

## PRENATAL DEVELOPMENT OF THE TONGUE AND ITS PAPILLAE IN THE ONE-HUMPED CAMEL (CAMELEUS DROMEDARIES)

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### ABSTRACT

*Tongues from 18 camel fetuses of different CVRL were divided into three groups, which were used for gross morphology and scanning electron microscopy (SEM). Grossly, the most rostral part of the apex of the tongue was narrow and marked by small constriction from the body in the first group. The tongue had the same width except the root which was slightly narrows than the rest of the tongue in the second group. Then, the tongue became longer and thicker, with clearly differentiated torus linguae and lingual papillae in the third group.*

*SEM revealed that in the first group the apex of the tongue was free from filiform papillae. Few fungiform papillae were started to appear on the lateral borders of the tongue. Flattened circumvallate papillae laterally and small rounded to elongated quadrilateral lenticular papillae medially begin their first indication on the torus linguae. Coniform papillae started to appear as small dome-shaped projections at the root of the tongue.*

*In the second group, the lateral parts of the apex and the rostral part of the body showed numerous short filiform papillae. Few fungiform papillae were sporadically scattered near the lateral borders of the apex and the body. On the dorsal part of the torus linguae both*

*lenticular and circumvallate papillae were easily demonstrated. Circumvallate papillae started to arrange themselves laterally in the form of one row on each side. The lentiform papillae appeared covering the whole torus linguae except an area occupied by the circumvallate papillae. Coniform papillae had increased in size and became elongated in shape.*

*In the third group, filiform papillae were numerous on the rostral part of the body and apex. lentiform papillae became larger in size with caudally directed pointed ends. They were arranged in 3-4 rows lateral to the circumvallate papillae and several rows in the paramedian zone. Fungiform papillae were increased in size but remained similar to those of the second group in the general appearance. Circumvallate papillae were about 5 to 6 on each side of the torus linguae. They were circular to oval in shape and surrounded by completely formed papillary grooves. Taste pores were easily demonstrated on the surface of the papillary bodies of the circumvallate papillae only.*

*The existence of large number of lenticular papillae in camels can be reflecting the feeding habits of thorny hard material by this animal. Also existence of large number of well developed circumvallate papillae may substitute the absence of foliate papillae in this species.*

## INTRODUCTION

Although the camel is an important animal in many arid areas of Africa, Asia and Australia, many of its morphological and anatomical aspects are still lacking. The camel lives in regions with dry climates and feeds on plants that grow in these regions. Lingual papillae have been

extensively studied in many adult animals such as in goats (*Kumara et al. 1998*), in equines (*Chamorro et al. 1986, Pfeiffer et al. 2000 and Abd-Elnaeim et al. 2002*), in bovines (*Stifleck et al. 1983, Chamorro et al. 1986, El-Sharaby 2006b*) and in cats (*Boshell et al. 1982 and Scala et al. 1995*). However, the gustatory papillae on the tongue of camels were described by many authors such as *Hegazi 1945, Girgis 1966, Dellmann et al. 1968, Fahmy and Dellmann 1968, Moustafa et al. 1976*, and *El-Sharaby 2006a*. Prenatal studies, which help in better understanding of the structure, are scant in camels. Therefore, the present study was conducted to highlight the prenatal development of the tongue and its papillae in the one-humped camel by using gross anatomy and scanning electron microscopy.

## MATERIALS AND METHODS

Tongues were collected from 18 camel fetuses of different CVR lengths. The camel fetuses were grouped into 3 equal groups according to the CVR lengths (5-20 cm, 45-55 cm and 100-120 cm CVR lengths). For gross anatomy three tongues from each group were used; the other three tongues were used for scanning electron microscopy. Small pieces from different areas of the tongues were dissected and fixed by immersion in 3% glutaraldehyde in 0.1M phosphate buffer for 4 hours at room temperature. The specimens were then washed several time in phosphate buffer and dehydrated in graded ethanol. Isoamylacetate substitution was done before critical point drying with CO<sub>2</sub>-substitution, then mounted on aluminum stubs, sputter-coated with gold and examined and photographed by using a scanning electron microscope (DSM 940).

