

Morphology of the lingual papillae of the bharal (*Pseudois nayaur*)

By

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Summary: We examined the dorsal lingual surfaces of an adult bharal (*Pseudois nayaur*) by scanning electron microscopy. The filiform papillae of the lingual apex and body consisted of a main papilla and smaller secondary papillae. The filiform papilla of the lingual body was big as compared to that of the lingual apex. The connective tissue cores of the filiform papillae consisted of several processes. The fungiform papilla was round in shape. The connective tissue cores of the fungiform papillae were flower-bud shaped. The lenticular papillae of large size were limited on the lingual prominence. The connective tissue cores of the lenticular papillae were hair-like in shape. The vallate papillae were located on both sides of the posterolateral aspects. The vallate papillae were flattened-oval shaped and the papillae were surrounded by an oval-shaped trench. The connective tissue cores of the vallate papillae were covered with numerous small spines. The lingual surface of the bharal closely resembled that of the family Bovidae.

Many studies have been published on the structures of the lingual surfaces in various animals. In the order Artiodactyla, there have been many scanning electron microscopic (SEM) studies of the tongues of cows (Steflik et al., 1983; Chamorro, 1986), serows (Funato et al., 1985; Atoji et al., 1998), one humped camels (Qayyum et al., 1988), buffalos (Scala et al., 1993), lesser mouse deer (Agungpriyono et al., 1995), blackbuck (Emura et al., 1999), Barbary sheep (Emura et al., 2000a), Bactrian camels (Eerdunchaolu et al., 2001), hippopotamuses (Yoshimura et al., 2009), sitatunga and roan antelope (Emura et al., 2011a, b), Egyptian buffalo (Emura and El-Bakary, 2014), eland (Emura, 2016). Such studies reveal variations in morphology and distribution of papillae on the dorsal lingual surface among animal species.

However, no SEM study on the tongue of the bharal has been carried out. This study three-dimensionally examined the dorsal lingual surface of the bharal, in order to compare results with those from previous reports on other mammals.

Materials and Methods

The tongue of an adult bharal (*Pseudois nayaur*) of the family Bovidae was used in this study. The tongue

was fixed in 10% formalin. Small blocks containing papillae were cut with a razor blade, 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 2 days. After maceration, tissues were washed in the distilled water and 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 under SEM (Hitachi S-3500N, Tokyo, Japan) at an accelerating voltage of 10 kV.

Results

Macroscopically, the tongue of the bharal was about 17 cm long and the lingual body had lingual prominence on the posterior third (Fig. 1). There was no foliate papilla.

The filiform papillae of the lingual apex and body consisted of a main papilla and smaller secondary papillae (Fig. 2a, 3a). The filiform papilla of the lingual body was big as compared to that of the lingual apex (Fig. 2a, 3a). The connective tissue cores of the filiform papillae



Fig. 1. Macrograph of the bharal tongue. A = lingual apex. B = lingual body. P = lingual prominence.

consisted of several processes (Fig. 2b, 3b). The fungiform papilla was round in shape (Fig. 2a). The connective tissue cores of the fungiform papillae were flower-bud shaped (Fig. 2b, 3b). The lenticular papillae of large size were limited on the lingual prominence (Fig. 4a). The connective tissue cores of the lenticular papilla were hair-like in shape (Fig. 4b). The vallate papillae were located on both sides of the posterolateral aspects. The vallate papillae were flattened-oval shaped and the papillae were surrounded by an oval-shaped trench (Fig. 5a). The connective tissue cores of the vallate papillae were covered with numerous small spines (Fig. 5b).

Discussion

Agungpriyono *et al.* (1995) reported that filiform papillae consist of a larger main papilla and smaller secondary papillae, and in the filiform papillae that the distribution of the secondary papillae in the lesser mouse deer, being present from the anterior part of the tongue to the end of the middle third and rare or absent in the posterior part, is relatively restricted. Atoji *et al.* (1998) observed filiform papillae and conical papillae, and reported that the filiform papillae have secondary papillae in the Formosan serow. Emura *et al.* (1999, 2000a, 2011a,

