Morphology of the lingual papillae in the fishing cat

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Summary: We examined the dorsal lingual surface of an adult fishing cat (*Prionailurus viverrinus*) by scanning electron microscopy. The filiform papillae on the lingual apex had several pointed processes. The connective tissue core of the filiform papillae resembled a well in shape. The filiform papillae on the anterior part of the lingual body were large and cylindrical in shape. The connective tissue core of the filiform papillae consisted of a large conical papilla. The filiform papillae on the central part of the lingual body were large and conical. The connective tissue core of the filiform papillae consisted of a large main process and some secondary processes. The connective tissue core of the fungiform papillae did not have processes. The vallate papillae were surrounded by a groove and a pad. The top of the connective tissue core of the vallate papillae had a rough surface with no spines.

Introduction

Many studies have reported on the structures of the lingual surfaces in various animals. In the order Carnivora, there have been some scanning electron microscopy (SEM) studies on the tongues of the cat (Boshell *et al.*, 1982), dog (Iwasaki and Sakata, 1985), mongoose (Iwasaki *et al.*, 1987), Japanese weasel (Furubayashi *et al.*, 1989), sea otter (Shimoda *et al.*, 1996), bush dog (Emura *et al.*, 2000), panther and Asian black bear (Emura *et al.*, 2001), lion (Emura *et al.*, 2003), tiger (Emura *et al.*, 2004) and jaguar (Emura *et al.*, 2013). Such studies have revealed variations in the morphology and distribution of papillae on the dorsal lingual surface among animal species.

However, no SEM study of the tongue of the fishing cat has been carried out. The purpose of this study is thus to examine three-dimensionally the dorsal lingual surface of the jaguar, in order to compare the results with those of previous reports on other mammals.

Materials and Methods

The tongue of one adult fishing cat (*Prionailurus viverrinus*) of the family Felidae was used in this study. The

tongue was fixed in 10% formalin. Small blocks containing papillae were cut with a razor blade and post-fixed with 1% osmium tetroxide for 1 h. Thereafter, the specimens were dehydrated through a graded series of acetone and critical-point-dried. To show the three-dimensional connective tissue structure of the lamina propria of the mucosa, some of the samples were washed in distilled water after fixation and macerated in 3.5N HCl at 35 °C for three days. After maceration, the tissues were washed in distilled water, post-fixed in 1% osmium tetroxide for 1 h, and dehydrated in a series of acetone and critical-point-dried. All specimens were sputtered with Pt-Pd before being examined by SEM (Hitachi S-3500N, Tokyo, Japan) at an accelerating voltage of 10 kV.

Results

Macroscopically, the tongue of the fishing cat was about 12 cm long. Filiform papillae were distributed over the entire dorsal surface of the lingual body (Fig. 1). Fungiform papillae were round in shape and more densely distributed on the tip of the lingual apex. There were no foliate papillae. Vallate papillae were located on both sides of the posterior end of the lingual body, and there were

Fig. 1. Macrograph of a fishing cat tongue. ①, ②, ③ and ④ show the parts prepared for SEM.

four vallate papillae in total.

By SEM, the filiform papillae on the lingual apex had several pointed processes (Fig. 2a). The connective tissue core of the filiform papillae resembled a well in shape (Fig. 2b). The filiform papillae on the anterior part of the lingual body were large and cylindrical in shape (Fig. 2c). The connective tissue core of the filiform papillae consisted of a large conical papilla (Fig. 2d). The filiform papillae on the central part of the lingual body were large and conical (Fig. 3a). The connective tissue core of the filiform papillae consisted of a large main process and some secondary processes (Fig. 3b). The connective tissue core

of the fungiform papillae did not have processes (Fig. 3b). The vallate papillae were surrounded by a groove and a pad (Fig. 3c). The top of the connective tissue core of the vallate papillae had a rough surface with no spines (Fig. 3d).

