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Summary: The superficial structure of the tongue for the Mongolian gerbil, *Meriones unguiculatus*, were observed by scanning electron microscope. The external characters of tongue and the types of papillae (the filiform, fungiform, vallate and foliate papillae) were fundamentally much the same to other Muridae and Cricetidae. In this animal, the small filiform and the fungiform papillae were observed not only on the dorsal surface of the palatal part, but also on the under surface of the anterior free part where there is no papilla in other rodents. The foliate papillae, furthermore, had well-developed von Ebner glands which opened into the bottom of the furrows. It is considered that these characters point to the adaptation to live in sandy deserts.

The Mongolian gerbil, *Meriones unguiculatus* (Rodentia, Cricetidae, Gerbillinae), lives in sandy deserts of northern China, Mongolia and adjacent parts of the U.S.S.R (Corbet, 1978). This species has a high capacity for temperature regulation and for water requirement, in comparison with many desert rodents. Their diet consists of seeds, leaves, bulbs, stems and roots (Walker, 1975).

The morphology of mammalian tongues vary according to species. Food habits and strains are considered to be the reasons. General descriptions of the mammalian tongues have been reviewed by Münch (1896), Sonntag (1920, 1925), Stadtmüller (1938), Keaster (1940) and Bradley (1971). In particular, Sonntag (1920) reported on the morphology of lingual papillae, that is the filiform, fungiform, vallate and foliate ones, and on these variations and the differences of the number of vallate papillae by species. Despite the numerous reports which were made on the tongues of Cricetidae (Tuckermann, 1890; Sonntag, 1924; Ozeki et al., 1981; Fujita et al., 1982), there is as yet only one report about the microridge of the filiform and fungiform papillae concerning the scanning electron microscopic study on the tongue of the Mongolian gerbils (Iwasaki et al., 1984).

In this paper, the morphological characters of the lingual papillae in the Mongolian gerbils are described in detail and compared with other rodents.
Materials and Methods

Tongues from 10 male Mongolian gerbils, weighing from 60g to 80g, were used for the observations in this study. Some of the tongues were fixed in neutral formalin, and dehydrated by a series of alcohol solutions. Afterwards this solution was replaced with isoamylacetate and dried at critical point with liquid CO₂. They were then coated with gold palladium, and examined by JEOL JSM-25 scanning electron microscope at 20 KV of accelerating voltage.

Several other specimens were embedded in paraffin after Bouin fixative according to the routine methods and sectioned frontally or sagitally. These sections were stained by haematoxyline-eosin and observed under a light microscope.

Observations

The tongue of the Mongolian gerbil

![Diagram of tongue regions](image)

Fig. 1. Schematic diagram of the main regions on the dorsal (upper) and lateral (under) view of the tongue. Afp: Anterior free part, Ipp: Intermolar prominence part, Lp: Lingual prominence, Pap: Palatal part, Php: Pharyngual part, Tb: Tongue base.
tapered down, being about 19.9 mm in length (approximately 15.5 mm in the palatal part, 4 mm in the pharyngeal part) and about 6.5 mm in maximum width. The palatal part was divided two well-marked divisions, i.e. the elongated anterior division and the elevated posterior division (intermolar prominence part). The anterior division was about 7 mm in length, and was free from the oral floor for about 6.5 mm distant from the tip (anterior free part). The lingual apex was thick, rounded, and notched (Fig. 1). The median sulcus that was one well-defined median groove with about 4 mm in length, passed through the tip of the organ, and continued for a short distance on the under surface of the tongue (Fig. 2).

The sulcus terminals and foramen cecum linguae were absent.

The various lingual papillae were present from the dorsal of the tongue to the under surface of the anterior free part (Fig. 2). These papillae were classified in four types by the characters, i.e. the filiform, fungiform, vallate and foliate ones.

The filiform papillae covered the palatal part of the dorsal surface and the anterior part on the under surface of the tongue. These papillae were divided into three shapes of which were small filiform, large filiform and conical papillae. The anterior dorsal and under surface of the tongue was covered with a number of small filiform papillae (Figs. 3, 4 and 5). The large filiform papillae

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Fig. 2. Dorsal (upper) and ventral (under) view of the tongue in the Mongolian gerbil. Ep: Epiglottis, La: Lingual apex, Ms: Median sulcus, Pc: Conical papilla, Pfs: Small filiform papilla, Pfl: Large filiform papilla, Pfo: Foliate papilla, Pfu: Fungiform papilla, Pv: Vallate papilla.
branched were present on the intermolar prominence part and the papillae arranged in a rosette-like shape on the lingual prominence were larger than those on the other regions (Fig. 6). The posterior palatal part of the tongue was covered with conical papillae. The fungiform papillae were scattered among the small filiform papillae in the dorsal surface except for the intermolar prominence part, pharyngual part, and in the anterior part of the under surface (Figs. 3, 4 and 5). This papillae was hemispherical with smooth surface (Fig. 7). Each of the fungiform papilla had a single taste bud at the upper part (Fig. 8).

