smooth whereas those of the pig show micropits and microplicae with some frequency. These surface differences are probably related to the different diet and feeding habits in both animals in the same way that was discussed above for vallate papillae. Thus, the pig filiform papillae show microplicae, since they are exposed to a minor environmental stress due to the consumption of prepared food. The wild boar filiform papillae show a smooth surface due to major friction caused by consumption of wild food. These considerations are corroborated by the more frequent presence of microplicae in the bases of the pig filiform papillae, which are zones of the papillae subjected to a minor mechanical stress, than apex which shows a smooth surface.

Conical papillae

Different groups of lingual mechanical papillae can be considered. Filiform papillae are widely distributed in all species. Conical and lenticular papillae were traditionally described only in cow. The denomination of each type of papilla refers to its shape. For this reason we have named conical papillae those mechanical papillae located on the caudal portion of the wild boar and pig tongue. The conical papillae denomination has also been used by us for some mechanical papillae of rabbit and cat (Chamorro et al., 1987) besides the typical conical papillae of cow (Paz et al., 1988). With this denomination some expressions as conical-shaped filiform papillae or conical filiform papillae, frequently viewed in literature, are avoided. Furthermore, conical papillae is in accordance with the denomination *papillae conicae* seen in the *Nomina Anatomica Veterinaria* (1983).

These conical papillae are caudally directed in both animals. This orientation and their caudal location indicate their function in food swallowing (according to Iwasaki et al., 1987b). In this sense, we have observed that the conical papillae are higher in pig than in wild boar.

At high magnification microplicae are seen in both animals which are associated with non-keratinized cells. Since the bolus is already elaborated when it reaches this caudal region of the mouth the conical papillae undergo little friction and thus they show a non-keratinized epithelium.

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