## **RESULTS**

### **Gross anatomy:**

In the first group, the tongues were small in size, flattened and compressed dorso-ventrally. Each tongue had nearly the same width except for the most rostral part of the apex which was slightly narrow in comparison to the body. There was a small constriction marking the apex from the body (fig. 1a).

In the second group the tongue appeared having the same width except the root, which was still narrow than the rest of the tongue. The constriction which was seen in the first stage was not clearly seen and the apex became wider than before (fig. 1b). In the third group, the tongue became longer and thicker than before, and characterized by a slightly constricted area in the rostral part of the body, slightly rostral to the developing torus linguae. The apex was flattened and wide with a median longitudinal groove which extended also to the rostral part of the body. All the mechanical and gustatory papillae were clearly seen (fig. 1c).

### **Scanning electron microscopy:**

In the first group, the apex of the tongue was free from filiform papillae. The lingual surface was covered with polyhedral cells except near the lateral borders where few fungiform papillae appeared developing (fig. 2a). In higher magnification, the fungiform papillae appeared in the form of convex, semicircular papillary projections incompletely encircled by a papillary groove (fig. 2b). A median linear cellular proliferation was demonstrated on the apex of the tongue and

few papillary projections could be seen on the rostral part of the body. Caudally, on the torus linguae, both circumvallate papillae laterally and lenticular papillae medially begin their first indication. The circumvallate papillae started to be formed by arrangement of the cells in two or three circular lines of cells around the papillary body (fig. 3a). Then the papillary groove is formed by cellular breakdown around the papillary body (fig. 3b).

In the second group, the lateral parts of the apex and the rostral part of the body of the tongue demonstrated numerous short thick filiform papillae (fig. 4a). Few fungiform papillae were sporadically scattered near the lateral borders of the apex and the body (figs. 4a & 4b). The body as well as the rostral part of the torus linguae showed cellular proliferation. The proliferation was accompanied by desquamation of many thread and leave-like projections on and around the newly formed papillae. The filiform papillae were more distinct and numerous on the rostral part of the body and on the apex. At the most rostral part of the body and lateral aspects of the tongue, fungiform papillae were seen developing between the filiform papillae (figs. 4a and 4b). On the dorsal part of the torus linguae, both lenticular and circumvallate papillae were easily demonstrated. The circumvallate papillae started to arrange themselves laterally in the form of one row on each side (fig. 5a). The circumvallate papillae were formed first by circular arrangement of cells followed by cell breakdown on the periphery to form papillary groove (fig. 5b). The lenticular papillae appeared covering the whole torus linguae except the area that occupied by the circumvallate papillae. The lenticular papillae appeared as short tongue-shaped papillary projections.

In the third group, all papillae either mechanical or gustatory were clearly visible on the tongue. Filiform papillae were numerous particularly on the rostral part of the body and apex. Lenticular papillae became larger in size with caudally directed pointed ends. These papillae were arranged themselves in rows, they constituted 3-4 rows lateral to the circumvallate papillae and several rows in the paramedian zone. In this region the free ends of the lenticular papillae were directed rostrally (fig. 6a). The fungiform papillae were not greatly changed than in the second group except for increase in size and complete formation of the papillary groove around the papillary body. Taste pores were not demonstrated on the fungiform papillae. Circumvallate papillae were developed; they became about 5-6 on each side of the torus linguae. Each papilla was typical circular or oval in shape and surrounded by a circular papillary groove (fig. 6b). The papillae were separated from the surrounding by relatively thick rims; these rims were surrounded by shallow grooves. The size of these circumvallate papillae was variable but the most caudal and rostral ones were smaller than those in-between. At this stage, formation of the papillary groove was completely finished and the process of cell proliferation and desquamation was ceased. On the other hand, process of cell proliferation and desquamation was still present on the inner side of the rim as well as on the shallow groove outside the surrounding rim (fig. 7a). This means the shallow groove or secondary groove could be deeper in postnatal life. Taste buds were of variable appearance and easily demonstrated on the surface of the papillary body. Some of them appeared as small elevated or dome-shaped areas with very small centrally located taste pore, others were circular in outline and slightly depressed with large opening (taste pore) and finger like projections representing the cells of taste buds (fig. 7b).

