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Contributors

Tuckerman, Frederick, 1857-
Royal College of Surgeons of England

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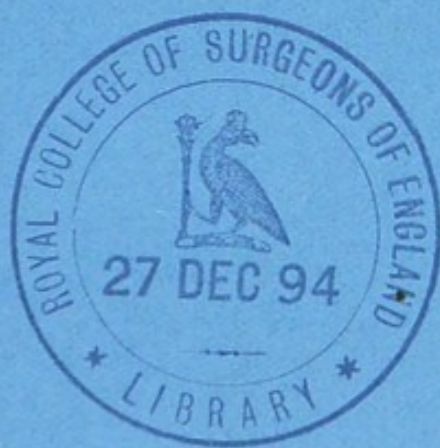


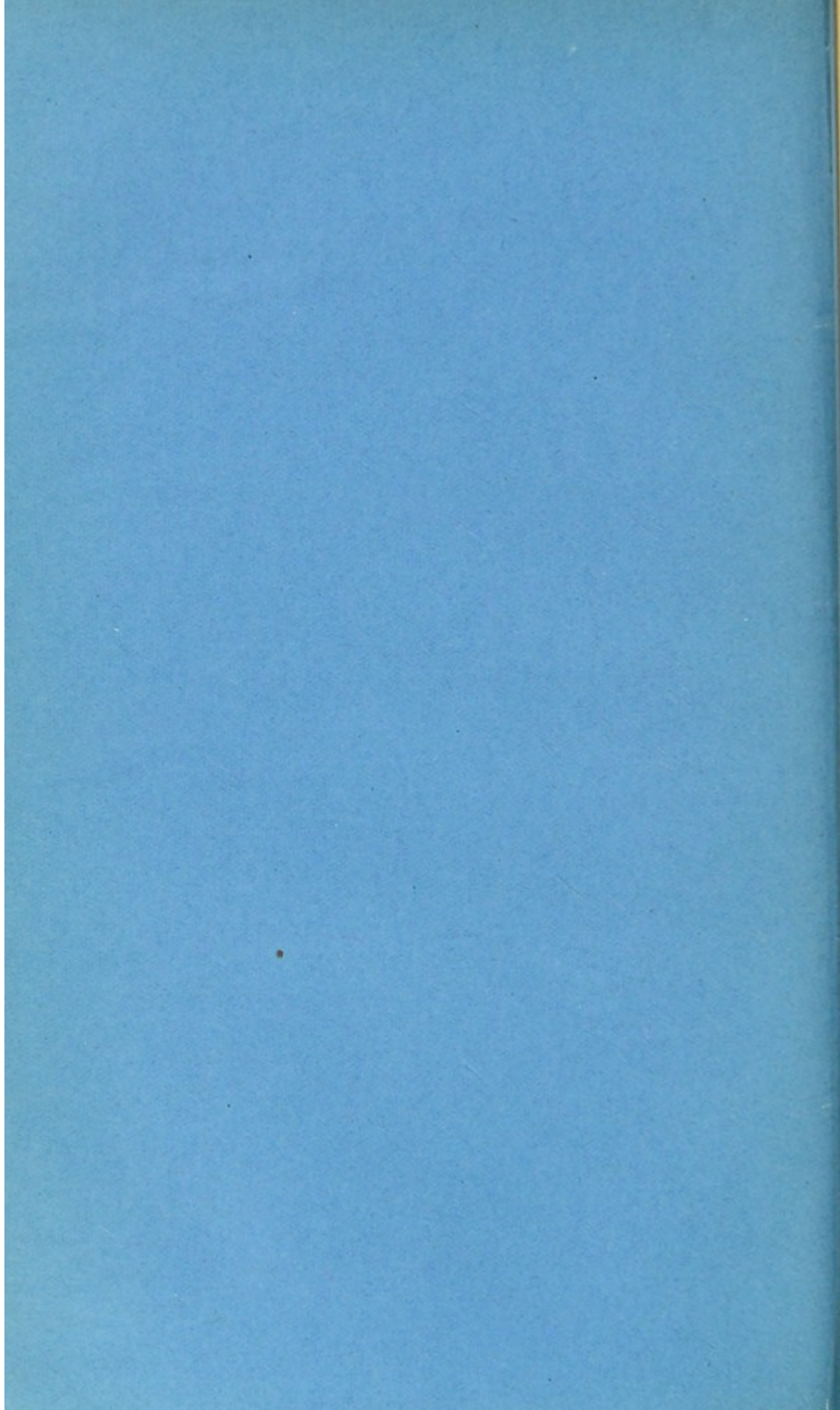
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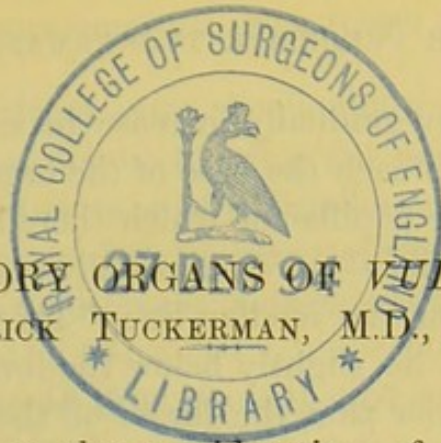
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THE GUSTATORY ORGANS OF *VULPES VULGARIS*.