A singular vallate papilla was located on the median and border line between the palatal and pharyngual part (Figs. 1 and 2). This papillae was adjacent to the conical papillae in the anterior half and generally resembled a spindle-like shape, composed of a middle (large spindle-shape) papilla surrounded by trenches, and two lateral (small spindle-shape) vallums parallel to the middle papilla (Fig. 9). There were poorly developed von Ebner glands which opened to the bottom of the furrows (Fig. 10).

The foliate papillae, which have 10 to 11 short grooves, located symmetrically about the lingual apex and margin (Fig. 11). There were well-developed von Ebner glands which opened into the bottom of the furrows (Fig. 12).

Discussion

Scanning electron microscopical studies of the lingual papillae in rodents have been performed on the rats (Yoshioka et al., 1976), mouse (Yoshioka et al., 1975), golden hamster (Fujita et al., 1982), Chinese hamster (Kobayashi et al., 1983b), old world harvest mouse (Kobayashi et al., 1983a) and guinea pig (Ooishi et al., 1977; Iwasaki and Miyata, 1985) etc. In these species, four types of the papillae were distributed in a definite area on the dorsal and lateral surface of the tongue. Sonntag (1924) got into connected previously several characters the tongue of the Muridae and Cricetidae including gerbils. He did not mentioned whether the papillae are present or not also on the under surface of the tongue in the Mongolian gerbil.

In this study, the fundamental morphology and structure of the tongue and the papillae are much the same to other rodents as mentioned above. The small filiform papillae, however, were observed not only on the dorsal surface of the tongue, but also on the under surface where there is no filiform papilla in other rodents. In the same way, the fungiform papillae in this animal were scattered also on the under surface of the anterior free part. These are clear differences between the Mongolian gerbil and the other Muridae and Cricetidae. On the other hand, the foliate papillae had more well-developed von Ebner glands in the grooves (Fig. 12) than those in other rodents (Kobayashi, unpublished). Robinson (1959) studied the metabolism of this species, but nothing is known of its water balance. Therefore, he suggested that the Mongolian gerbil may be not a true desert rodent. Winkelmann and Getz (1962) and Harriman (1969a, b), however, described that the intake of water in the gerbils was a small amount in comparison with other rodents. This tendency was more conspicuous in the experiment of Winkelmann and Getz (1962). Kubota (1965a, b) also indicated as the result of observations for the tongue in various mammals that the nearer the habitat is to a watering place, the less necessary the papillae (in particular von Ebner glands) become. It is, accordingly, considered that the presence of the small filiform and fungiform papillae on the under surface of the anterior free part and of the foliate papillae with well-developed von
Ebner glands are a function of water regulation. This adaptation may be needed to live in sandy deserts.

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References

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PLATES
Plate I

Fig. 3. Median sulcus on the dorsal surface of tongue. Fungiform papilla (arrows) scattered among the filiform papillae.

Fig. 4. Ventral view of the lingual apex. The filiform papillae bend towards the tip or dorsal of tongue, and the fungiform papillae (arrow) are scattered among the filiform papillae.

Fig. 5. Lateral view of the lingual apex. The filiform and fungiform papillae (arrow) are present also on the under surface of the anterior free part.

Fig. 6. Larger filiform papillae arranged in a rosette-like shape on the intermolar prominence part. Fungiform papilla is absent on this area.
Plate II

Fig. 7. Fungiform papilla on the palatal part.

Fig. 8. Single taste bud (arrow) in the frontal section of the fungiform papilla.

Fig. 9. Only one vallate papilla with a spindle-like shape on the median line of the dorsal surface in the tongue. Pv: Vallate papilla.

Fig. 10. Von Ebner glands poorly developed in the frontal section of the vallate papilla. The mucous glands open onto the surface of the tongue and form a crescent on the base of the tongue. Sg: Serous gland, Mg: Mucous gland.

Fig. 11. Foliate papillae indicated the appearance of 10-11 short grooves and flat laminae (arrows)

Fig. 12. Frontal section of the foliate papilla. They have large serous gland and numerous taste buds.