## DISCUSSION

The present study revealed that the fungiform papillae were the first ones to appear among the other mechanical and gustatory papillae in camel fetuses in accordance with *Moustafa (1983)* and on the contrary with *Dougbag (1988)*. These papillae were distributed with a high density on the tip of the tongue and on the lateral parts of the body. Similar distribution was recorded by *Dougbag (1987)* in the same species and by *Davies et al. (1979)* in the cow. The general appearance of the fungiform papillae in the present study was not typically rounded as in equines as mentioned by *Chamorro et al. (1986)*, *Pfeiffer et al. (2000)* and *Abd-Elnaeim et al. (2002)*. Other forms like lobulated papillae which had been detected in the donkey were not observed in the current study. *Barone (1979)* in the horse and *Abd-Elnaeim et al. (2002)* in the donkey found that the fungiform papillae lack the taste pores and considered them to have only a mechanical function. Absence of the taste pores had been reported also in the goat by *Kumara et al (1998)*. The current study by SEM could not detect the taste pores in the fungiform papillae of camel tongues under investigation, suggesting that these papillae might have only a mechanical function or might be develop later postnatal. This result could be sustained by the finding of *Dougbag (1987)* in adult camels, because he demonstrated a few number of taste buds in the fungiform papillae.

The present study revealed that the lentiform papillae were clearly visible at the age of 5 cm CVRL of pregnancy. However, *Moustafa (1983)* and *Dougbag (1987)* reported the same results but at somewhat older ages in the same species. At the same age coniform papillae started to develop only at the root of the tongue. Therefore, the present study can confirm that the lentiform papillae are the first papillae to appear among the mechanical papillae of camel tongue.