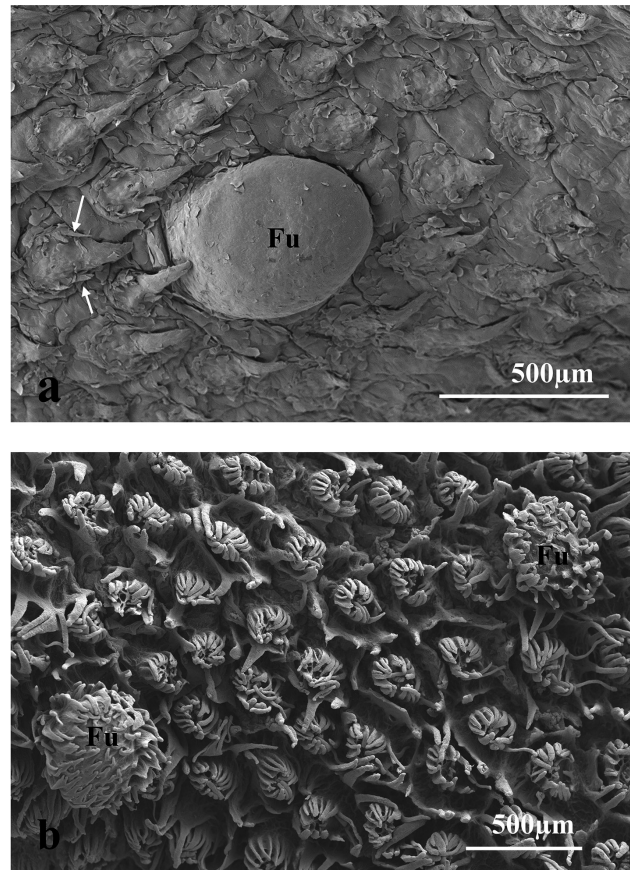


Fig. 2. Scanning electron micrographs of A in Fig. 1. (a) The filiform papilla on the apical surface consists of a main papilla and secondary papillae (arrows). The fungiform papillae (Fu) are round in shape. (b) The connective tissue core of the filiform papilla consists of several processes. The connective tissue core of the fungiform papilla is flower-bud shaped.

b) and Emura (2016) also observed similar filiform papillae in the blackbuck, Barbary sheep, sitatunga, roan antelope and eland. The filiform papillae of the bharal in this study were morphologically similar to those of the blackbuck, Barbary sheep, sitatunga, roan antelope and eland (Emura *et al.*, 1999, 2000a, 2011a, b) and Emura (2016). A top of the connective tissue cores of the filiform papillae distributed in the roan antelope's tongue showed several depressions (Emura *et al.*, 2011b). However, the connective tissue core of the filiform papilla of the bharal was similar to those of the sitatunga and eland and did not show those depressions.

The fungiform papillae were more densely distributed on the tip and ventral surface of the lingual apex in Japanese serow, Formosan serow, blackbuck, Barbary sheep, sitatunga, roan antelope and eland (Funato *et al.*, 1985; Atoji *et al.*, 1998; Emura *et al.*, 1999, 2000a, 2011a, b) and Emura (2016). These reports coincide with the findings on the bharal. The connective tissue core of the

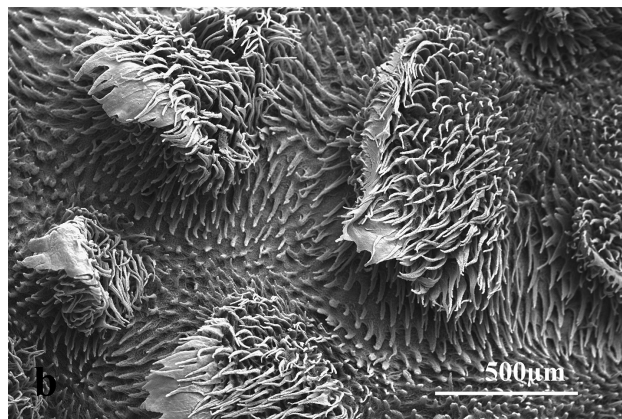
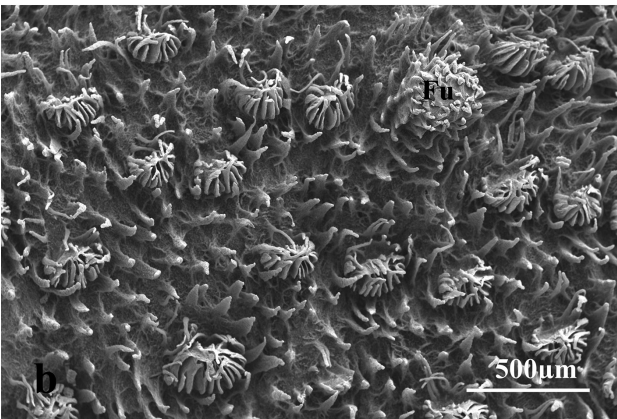
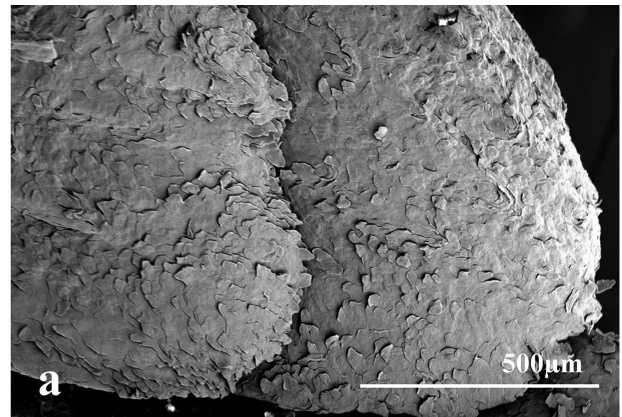
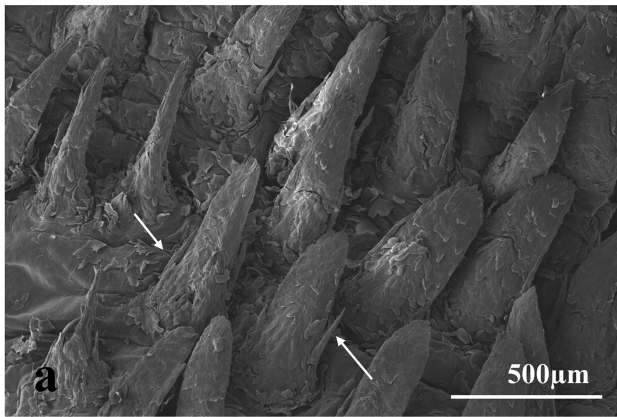


