Int. J. of Life Sciences, 2013 Vol.1 (1): 37-41 **ISSN: 2320-7817**

Morphological Studies on the Lingual papillae with special reference to Circumvallate papillae of Insectivorous Bat *Taphozous longimanus* (Dobson) Emballonuridae Chiroptera.

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ABSTRACT

Investigations were carried out on the morphology, structural arrangement, location and the numbers of the lingual papillae in Emballinurid microchiropteran bat, Taphozous longimanus with special reference to gustatory circumvallate papillae, using light microscope. The anterior tip of tongue was pointed and three types of lingual papillae covered the dorsal surface of tongue i.e. tricuspid filiform papillae on the anterior region, gustatory fungiform and two circumvallate papillae are arranged on the smooth root of the tongue (posterior side). The the number of the circumvallate papillae are strongly adapted to feeding behavior i.e. insectivorous feeding habits.

KEYWORDS

Bat, Papillae, Insectivorous, Taste bud, Tongue.

INTRODUCTION

Tongue is a highly specialized organ for taste sensor located in oral cavity that plays an important role in feeding as well as for taste i.e. sensory secretor function among in many vertebrates. The surface epithelium of the tongue is raised in a series of elevations called papillae. Three kinds of lingual papillae were observed: filiform, fungiform and circumvallate papillae and each papilla had a different morphological structure, shape and function. The function of filiform papillae is touch and attachment of food until it is swallowed. An important feature of the mammalian tongue is taste bud specially present in circumvallate papillae and rarely in fungiform papillae and their function are taste reception. Distribution of lingual papilla in vertebrates was specific according to their specific types of species (Toprak, 2006; Iwasaki, 2002; Jackowiak et al., 2004 and Pawan Kumar and Timoney, 2006). The morphological and anatomical adaptations of tongue according to their different feeding habits had already been described for a series of mammalian orders (Iwasaki, 2002) including few species of bats (Uieda, 1986 and Kulzer, 1982).

Taphozous longimanus bats belongs the order of chiroptera and our studies dealing with lingual papillae of tongue and specially focused on the circumvallate papillae. *Taphozous longimanus* belongs to Family Emballonuridae of Suborder Microchiroptera. *Taphozous longimanus* is commonly called as Indian Sheath Tailed Bat and are roosting in diverse habitat viz. large dense trees, caves, tunnels, hollows in walls of wells, old dilapidated houses and mines, under tiles of roof of houses, under bridges, hollows of coconut tree trunks, cleft and crevices of mountains and walls of old temples and animal shades etc. (Madhavan, 2000; Patil, 2006). *Taphozous longimanus* shows the insectivorous feeding habits. The morphological and histological structure of tongue of two species of insectivorous bats i.e. *Rhinopoma kinneari* (Fam-

International Journal of Life Sciences
www.ijlsci.in
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Rhinopomatidae) and *Scotophilus heathi* (Vespertilioidae) (Agarwal and Gupta, 1982) and the lingual papillae in Korean long fingered bat (*Miniopterus schreibersi fuliginosus* and *Pipistrellus savii*) (Park and Lee, 2009) were examined.

The lingual organ of the Emballonurid bat *Taphozous longimanus* were adapted for insectivorous feeding habits, helpful in insect- pest suppression and gives ecological and economical benefits to the environment (Ramteke et al., 2012a). Numerous large sized, round shaped fungiform papillae were noticed all over the tongue in megachiropteran bat *Cynopterus sphinx*. The tongue and papillae in this megachiropteran bats supports the role of pollination as well as seed dispersal (Ramteke et al., 2012b). In present study describe the morphology of the tongue in the insectivorous bat; *Taphozous longimanus* and specially examined the distribution, microstructure and the number of circumvallate papillae on the posterio-dorsal surface of the tongue in view of the adaptation of its diet.

Taphozous longimanus shows the insectivorous feeding habits. Agarwal and Gupta (1982) studied the morphological and histological structure of tongue of two species of insectivorous bats i.e. *Rhinopoma kinneari* (Fam- Rhinopomatidae) and *Scotophilus heathi* (Vespertilioidae) and Park and Lee (2009) studied the lingual papillae in Korean long fingered bat (*Miniopterus schreibersi fuliginosus* and *Pipistrellus savii*).