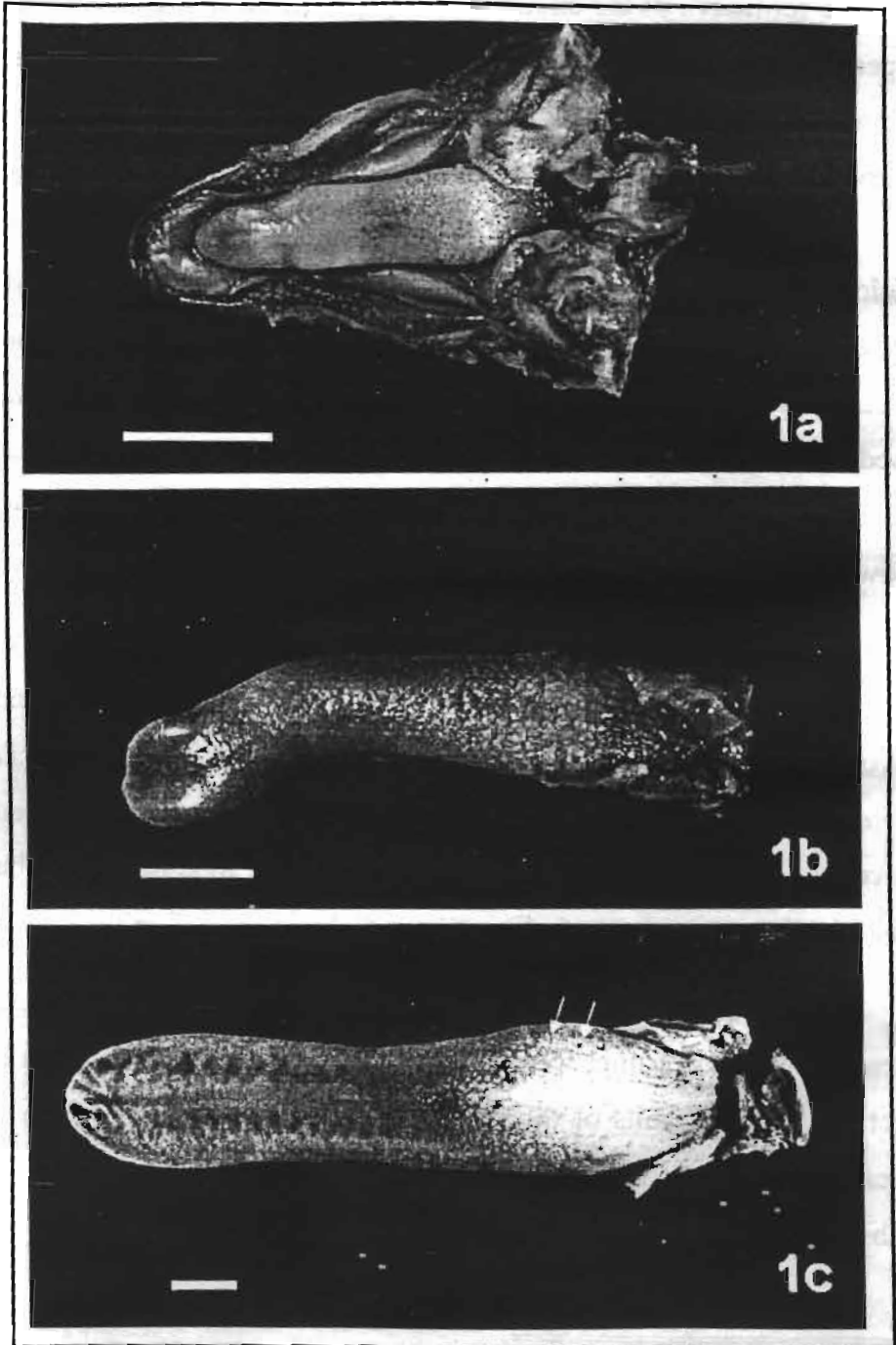
The present study has recorded only 5-6 circumvallate papillae on both sides of the torus linguae. Also we noticed that most of the circumvallate papillae of the same specimen were nearly identical on both sides of the torus linguae. The circumvallate papillae which were located at the beginning and at the end of the line on both sides of the torus linguae were smaller than the rest. However, *Moustafa (1983)* and *Dougbag (1988)* have been reported that about 6-8 large flattened circumvallate papillae are arranged in two lines on both rims of the torus linguae. *Moreover, El-Sharapy (2006a)* mentioned that in adult camels the circumvallate papillae were most frequently arranged along an identical line on each side of the torus linguae. These papillae were not identical or symmetrical in the two lines of the same specimen. He added that each papilla; rounded or flat; small or large; single or paired was surrounded by a prominent gustatory groove. These papillae subjected to several developmental stages in adult camels. Only flat or oval papillae were found in the present study and we could see the various forms that mentioned by *El-Sharapy (2006a)*. The most interesting finding of our