Discussion

Shimoda *et al.* (1996) reported that the filiform papillae on the margin of the tongue of a newborn sea otter were divided into two shapes: horned and club-shaped, while the fungiform papillae were also divided into two shapes: hemispherical and club-shaped. Emura *et al.* (2001, 2003) reported that large papillae were observed on the margins of the lingual apices of a newborn panther, newborn Asian black bear and lion. In the cat (Boshell *et al.*, 1982), newborn panther (Emura *et al.*, 2001), lion (Emura *et al.*, 2003), tiger (Emura *et al.*, 2004) and jaguar (Emura *et al.*, 2013), a marked transition occurred between the tip and midportion of the dorsum of the tongue. This transition was characterized by an increase in size of the projections of the filiform papillae. In the midportion of the tongue, these projections were very prominent. This finding is fairly consistent with the observations of the tongue of the fishing cat. Furthermore, the marked regional variation in size and morphology of the filiform papillae in the fishing cat tongue contrasts with the descriptions in plant-eating animals. The filiform papilla on the lingual apex consisted of a large main papilla and some secondary papillae in the jaguar (Emura *et al.*, 2013). The connective tissue core of the filiform papilla was mountain-like in shape (Emura *et al.*, 2013). However, the filiform papilla on the lingual apex had several pointed processes in the fishing cat. The connective tissue core of the filiform papilla resembled a well in shape.

Many studies have reported on the three-dimensional structure of the vallate papillae in the mammalian tongue. Several studies have indicated that the vallate papillae were flattened and oval in shape and were surrounded by a groove and a pad (Krause and Cutts, 1982; Chamorro *et al.*, 1986; Qayyum *et al.*, 1988; Chunhabundit *et al.*, 1992; Agungpriyono *et al.*, 1995; Atoji *et al.*, 1998; Emura *et al.*, 2013). The vallate papillae of the cat, dog and flying squirrel were found to be encircled by the filiform papillae in the posterior body (Boshell *et al.*, 1982; Iwasaki and Sakata, 1985; Emura *et al.*, 1999). Equine vallate papillae were composed of a primary papilla that was divided into several secondary papillae by intermediate grooves (Chamorro *et al.*, 1986). Occasionally, in bovine vallate papillae, twin papillae were surrounded only by a primary papillary groove (Chamorro *et al.*, 1986). The vallate papillae of the bush dog were surrounded by a groove and a crescent pad, and on the dorsal surfaces of the papillae, small conical papillae were observed. In addition, some vallate papillae of the Asian black bear were shown to

Fig. 2. (a, b) SEM micrographs of ① in Fig. 1. The filiform papillae on the lingual apex have several pointed processes. The connective tissue core of the filiform papillae are resembled a well in shape. (c, d) SEM micrographs of ② in Fig. 1. The filiform papilla on the anterior part of the lingual body is large and cylindrical in shape. The connective tissue core of the filiform papilla consists of a large conical papilla. Fu = fungi-form papilla.

be composed of primary papillae that were divided into several secondary papillae by intermediate grooves (Emura *et al.*, 2001). The structure of the vallate papillae in the fishing cat was similar to that of the jaguar reported by Emura *et al.* (2013).

The number of vallate papillae has been reported in many vertebrates. On the tongue of the tiger, Emura *et al.* (2004) observed four vallate papillae. In contrast, five vallate papillae were observed in the bush dog (Emura *et al.*, 2000). There were ten in the panther and seven or

Fig. 3. (a, b) SEM micrographs of ③ in Fig. 1. The filiform papilla on the central part of the lingual body is large and conical. The connective tissue core of the filiform papilla consists of a large main process and some secondary processes. The connective tissue core of the fungiform papilla (Fu) does not have processes. (c, d) SEM micrographs of ④ in Fig. 1. The vallate papillae (V) are surrounded by a groove and a pad. The top of the connective tissue core of the vallate papillae (V) has a rough surface with no spines.

eight in the Asian black bear (Emura *et al.*, 2001). Five to nine vallate papillae were observed in the lion (Emura *et al.*, 2003). Seven vallate papillae were observed in the jaguar (Emura *et al.*, 2013). In this study, four vallate papillae were observed in the fishing cat. Further studies are required to clarify the relationship between the species

and the number of vallate papillae.

In conclusion, the morphological characteristics of the tongue in the fishing cat, for which the staple food is fish, were shown to be similar to those of animals in other members of the Felidae.

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