Fig. 3. Scanning electron micrographs of B in Fig. 1. (a) The filiform papilla on the apical surface consists of a main papilla and secondary papillae (arrows). The filiform papilla of the lingual body is big as compared to that of the lingual apex. (b) The connective tissue cores of the filiform and fungiform papillae resemble those of the lingual apex. Fu = fungiform papilla.

Fig. 4. Scanning electron micrographs of P in Fig. 1. (a) Note the lenticular papillae of large size. (b) The connective tissue core of the lenticular papilla is hair-like in shape.

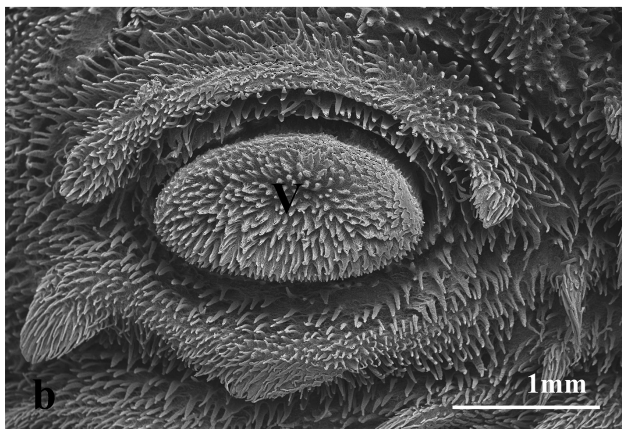
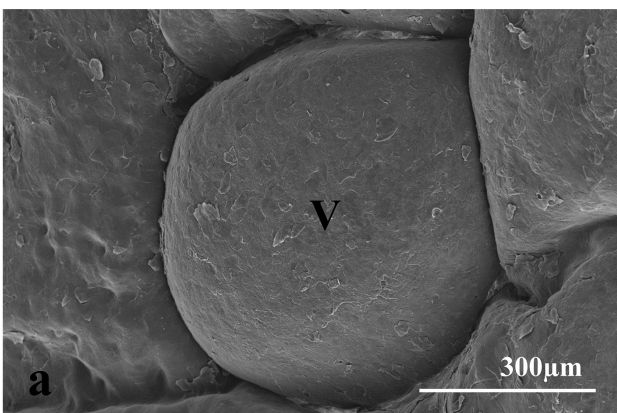


Fig. 5. Scanning electron micrographs of the vallate papillae. (a) The vallate papilla (V) is flattened-oval shaped and the papillae is surrounded by an oval-shaped trench. (b) The connective tissue core of the vallate papilla (V) is covered with numerous small spines.

fungiform papilla on the bharal's tongue was flower-bud shaped.

The lenticular papillae of the various sizes were limited on the lingual prominence of the sitatunga (Emura *et al.*, 2011a). The connective tissue core of the lenticular papilla consisted of numerous small spines, or these spines and rod-shaped processes (Emura *et al.*, 2011a). The lenticular papillae of the bharal were hair-like in shape.

The vallate papillae surrounded by a groove was round or oval in shape (Funato *et al.*, 1985; Atoji *et al.*, 1998). It was reported that a pair of long-flat vallate papillae were observed in the lesser mouse deer tongue (Agungpriyono *et al.*, 1995). Equine vallate papillae were composed of a primary papilla which was divided into several secondary papillae by intermediate grooves (Chamorro *et al.*, 1986). In this study, the vallate papillae were flattened-oval shaped. The connective tissue core of the round central papilla in the Japanese serow was covered with numerous small spines and numerous slender processes delivered from the lateral surface of the surrounding wall (Yamaguchi *et al.*, 2002). In this study, the connective tissue core of the vallate papilla was covered with numerous small spines.

In the order Perissodactyla, the filiform papillae on the lateral sides of the lingual apex and body of the black rhinoceros had a hair-like shape, and consisted of main papillae and some smaller secondary papillae (Emura *et al.*, 2000b). The fungiform papillae were scattered among the hair-like papillae (Emura *et al.*, 2000b). On the lingual apex of the donkey, the filiform papillae were abundant with more or less slim cylindrical form with pointed endings (Abd-Elnaeim *et al.*, 2002). On the caudal part of the body, the filiform papillae were thinner than those on the apex, very long, cylindrical and abundant (Abd-Elnaeim *et al.*, 2002). Their filiform papillae were not showed in the lingual surface of the bharal.

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