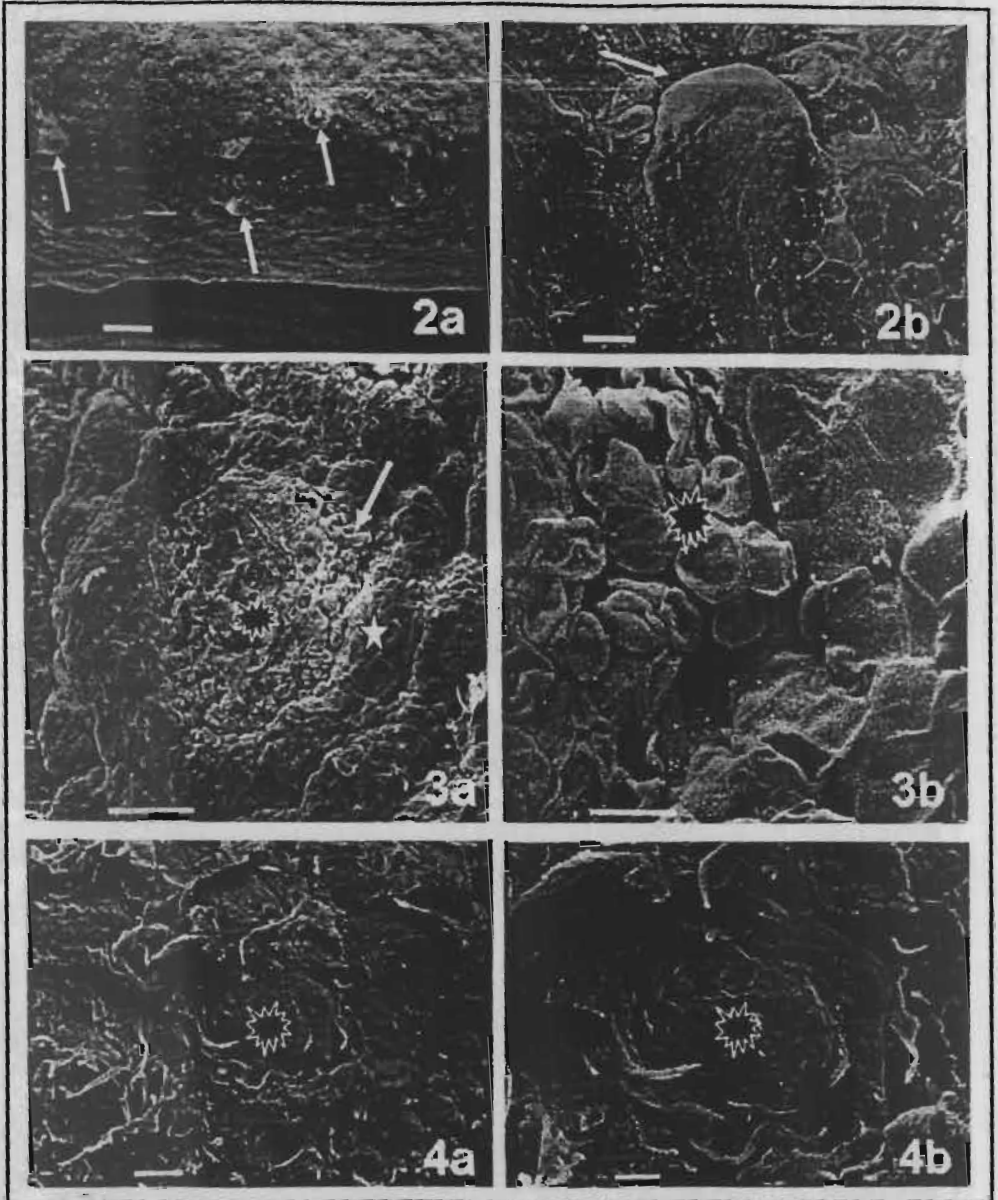


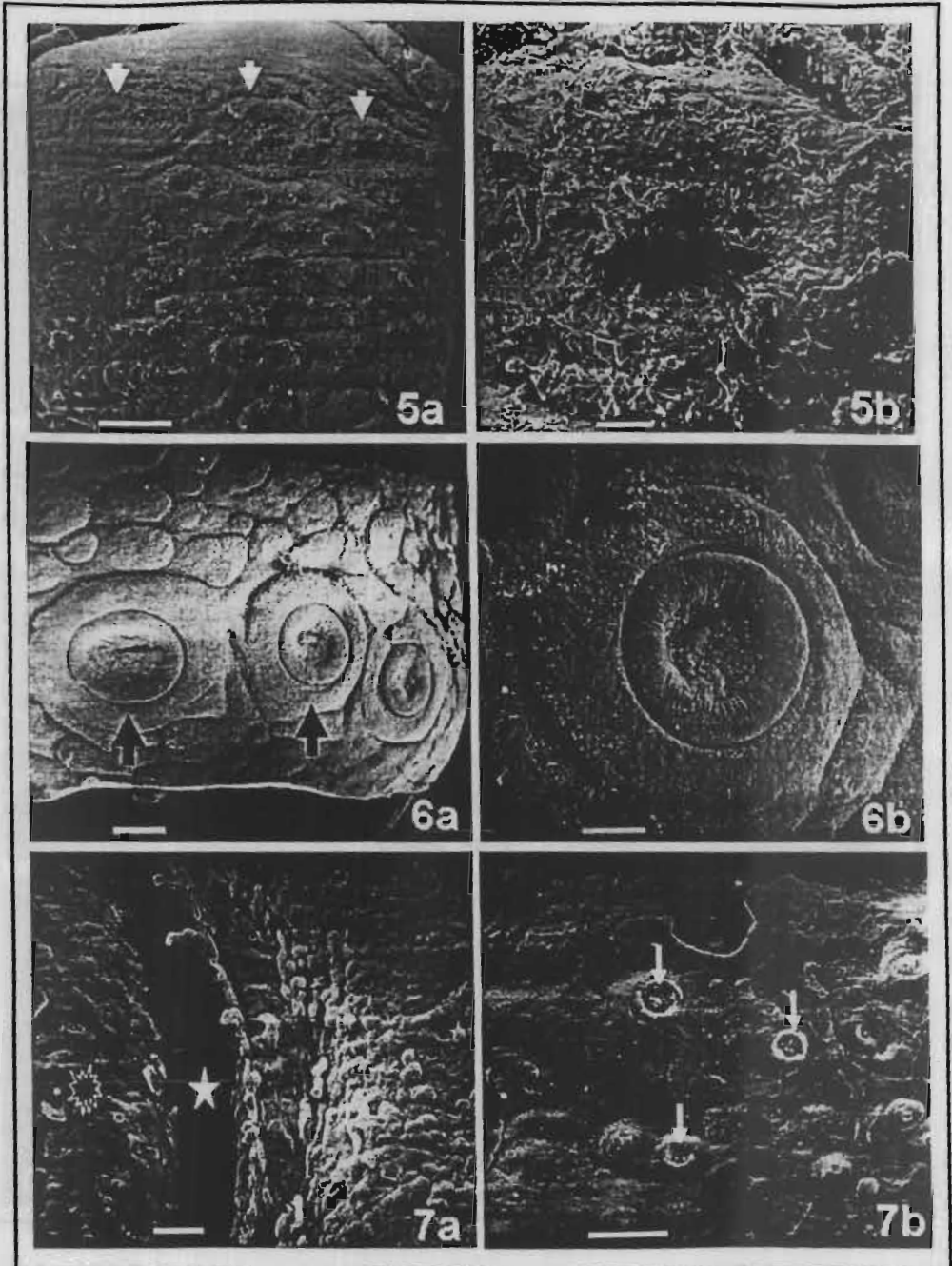
study is the formation of the circumvallate papillae, these papillae started to appear as a circular collection of cells, then these cells started to proliferate rapidly followed by cell breakdown on the periphery of the papillary body to form a circular gustatory groove. In some papillae another gustatory groove was also formed by the same method. Also formation of a central lingual groove or depression was seen during its formation by cell proliferation and breakdown similar to the gustatory groove. Prenatal development of the circumvallate papillae in the one-humped camel had been studied by *Dougbag (1988)*. He reported that the papillae were developed gradually in a caudorostral direction forming one row on each side of the torus linguae.

The present study revealed that several taste pores were observed on the surface of papillary body of the circumvallate papillae in camel embryos and fetuses. This was on the contrary of the finding of *El-Sharapy (2006a)* because he mentoned that no taste pores were observed on the surface of the circumvallate papillae in adult camels but most of the them were located along the medial trench wall epithelium.

