

## MORPHOLOGICAL STUDY BY SCANNING ELECTRON MICROSCOPY OF THE LINGUAL PAPILLAE IN THE COMMON EUROPEAN BAT (*PIPISTRELLUS PIPISTRELLUS*)

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**Summary**—There are many accounts of the tongues of mammals observed with scanning electron microscopy (SEM), but apparently only one article about the tongue of the Chiroptera. In the present study the tongue surface (after removing extracellular material) of the European common bat (*Pipistrellus pipistrellus*) was examined. The tongue is covered with papillae and has an elevation between its medial and posterior half. There are three types of papillae: filiform, fungiform and circumvallate, and the filiform can be classified as strictly filiform, conical and crown-like. The shapes and disposition of these papillae are related to function, which is principally to retain captured food during flight. At higher magnification the surface of the filiform papillae has many pores and microridges, which may serve for the production and distribution of mucus over the papillary surface.

**Key words:** bat, tongue, papilla, scanning electron microscopy.

### INTRODUCTION

The structure of dorsal surface of the mammalian tongue is very variable, generally in relation to feeding habits, either because it is involved in catching food or because it promotes swallowing. The variable morphology is due to the type of papillae.

Tuckerman (1988), and later Sonntag (1920), produced a morphological classification of the papillae on mammalian tongues into four types: filiform, foliate, fungiform and circumvallate. The individual characteristics of each species lie in the number, distribution and modifications of these papillae.

The tongue surfaces of a number of different mammalian species have been studied by SEM (Iwasaki, Miyata and Kobayashi, 1987a; Iwasaki and Miyata, 1989; Qayyum, Fatani and Mohajir, 1988; Iwasaki, Miyata and Kobayashi, 1988; Krause and Cutts, 1982), but there are few observations relating to chiropters except for those of Kobayashi and Shimimura (1982), who studied with SEM and optical microscopy the dorsal surface of the Japanese long-fingered bat (*Miniopterus schreibersi fuliginosus*).

In insectivorous bats, the spatial distribution and perfect orientation of the papillae enable the tongue to retain captured insects in the mouth until they can be swallowed. We have now studied such papillae by SEM.

### MATERIALS AND METHODS

Four adult European common bats were killed under ether anaesthesia, the tongues removed and

immersed in Karnovsky fixative. The tongues were then washed with cacodylate buffer and postfixed in a solution of osmium tetroxide. The samples were hydrolysed in 8N hydrochloric acid at 60°C for 30 min to remove any extracellular mucus from the tongue surface. Finally, the specimens were processed routinely for scanning electron microscopy.

### RESULTS

The dorsal surface of the tongue was covered by papillae of different types, filiform and fungiform, each with some regional variations. In the posterior third there were only two circumvallate papillae, on either side of the midline.

At the junction of the posterior and medial thirds, there was a semicircular tuft of filiform papillae, with their branched tips oriented anteriorly in opposition to all the others (Fig. 1). This formation corresponds to the intermolar tubercle or eminence.

There were three types of filiform papillae: strictly filiform, conical and crown-shaped. The strictly filiform were in the anterior and middle thirds of the tongue; their tips all pointed towards the posterior part (Fig. 1).

The conical papillae were on the posterior third of the tongue, surrounding the circumvallate papillae. They had a round tip, and became longer and more posteriorly inclined towards the sides (Fig. 2).

The crown-shaped papillae were on the middle third of the tongue. Between the anterior and middle thirds there was a transitional area with papillary formations intermediate between the strictly filiform and the crown-shaped (Fig. 3).

At higher magnification, we could see the outline of the cellular surfaces in all types, demonstrating

*Abbreviation:* SEM, scanning electron microscopy.

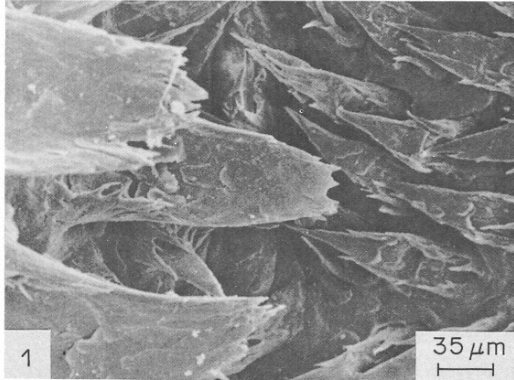


Fig. 1. Disposition of the filiform papillae in the intermolar eminence.  $\times 200$

different degrees of keratinization (Fig. 4). Although not very prominent, there were many microridges on the dorsal surface of the papillae, more distinct on the conical types, which also had micropores scattered all over.

The fungiform papillae had smooth surfaces and constituted slight protuberances among the filiform papillae all over the tongue (Fig. 5).

Between the two circumvallate papillae located on the caudal part of both sides of the midline and more posteriorly there was an area without papillae (Fig. 6).

#### DISCUSSION

In the few descriptions of the lingual structure of the Chiroptera there are many divisions of the papillary types, particularly of the filiform papillae, of which Park and Hall (1951) make seven groups and Kobayashi and Shimimura (1982) six. We have distinguished three types only, as we think that some of the types distinguished before could be considered as transitional forms.

