

## Anatomic study and distribution of the *Vallate papillae* in domestic cats

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### Abstract

The tongue of domestic animals varies in size and shape and according to these animals feeding habits, there are different degrees of tongue surface specialization. At the dorsal surface of the tongue lingual papillae can be observed, such as the vallate papillae, related to taste perception. With the help of a magnifying glass, differences in the number, size and distribution of *vallate papillae* were studied. Fifty five tongues of adult domestic cats from both sexes (38 females and 17 males) were analyzed. The samples were fixed in 10% buffered formalin. The *vallate papillae* were found to be symmetrically distributed on 21 tongues (38.18%). However, it was observed that in some of the tongues the number of *vallate papillae* varied when one side of the tongue was compared to its contralateral side. The *vallate papillae* showed different shapes: elongated (42.58%), oval (31.61%), round (25.48%) and pear shaped (0.33%). The *vallate papillae* were classified into 10 different categories: symmetrical I (2 right and 2 left), II (3:3), III (4:4) and asymmetrical IV (3:2), V (4:2), VI (2:3), VII (4:3), VIII (5:3), IX (3:4) and X (4:5). Measurements of length and width were made with averages of  $0.84 \pm 0.23$  mm and  $0.55 \pm 0.18$  mm, respectively, besides the calculation of the total area of these papillae per tongue, that showed average of  $2,74 \pm 0,31$  mm<sup>2</sup> in males and  $1,94 \pm 0,14$  mm<sup>2</sup> in females. However, upon examining the *lingual papillae* of the cat tongues, specimens demonstrating 7, 8 or 9 *vallate papillae*, arranged in pairs (4:3, 5:3, 3:4 and 4:5) by category, were observed in this study but not cited in the literature.

### Key words:

Tongue.  
*Vallate papillae*.  
Gustatory *papillae*.

### Introduction

The tongue of mammals is an important tactile organ contributing significantly to food apprehension. It varies in form and size and demonstrates morphologic diversity that is greatly influenced by feedings habits.<sup>1,2,3</sup>

The dorsal surface of the tongue in domestic mammals is rough due to the presence of structures called *lingual papillae*.<sup>4,5</sup> These *papillae* are classified as: filiform, lenticular, conical, foliate, fungiform and vallate, each one possessing different

functions.<sup>2,3,4,5,6,7,8,9,10</sup> Filiform, lenticular and conical *papillae* possess a protective and mechanical function. The fungiform, foliate and *vallate papillae* are related to taste perception<sup>2,3,10</sup> and, according to Sonntag<sup>5</sup> the foliate *papillae* are mechanical.

The present study focused on the *vallate papillae* founded in cats, dogs, pigs, cattle and horses.<sup>2,5,11</sup> They are located in the caudal third of the tongue<sup>3,4,6,12,13,14,15,16,17</sup>, on the dorsal face of the tongue's root<sup>3,6,16</sup>.

In domestic mammals, the *vallate papillae* are wrapped in a groove that follows their specific shape. Ducts open from serous

glands that help to clean the groove with their secretion.<sup>4,6,11,12,14</sup> Particularly in cats, dogs and wild carnivores the *vallate papillae* are distributed in two convergent lines forming a “V”, with the point of the V directed toward the base.<sup>3,4,7,8,9,10,13,16,17</sup> This arrangement occurs when an even number of these *papillae* are present in symmetrical form. Whenever there is an odd number (three or five), they are asymmetrically arranged.<sup>4</sup> This arrangement is described as typical and atypical by Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup>.

Cats<sup>7,8,9</sup> and dogs<sup>4</sup> do not have medial *vallate papillae*. In dogs, when the *papillae* are arranged asymmetrically, the V arrangement is absent.<sup>4</sup>

The number of *vallate papillae* may vary in cats from four to six<sup>17,18,19</sup> or four to eight<sup>7,8,9</sup>. In dogs there may be three to six *vallate papillae*<sup>4</sup> or four to six<sup>3,13,14,15,16</sup>. These *papillae* are arranged in pairs of three in the Beagle breed.<sup>10</sup> In dogs the *vallate papillae* have diameters between 1.5 to 2.5 mm.<sup>4</sup>

The present study was carried out with the intention of obtaining more information on shape, dimension and distribution of *vallate papillae* in the tongue of the domestic cat, so as to increment anatomical information on this specie.