It is believed that the existence of large number of well developed lenticular papillae in camel fetuses as strong mechanical papillae can be reflect the feeding habits of thorny hard material by adult camels. Also existence of large well developed circumvallate papillae may substitute the absence of foliate papillae in this species.







## LEGENDS

**Fig. (1a):** Photograph showing the tongue of 12 cm CVR length camel fetus in the floor of the oral cavity. Note the rostrally constricted part which separates the body from the apex. The lingual papillae are not visible. Par = 1 cm.

**Fig. (1b):** Photograph showing the tongue of 55 cm CVR length camel fetus. The tongue has nearly the same width from the most caudal part of the body to the rostral end of the apex. Circumvallate and lenticular papillae are visible on the caudal part of the body. Par = 1 cm.

**Fig. (1c):** Photograph showing the tongue of the near term fetus. The tongue is wide at the caudal part of the body (torus linguae) and at the apex, but constricted at the middle part. Five circumvallate papillae (arrows) and several rows of lenticular papillae are clearly seen on the torus linguae. The filiform and fungiform papillae are difficult to be seen. Par = 1 cm.

**Fig. (2a):** Scanning electron micrograph showing the dorso-lateral part of the body of the tongue near to the apex. Note presence of bulb-like papillary bodies of the fungiform papillae (arrows). The rest of the dorsal surface is covered by polyhedral cells. X 100, par = 100  $\mu$ m.

**Fig. (2b):** Scanning electron micrograph showing beginning of formation of fungiform papilla which is surrounded by incompletely formed papillary grooves (arrow). Most of the surrounding cells are polyhedral in-shape and covered by fine, short microvilli. X 500, par = 20  $\mu$ m.

**Fig. (3a):** Scanning electron micrograph showing the first step in the formation of the circumvallate papillae. The cells are arranged themselves in rows which constitute two circles around the papillary body. The inner row (asterisk) is completely encircled the papillary body (star). The papillary groove begins to be formed by cell proliferation and desquamation immediately inside the inner row (arrow). X 150, par =100  $\mu$ m.

**Fig. (3b):** Higher magnification from figure 3b demonstrating cell proliferation and desquamation (asterisks) to form the papillary groove. Most of cells are polyhedral in shape and covered by short microvilli. X 800, par =20  $\mu$ m.

**Fig. (4a):** Scanning electron micrograph from a tongue of second stage fetuses, which is taken at the most rostral part of the body. Large rounded fungiform papillae (asterisks) are visible between the numerous filiform papillae. Superficial cell desquamation in the form of leave-like is clearly visible here. X 100, par =100  $\mu$ m.

**Fig. (4b):** Higher magnification from figure 4a showing a single fungiform papilla (asterisk) surrounded by some filiform papillae. The taste pores are not seen. X 200, par = 50  $\mu$ m.

**Fig. (5a):** Scanning electron micrograph from a tongue of second stage fetuses at the torus linguae. Three circumvallate papillae (arrowheads) and several lenticular papillae are visible on the paramedian part of the torus linguae. X 12, par = 1mm.

**Fig. (5b):** Magnification from figure 5a showing a single circumvallate papilla in a stage of development. The papillary body showing a centrally depressed area and the papillary groove is still in a stage of formation by cell desquamation. X 50, par = 200  $\mu$ m.

**Fig. (6a):** Scanning electron micrograph from a tongue of third stage fetuses. On the torus linguae, typical circumvallate papillae (arrowheads) are formed. Just lateral to the circumvallate papillae 3-4 rows of tongue-shaped lenticular papillae with caudally directed free ends are formed. X 10, par = 1mm.

**Fig. (6b):** Magnification from figure 6a showing a single typical circumvallate papilla. The papillary body is circular in outline with slightly depressed central zone. The papillary groove is completely formed. The process of cell proliferation and desquamation is nearly stopped in the region of the papillary groove. X 25, par = 500  $\mu$ m.