The treatment of samples with hydrochloric acid has proved to be an efficient method for cleaning the lingual surface (Evan *et al.*, 1976), although it prevents observation of the presence and disposition

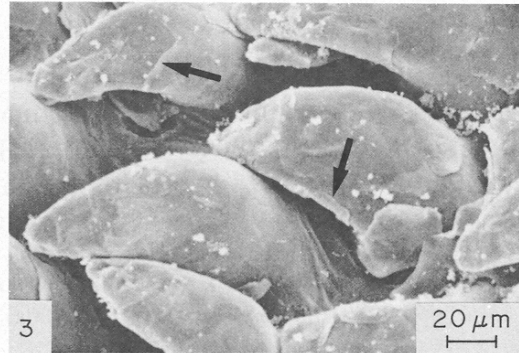


Fig. 3. Conical filiform papillae of the posterior region. Their length and inclination increase as they become more lateral. The arrow shows desquamated cells.  $\times 350$

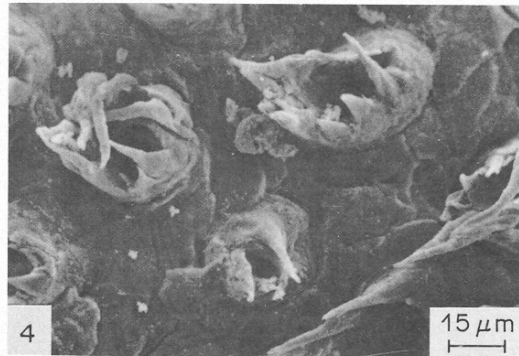


Fig. 4. Crown-shaped filiform papillae in the medial part of the tongue.  $\times 750$

of micro-organisms, as described by Kullaa-Mikkonen, Hynynen and Hyvonen (1987).

The prominence of the intermolar eminence demonstrates the mechanical importance of this papillary formation in the capture of insects while flying. Insects are stopped by this eminence, which developed in mammals that need to keep their food in the mouth before swallowing (Sonntag, 1920; Kobayashi and Shimura, 1982). The eminence is formed by a cluster of filiform papillae, giving a

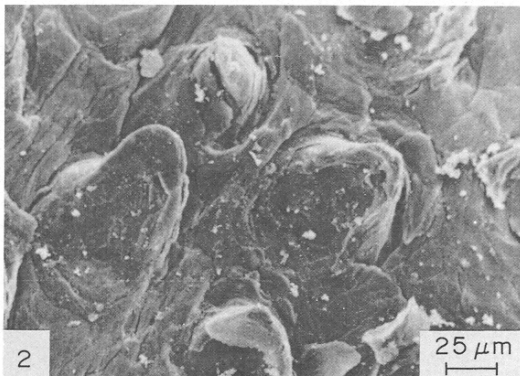


Fig. 2. Conical filiform papillae located in the lingual posterior region.  $\times 350$

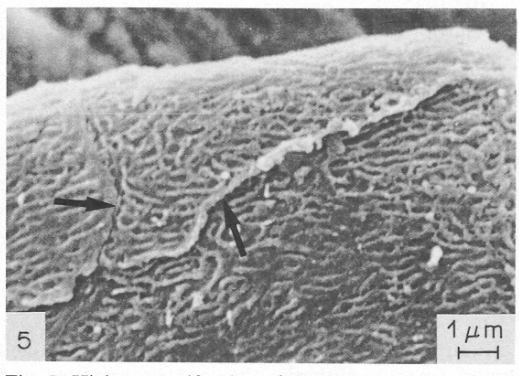


Fig. 5. Higher magnification of the conical papillae, which shows various pores and microridges over all the surface. The arrows show the zones of intercellular junctions.  $\times 3500$

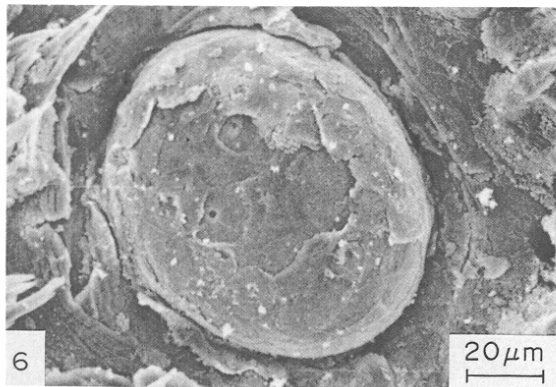


Fig. 6. Fungiform papillae localized in the lingual posterior zone.  $\times 200$

terminal serrated edge. In contrast, that in other mammals is formed of conical papillae with a more rounded surface, and more particularly promotes suction.

The distribution of the three types of filiform papillae is well differentiated, such that the strictly filiform appear on the anterior third of the tongue and change gradually into crown-shaped papillae in the middle third. The conical papillae could be seen only in the posterior third, and became more dense and more inclined as they approached the sides of the tongue. This differs from what was observed in the opossum by Krause and Cutts (1982) and in the rat and mouse by Iwasaki *et al.* (1987a, b), where conical papillae were also found in other areas.

The papillae are all smaller than those of bats with liquid feeding habits (nectar drinkers), in which large filiform papillae project backwards. In insectivorous bats, the orientation and distribution of the papillae is probably more important than the size, as their food is exclusively solid.

Cleaton-Jones and Fleisch (1973) related the microridges to the keratinization of the oral mucosa epithelium. Microridges were observed clearly by a papillary level by Iwasaki and Sakata (1985), Iwasaki and Miyata (1989), Iwasaki *et al.* (1987a, b, 1988), when they introduced the treatment of tongues with hydrochloric acid into processing for SEM. Several functions have been attributed to these microridges: Fahrenbach and Knutson (1985) suggested that they were an adaptation to specific function, while Sperry and Wassesug (1976) suggested that they might act in the distribution of mucus over the tongue surface. Although their function is not absolutely clear, we cannot rule out the possibility that they might act as a support for mucopolysaccharides. It is also possible

that they provide sites for bacterial colonization of the tongue surface. However, we have no direct evidence on either possibility because treatment with hydrochloric acid causes the disappearance of all the micro-organisms together with the mucus.

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