MATERIAL AND METHODS

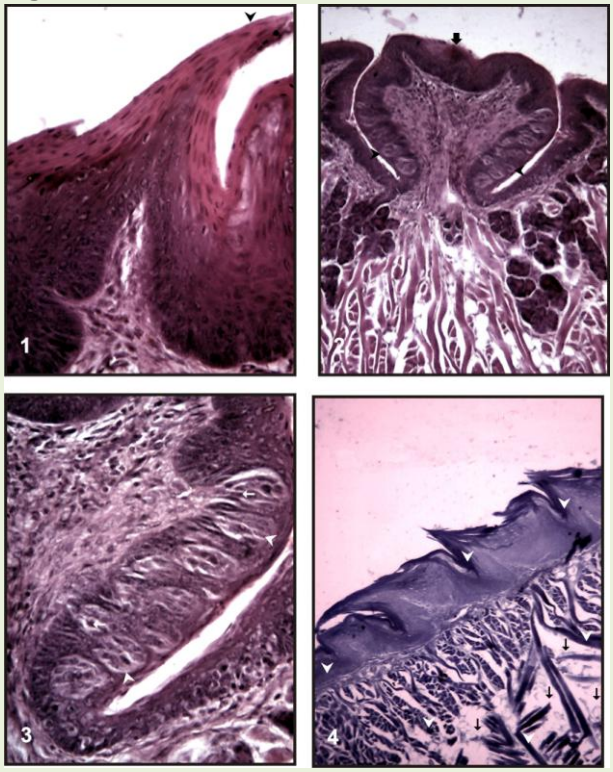
The specimens of *Taphozous longimanus* were captured from shades, under roof, crevices of walls of old building in and around Nagpur city. The bats were collected with the help of a butterfly net and then clinically anaesthetized. The body weight were recorded, the tongue was dissected out, measured and observed under light microscope as well as photographed for anatomical study. The parts of tongue were fixed in different fixatives: Alcoholic Bouin's, Aqueous Bouin's and 10% Formalin for 24 hours for morphological and histological study. The fixed tongues were washed overnight in running water and dehydrated by passing through different grades of ethyl alcohol, cleared in xylene and mounted in paraffin (58-60C). The sections were cut at 5-7µm with the help of rotary microtome. For routine histological observations the sections were stained with Haematoxylin-Eosin method.

RESULTS

Anatomically the tongue of *T. longimanus* was pointed at the anterior tip, the dorsal surface of the tongue covered with different types of papillae i.e. filiform, fungiform and circumvallate papilla. A cluster of (15-18) large tricuspid filiform papillae were observed near the anterior tip covered by median sized posteriorly directed scale-like filiform papillae. Large number of small sized conical filiform papillae was observed on the anterior half of the tongue. Two large circumvallate papillae were present laterally to central groove near the posterior end. Numerous large sized filiform papillae were observed on the posterior half of the tongue, which were directed towards posterior and central directions. Few fungiform papillae were observed embedded in the filiform papillae towards posterior half of the tongue. The central groove was poorly developed near the posterior end. The ventral surface of the tongue shows one third part of the anterior free tongue and a prominent central ridge. A sharp lateral border was provided with a border of posteriorly directed filiform papillae.

Histologically, the adult tongue show the anterior tip covered by a small cluster of tricuspid papillae. The height and breadth of the tricuspid filiform papillae are 11.2 µm and 16.6 µm. Tricuspid papillae at the anterior tip encircled with scaly papillae which giving a rough appearance to the tongue. The scale like filiform papillae are present throughout the dorsal surface of tongue, directed towards the posterior region and their height and breadth are 24.0 µm and 20.8 µm. At the posterior region two circumvallate papillae are observed; some fungiform and numerous large sized filiform papillae are present around the circumvallate papillae. The height and breadth of the fungiform papillae are 17.6 µm and 14.4 µm and the height and breadth of the circumvallate papillae are 30.4 µm and 32.0 µm. Taste buds of the circumvallate papillae are present in the surface epithelial covering of the lateral wall of the trench and the sides of the circumvallate papillae. The taste buds are variable in size and shape and received a branch of the glossopharyngeal nerve. The pointed horney filiform papillae densely set as compared to the other corresponding papillae

Figures



EXPLANATION OF FIGURES

Fig. 1. Section to show pointed horney papilla surrounded by highly keratinized squamous epithelium (arrow heads).

Figs. 2 and 3. Part of the section showing the circumvallate papilla (thick arrow) surrounded by a narrow moat like channel of epithelium in which taste buds (arrow heads) are present (Fig 2). Each taste bud occupied the full thickness of the epithelium and comprised pale stained spindle shaped cells (small arrows). The luminal surfaces of cells open into the epithelium called as taste pore, which bears a number of microvilli. Some of the spindle shaped cells had synaptic vesicle with small afferent nerve fibres; these are the taste receptor cells (Fig. 3).

Fig. 4. Dorsal surface of the tongue of *Taphozous longimanus* showing high karatinisation at the outer epithelial covering of filiform papillae, striated muscles (small arrows) and mucous membrane (arrow heads).

and shows great keratinization (Fig. 1 and 4), the height and breadth of these horney papillae are 14.4 µm and 16.0 µm. Each circumvallate papilla was surrounded by a narrow moat like channel of epithelium lying numerous taste buds (Fig. 2 and 3), the height and breadth of the taste buds are 17.6 µm and 6.4 µm. The taste buds occupied the full thickness of the epithelium and comprised of pale stained spindle shaped cells and the height and breadth of the single taste bud cell are 11.2 µm and 3.2 µm. The luminal surfaces of cells open into the epithelium called as taste pore, which bears a number of microvilli. Some of the spindle shaped cells had synaptic vesicle with small afferent nerve fibres are the taste receptor cells. The gustatory lingual glands are located deeper amongst the muscle bundles in the vicinity of the circumvallate papillae. Ducts of glands opened into the moats i.e. outer cover of papillae and poured their secretion into the trench of papillae.