## Material and Method

Fifty five tongues of unknown breed adult domestic cats were studied, being 38 female and 17 male. They proceeded from the Regional Center of Zoonosis Control of Uberaba, Minas Gerais State - Brazil, and were fixed and immersed in 10% buffered formalin immediately after death. With the help of a magnifying glass the length and width of the *vallate papillae* were measured using a paquimeter (Mitutoyo®) and each of the *vallate papillae* was classified as oval, round, elongated or pear shaped. The *vallate papillae's* area were calculated by the application of the formula  $A = p.a.b$  (ellipsoid's area). This formula can't be applied to the pear shaped papillae with high precision, but this morphological difference

was minimized by its low frequency of occurrence. For the number and distribution analysis of the *vallate papillae*, all tongues had their *papillae* numbered and classified into two distributions, described as symmetrical and asymmetrical. The symmetrical forms were those that presented the *vallate papillae* in equal numbers on each side of tongue. These were classified as types I (two on the right side and two on the left side), II (3:3) and III (4:4). The asymmetrical forms were those with *papillae* distributed in different numbers when both sides of the tongue were compared. These were classified as types IV (3:2), V (4:2), VI (2:3), VII (4:3), VIII (5:3), IX (3:4) and X (4:5).

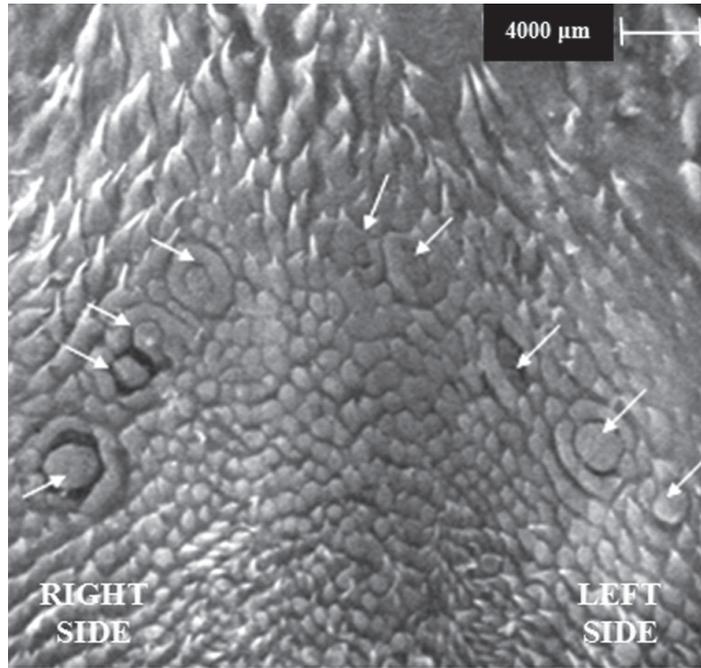
In the descriptive statistical analysis the absolute and relative frequencies of the *vallate papillae* were calculated. It was applied the t-Student test to compare the values found to the *vallate papillae's* area and the number of these *papillae* per tongue in accordance with the gender of the animals. The qui-quadrado test was done to compare the values obtained for the types of distribution of *vallate papillae*. Both of these two statistical tests using S.A.S.® (Software Analysis System).

## Results

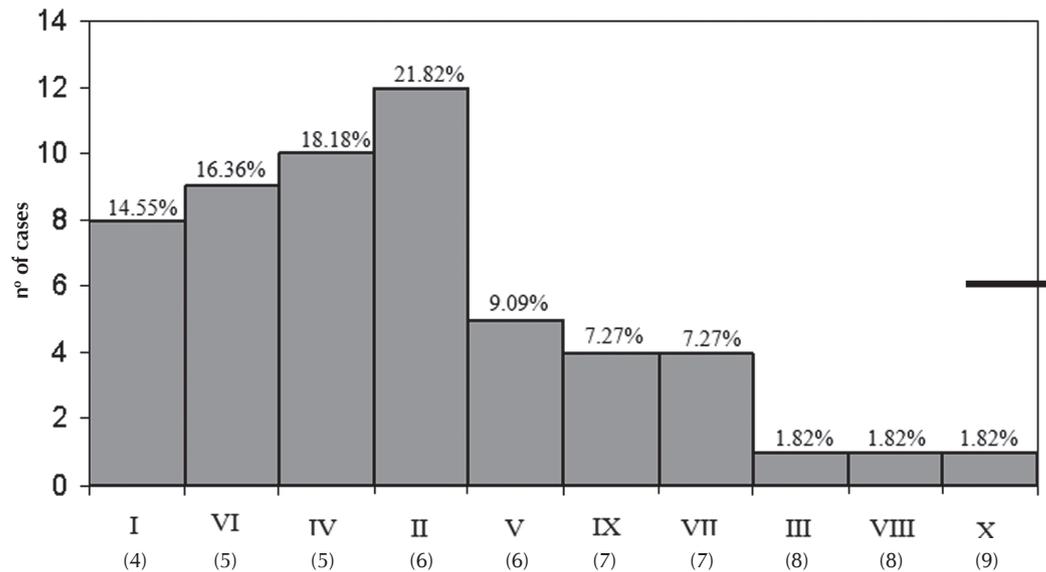
The *vallate papillae* in the cat tongues presented an average of  $5.64 \pm 1.13$  *papillae*/tongue ( $5.65 \pm 1.17$  in males and  $5.63 \pm 1.13$  in females). The number of these *papillae* vary from two (30.91% on the right side and 41.82% on the left side), three (47.27% on the right side and 47.27% on the left side), four (20.00% on the right side and 9.09% on the left side), or five (1.82% on the right side and 1.82% on the left side) *vallate papillae* (Figures 1, 2 and 3).