**Fig. (7a):** Magnification from figure 6b showing part of the papillary body (asterisk), papillary groove (star) and the adjacent zone surrounds the circumvallate papilla. Note the small openings on the papillary body. X 200, par = 50  $\mu$ m.

**Fig. (7b):** Higher magnification from figure 7a showing taste pores on the body of circumvallate papilla. In some taste pores finger-like processes are seen, representing the cells of the taste buds. X 350, par = 50  $\mu$ m.

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### تطور اللسان وجليماته قبل الولادة في الجمل وحيد السنم

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لقد تم استخدام عدد 18 لسانا من أسنة أجنة الجمال ذات الأطوال المختلفة والتي تم تقسيمها الى ثلاث مجموعات لدراستها مورفولوجيا وكذلك باستخدام المجهر الالكتروني الماسح. أوضحت الدراسة الظاهرية ضيق الجزء الامامي من قمة اللسان ووجود انقباض صغيرة بين جسم اللسان وقيمة في المجموعة الأولى. وقد تميز اللسان بنفس العرض باستثناء الجذر الذي بدا يضيق قليلا من بقية اللسان و ذلك في المجموعة الثانية. أما في المجموعة الثالثة فإن اللسان أصبح أطول وأكثر سمكا وتميزت فيه بوضوح الحليمات اللسانية والمرتفع اللساني.

أوضحت الدراسة باستخدام المجهر الالكتروني الماسح أن قمة اللسان كانت خالية من الحليمات الخيطة في المجموعة الأولى. وأن قليل من الحليمات الفطرية بدأت تظهر على جانبي الحواف اللسانية. وبدأت في الظهور على المرتفع اللساني خارجيا حليمات كأسية مفطحة وحليمات عدسية صغيرة مدورة الي طويلة رباعية الشكل داخليا. وبدأت تظهر الحليمات المخروطية على شكل قنب صغيرة على جذر اللسان.

في المجموعة الثانية ، ظهرت علي الأجزاء الجانبية لقمة اللسان وعلي الجزء الأمامي من الجسم العديد من الحليمات الخيطية القصيرة. أما الحليمات الفطرية كانت قليلة ومنتشرة بشكل منقطع بالقرب من الحدود الجانبية للقمة والجسم. وبدأت الحليمات الفطرية ترتب نفسها أفقيا في شكل صف واحد على كل جانبي المرتفع اللساني. وبدأت الحليمات العدسية تغطي المرتفع اللساني باستثناء منطقة محتلة من قبل الحليمات الكأسية. وقد زادت الحليمات المخروطية في الحجم وأصبحت طويلة الشكل.

في المجموعة الثالثة ، كانت الحليمات الخيطية عديدة على الجزء الأمامي من الجسم وقمة اللسان وأصبحت الحليمات العدسية أكبر في الحجم ومتجهة للخلف وترتبت في 3-4 صفوف خارج الحليمات الكأسية وعدة صفوف في المنطقة بين الحليمات الكأسية. أما الحليمات الفطرية فزادت في الحجم لكنها ظلت مشابهة لتلك التي في المجموعة الثانية في المظهر العام. وكانت الحليمات الكأسية حوالي 5 إلى 6 حليمات علي كل جانب من المرتفع اللساني وكانت هذه الحليمات دائرية إلى بيضاوية الشكل ومحاطة تماما بأخاديد حلزونية. وظهرت بوضوح تقوي براعم التزوق علي أسطح أجسام الحليمات الكأسية فقط. وقد خلصت هذه الدراسة الي أن وجود عدد كبير من الحليمات العدسية في الجمال يمكن أن يعكس عادات التغذية علي مواد صلبة شائكة وأن وجود عدد كبير من الحليمات الكأسية المتطورة قد يعوض غياب الحليمات الورقية في هذا النوع من الحيوانات.