DISCUSSION

The numbers and the structural arrangement of the gustatory lingual papillae of the tongue in *Taphozous longimanus* are adapted to their alimentary group into an insectivorous feeding habit. The anterior pointed tip showing the scale like, single horney and the cluster of mechanical tricuspid filiform papillae that means the shapes and specific types of filiform papillae are helpful to capturing the insect during the flight and all these different types of filiform papillae on the anterio-dorsal surface of the tongue are oriented towards the rear part of the tongue. The arrangement, shapes, sizes and the direction of their keratinization process are related to their habitat.

In our work, the aim was to examine the microstructure and distribution of the circumvallate papillae of *Taphozous longimanus*. Two circumvallate papillae present at the posterior-dorsal surface of tongue in which, one on the left and the other on the right. The circumvallate were flat and doughnut in shaped. They had an irregular troughs in the center and alongside with large circular trough around the inner part. The outer ring of circumvallate papillae was somewhat integrated with the surrounding part of the tongue. The circumvallate papillae formed by a group of eight to twelve elevations; situated at the base of the tongue, extended slightly above the general epithelial surface and are arranged in the form of an inverted 'V' (Kastelein et al., 1997). The circumvallate papillae are begins to take shape by its penetration into the epithelium. The penetrated epidermal ring separates from the external trench wall of papillae. The thickness of the circumvallate papillae is due to the multilayered epithelium. The circular shape of circumvallate papillae had a smooth basement membrane with many pores.

Two circumvallate papillae of *Taphozous longimanus* had five to six tiers of taste bud. The taste buds are ovoid, ellipsoidal or spheroidal in shape and occupied the entire depth of epithelial layer. The number of large sized taste bud is found in the lateral wall of trench but very rare in the floor of the trench. Akisaka and oda, 1978 (in rats); Jahnke and Baur, 1979 (in rabbit), observed the tight junction within the taste buds as well as surrounding lingual epithelium which produce a seal between the taste buds and oral enviorment. Ciliated and mucous cells occurred in the peripapillary trench of circumvallate papillae which helpful for circulation of saliva, wetting the taste pore and removal of debris from papillary trench. At postnatal stage, the thickness of the circumvallate papillae are increased is due to the increased the numbers of the taste bud as well as the number of taste cells as per taste bud. Two types of taste cell in the taste bud i.e. Dark cell and light cell (Kinnamon et al., 1985) classified according to their cytoplsmic content and nuclei. Dark cells had irregular outline and light cells had a circular and oval in outline. The taste bud innervated by glossopharyngeal nerve (Aktas and Negriz, 2006 and Jackowiak, 2006). Synapses are two types i.e. macular or fingerlike and conventional, (Royer and Kinnamon, 1988) and occurred between the taste bud cells and nerve fibres. The subsurface cisternae and mitochondria of taste bud cells plays important role in interactions between the taste cells and nerve fibers. Due to the loss of nerve fibers within the taste bud, the numbers of pores were decreased and finally disappeared, but reappeared again due to the penetration and regeneration of nerve fibers into taste buds. Full development of basement membrane with disappearance and reappearance of the taste pores at different stages of age depend upon the presence and absence of the nerve fibers (Mistretta et al., 1984), because of some changes occurred in morphology and in neural organization.

The posterior surface of tongue covered by smooth mucosa and large posterior lingual glands i.e. serous glands located in front of the medial circumvallate papillae, along the margins of the tongue near its root, and under the mucosa of the lymphatic area (Couchman et al., 1979). The serous glands embedded among in connective tissue beneath the muscle bundles. The serous gland had the small ducts for secretion found deeply into the posterior region of the tongue ad the main function of glands to secrete the secretion which is very useful at the time of feeding, when the insects are lapped up with the tongue which is specially covered in sticky saliva developed by numerous colonies of salivary glands.

The distribution and microstructure of circumvallate papillae at the posterior region depend upon the different types of food consumed by the specific types of bat species. Usually fruit eating bat have three circumvallate papillae while insectivorous bats have two circumvallate papillae (Pastor et al., 1993; Son et al., 2000; Emura et al., 2001, 2002; Gregorin, 2003; Hwang and Lee, 2007). The Japanese long-fingered *Miniopterus schreibersi fuliginosus* and *Pipistrellus savii* are highly adapted for insect feeding habit (Kobayashi and Shimamura, 1982 and Park and Lee, 2009) and showed two circumvallate papillae on the posterio-dorsal surface of tongue. Increased numbers of gustatory papillae and the taste buds indicates that the greater capacity of the innervation at the posterior region of the tongue so the greater number of gustatory papillae increased the gustatory function of the tongue and it is due to the numerous nerves scattered amongst the muscular core of the bat tongue

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