The *papillae* shape observed varied between elongated (42.58%), oval (31.61%), round (25.48%) and pear shaped (0.33%). In all cases observed, they were surrounded by a groove that conformed to the *papillae's* shape (Figure 4).

The distribution of *vallate papillae* and their respective frequencies are presented in figure 2.



**Figure 1** - Image of the dorsal surface of caudal third of cat tongue demonstrating *vallate papillae* (arrows) distribution (type x)



**Figure 2** - Number of *vallate papillae* and % (n = 55) by type of distribution on cat tongues

The arrangement of the *vallate papillae* classified previously as symmetrical, was found in 38.18% of the animals, 21.82% in females and 16.36% in males. The asymmetrical forms were found in 61.82% of the tongues, being 47.27% from females and 14.55% from males (Figure 3).

Measurements of length and width were made, showing an average of  $0.84 \pm 0.23$  mm for length and  $0.55 \pm 0.18$  mm for width of *vallate papillae* observed. The total area of these papillae per tongue was  $2,74 \pm 0,31$  mm<sup>2</sup> in males and  $1,94 \pm 0,14$  mm<sup>2</sup> in females (Figure 5).

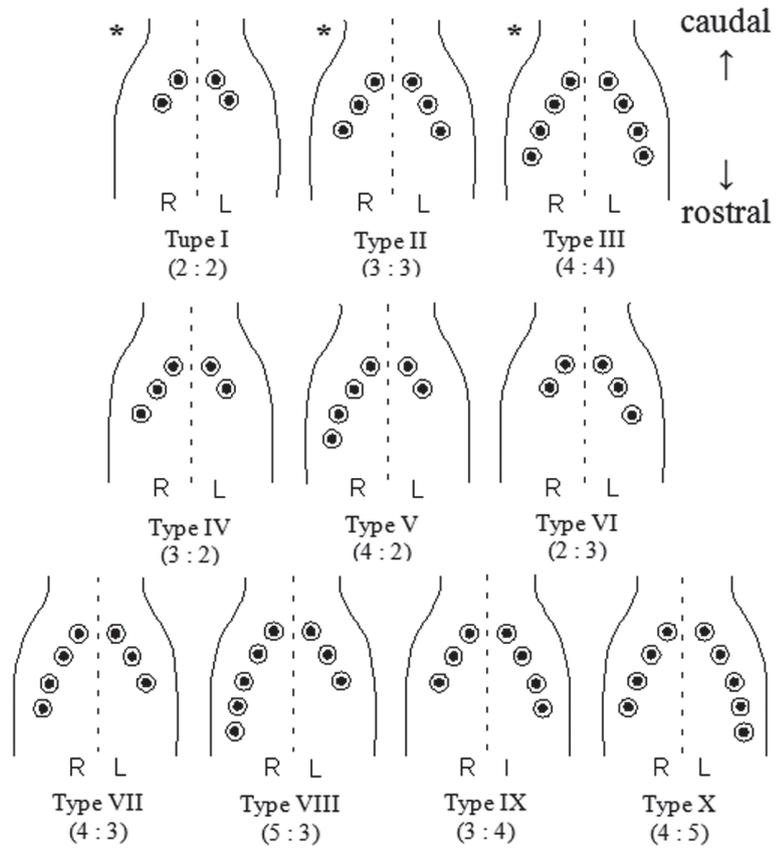


Figure 3 - Localization of *vallate papillae* in different distributions on the dorsal surface of the cat tongue, with emphasis on the symmetrical (\*) and asymmetrical arrangements

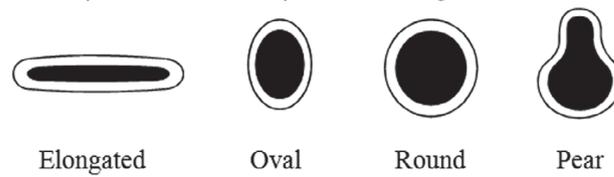


Figure 4 - Observed shapes of the *vallate papillae* on cat tongues

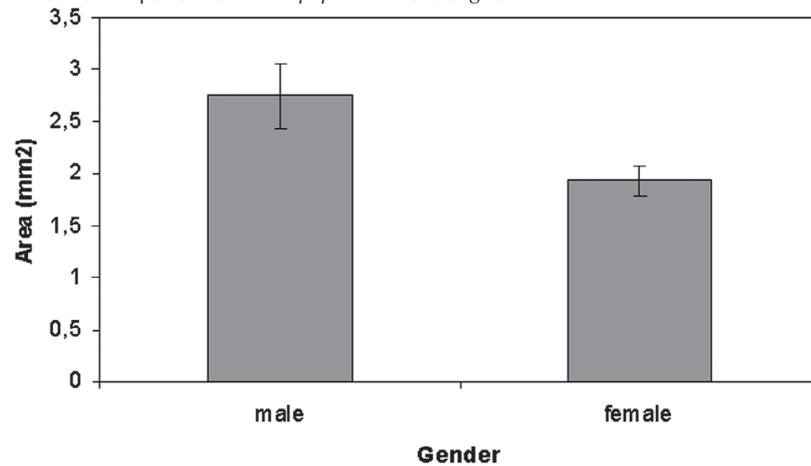


Figure 5 - Total area of cat's tongues *vallate papillae* in accordance with the gender

There was no significant difference ( $p > 0.05$ ) as for the type of symmetrical and asymmetrical distribution of the *vallate papillae*, as for the number of these *papillae* per tongue considering males and females, and also as for the number of these *papillae* in each side of the tongue; however, the average of the total area of these *papillae* per tongue showed a significant difference ( $p \leq 0.05$ ) when compared the gender of the animals.

## Discussion

Information in current literature regarding *vallate papillae* of the domestic cat is in agreement with the present study, however few references exist as to the characteristics of these *papillae* in the specie studied.

In all of the tongues examined, the *vallate papillae*, located on the basal third of the tongue dorsum, were surrounded by a groove that conformed to the *papillae*'s shape. The findings of the present study are also in accordance with the reports from Hudson and Hamilton<sup>17</sup>, Tichý<sup>20</sup>, Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup>.

When these *papillae* appear symmetrically on the cats' tongues they are arranged in two lines forming a rostrally open V on the lingual root, similar to those described in cats by Hudson and Hamilton<sup>17</sup>, Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup>. However, when the *papillae* appear asymmetrically, the V is not clear, the *papillae* are arranged in two convergent lines.

Considering the *vallate papillae* shapes, the descriptions of the present study are in agreement with the findings of Tichý<sup>20</sup>, Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> in cats. According to the first and second authors, these *papillae* were identified as being oval and spherical, round elliptical and elliptical. The last author identified them as being oval, elongated oval and circular in shape. In the present study these *papillae* were denominated as being elongated, oval and round. Besides those, the pear shape was also identified. Their size

varied according to their localization, where the largest *papillae* were found by Tichý<sup>20</sup> near the lateral margin of the lingual dorsum, but their size decreased towards the median groove.

Ojima et al.<sup>9</sup> described these *papillae* as being large or small in size. In the literature consulted on cats no data as to length, width and area of the *vallate papillae* were found. These measurements were made in the present study, demonstrating an average of  $0.84 \pm 0.23$  mm for length and  $0.55 \pm 0.18$  mm for width, showing total area per tongue of  $2.74 \pm 0.31$  mm<sup>2</sup> in males and  $1.94 \pm 0.14$  mm<sup>2</sup> in females.

The number of *vallate papillae* found in the animals studied coincides with those described in cats by Crouch<sup>18</sup>, Kobayashi et al.<sup>19</sup> and Hudson and Hamilton<sup>17</sup>. They described the occurrence of four to six *papillae* on each tongue, but is possible to observe four to eight *papillae* Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> on each tongue. However, one case with nine *papillae* was also observed in the present study.

As to the distribution of the cats' *vallate papillae*, it was reported total of two (7.0%<sup>7</sup>, 13.0%<sup>8</sup> and 24.0%<sup>9</sup>), three (82.0%<sup>7</sup>, 71.0%<sup>8</sup> and 62.0%<sup>9</sup>) and four (11.0%<sup>7</sup>, 16.0%<sup>8</sup> and 14.0%<sup>9</sup>) on the right side of the tongue and two (14.0%<sup>7</sup>, 21.0%<sup>8</sup> and 28.0%<sup>9</sup>), three (79.0%<sup>7</sup>, 66.0%<sup>8</sup> and 62.0%<sup>9</sup>) and four (7.0%<sup>7</sup>, 13.0%<sup>8</sup> and 10.0%<sup>9</sup>) on the left side of the tongue.

In the present study, cases with two *papillae* on the right side were 24.0%, 18.0% and 7.0% more frequent than those described by Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> respectively. The cases with three *papillae* were 42.0%, 24.0% and 15.0% less frequent than Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> respectively, and cases with four *papillae* were 9.0%, 4.0% and 6.0% more, respectively, on the right side, from those reported by the researchers cited. Cases of five *papillae* (1.8%) on the right and the left side were also observed.

The *vallate papillae* were described by Ojima<sup>7</sup> as being found in three typical distributions (2:2, 3:3 and 4:4) and two

atypical distributions (3:2, 4:2). Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> described one additional type of atypical distribution (2:3).

Ojima<sup>7</sup> found the following frequencies of the typical cases: 2:2 (8.0%), 3:3 (76.0%), 4:4 (8.0%) and for the atypical cases: 3:2 (4.0%) and 4:2 (4.0%). However, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup> found, respectively, 2:2 (11.0% and 11.0%), 3:3 (62.0% and 50.0%), 4:4 (13.0% and 10.0%), 3:2 (8.0% and 11.0%), 4:2 (3.0% and 7.0%) and 2:3 (3.0% and 11.0%).

The tongues studied showed four

other types of pattern besides the five and six patterns described by Ojima<sup>7</sup>, Ojima, Takeda and Matsumoto<sup>8</sup> and Ojima et al.<sup>9</sup>. They were classified as asymmetrical (3:4, 4:3, 5:3 and 4:5) appearing respectively in 7.27%, 7.27%, 1.82% and 1.82% of the animals.

## Conclusion

The data provided in the present study demonstrate the numerical variation and general arrangement of the *vallate papillae*, demonstrating particular aspects of their distribution in domestic cats.

## Estudo anatômico e distribuição das papilas valadas no gato doméstico

### Resumo

A morfologia descritiva e topográfica, bem como, a distribuição, o número e o tamanho das papilas valadas foram estudados na língua de 55 gatos adultos, sem raça definida, 38 fêmeas e 17 machos, após fixação do material em solução aquosa de formaldeído a 10%. As papilas valadas se distribuíram simetricamente em 21 línguas (38,18%). Estas papilas apresentaram-se sob diferentes formas: afiladas (42,58%), ovaladas (31,61%), arredondadas (25,48%) e com formato de pêra (0,33%). A distribuição das papilas valadas foi classificada em 10 diferentes tipos de acordo com o número de papilas por antímero: I (2 papilas no antímero direito e 2 no antímero esquerdo), II (3:3), III (4:4), IV (3:2), V (4:2), VI (2:3), VII (4:3), VIII (5:3), IX (3:4) e X (4:5). A distribuição assimétrica (2:4) e simétricas (1:1) e (5:5) não foram notadas. Medidas de comprimento e largura foram realizadas, observando-se média de  $0,84 \pm 0,23$  mm para o comprimento e  $0,55 \pm 0,18$  mm para a largura, além do cálculo da área total destas papilas por língua, que exibiram média de  $2,74 \pm 0,31$  mm<sup>2</sup> em machos e de  $1,94 \pm 0,14$  mm<sup>2</sup> em fêmeas. Não houve diferença significativa ( $p > 0,05$ ) quanto ao tipo de distribuição simétrica e assimétrica, quanto ao número de papilas valadas por língua e quanto ao número destas papilas por antímero. Entretanto, a média da área total destas papilas exibiu diferença estatisticamente significativa ( $p \leq 0,05$ ) quando comparados os sexos dos animais.

### Palavras-chave:

Língua.  
Papilas valadas.  
Papilas gustatórias.

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