By FREDERICK TUCKERMAN, M.D., *Amherst, Massachusetts.*

BEFORE passing to the consideration of the taste-organs of *Vulpes*, I will describe briefly the form and external appearance of the tongue of this mammal.

The tongue is long, comparatively narrow, flat, and a little expanded anteriorly, and terminates in an obtuse apex. It measures 120 mm. in length, 20 mm. in breadth, and 15 mm. at its thickest part. It is free from the floor of the mouth for 45 mm.

The upper surface resembles fine shagreen, and the small fungiform papillæ which are scattered over the greater part of the dorsum give it the appearance of being studded with minute white beads. It is impressed for nearly its entire length by a very shallow longitudinal median groove, which disappears near the base and tip. About the root and extreme posterior borders are thick, coarse, fleshy, recurved, cone-shaped papillæ. The rest of the dorsal surface is covered with small, closely-set, cone- or club-shaped mechanical papillæ, having their apices directed backwards. When stroked in the opposite direction, these papillæ convey the feeling of a fine-toothed rasp. Each papilla is seated upon one or two papillary upgrowths of the mucosa, and has from one to three minute spines projecting from its upper surface. The papillæ are largest and most thickly placed at the posterior part of the dorsum, and decrease in size towards the tip, where they also lose their spinules to a great extent. At the back of the tongue they measure about 0.80 mm. in height and 0.40 mm. in breadth. The epithelium sheathing the papillæ is partially, and that composing the spinules entirely, cornified.

The fungiform papillæ are abundant, and are distributed quite uniformly over the upper surface and sides from the tip to the gustatory area. They are smallest and closest set at the fore part of the dorsum, the anterior edge being thickly beset

with them, and they gradually increase in size as they recede from the tip and approach the base of the organ.

The circumvallate papillæ, of which there are two pairs,—an anterior and a posterior,—are situate well back on the dorsum, a few millimetres from the median line. They are small, somewhat concealed, and lie slightly below the level of the adjacent surface. The posterior pair, the larger of the two, are 21 mm. from the base of the tongue, and 7 mm. from each other. The anterior pair are 1 mm. distant from the posterior, and are 9 mm. apart. At each side of the base of the tongue, immediately in front of the glosso-palatine arch, is a papilla foliata.

The mucous membrane of the under surface of the tongue is here and there thrown into small transverse folds, having a sub-parallel arrangement, and which are more noticeable near the lateral margins.

Gustatory Areas.

The Circumvallate Papillæ.—The adjoining surface surrounding this taste-area is covered with papillæ of both tactile and mechanical function. The latter are mainly cone-shaped, and terminate in a recurved pointed extremity.

A noteworthy and interesting feature of these papillæ is presented in the appearance of their upper part. In vertical sections this is seen to be cleft. The depth of the fissure varies greatly in different parts of the same papilla, and sometimes extends from the summit half-way to the base, leaving a wedge-shaped space partially filled with epithelium. Comparison of vertical and horizontal sections of the circumvallate papillæ show them to be distinctly lobate in their upper portion, there usually being one large lobe and one or two smaller ones to a single papilla. The posterior pair are more distinctly cleft, and more inclined to lobation than the anterior. They measure 1.5 mm. in their transverse diameter, and are about 0.80 mm. in height. Each papilla is encircled by a deep and narrow trench of uniform width. Serous glands are not abundant, and are only very sparingly present within the papillary body itself. Their ducts open into the trench at its base and sides. At the base of the papilla, the nerves, which at first are chiefly medullated, but finally lose their medullary sheath, form a plexus.

From this plexus fibres enter the papilla and ramify throughout it. In the submucosa underlying the gustatory region fat is very abundant, either massed in smaller or larger groups of fat cells, or in the form of lobules between the bundles of muscular fibres, or, in some instances, separating the individual fibres themselves.

The taste-bulbs of this area are quite plentiful. They are disposed at the sides in a zone of sixteen tiers, the uppermost tier occasionally being well up towards the top of the papilla. Rarely, isolated bulbs are present in the epithelium of the free upper surface. Taste-bulbs are also present in the lower part of the outer wall of the trench. Here they are arranged in a girdle of ten tiers. When viewed in horizontal section the bulbs of this area are very beautiful. They are generally in contact by their edges, and thus form a nearly unbroken belt around the free border of the papilla. From horizontal sections, made at different levels, I estimated the number of bulbs in a tier at 120. Those of the outer wall, though normally present, are more irregular in their distribution and arrangement, and the number visible in a horizontal section is much less than in the papilla proper. The total number of bulbs divided between the four papillæ comprising this gustatory area cannot, I think, be less than 9500.

The bulbs, like the papillæ which lodge them, are smaller than would be expected in an animal of this size.¹ They measure 0.042 mm. in length and 0.020 mm. in breadth. The gustatory pores vary in shape as well as in size. One that I measured was 0.0025 mm. in diameter.

The Foliate Papillæ.—The papillæ foliatæ of *V. vulgaris* are so inconspicuous that they might easily be overlooked. They lie deeply embedded in the tongue, their ridges scarcely reaching the surface, while externally a fringe of papillæ serves quite effectually to conceal their presence.

Each papilla consists of eight to fourteen quite regular folds, having the same general appearance but varying somewhat in size. The furrows separating the folds are narrow, with a nearly

¹ The Table on p. 205, appended to this paper, contains some comparative data respecting the taste-organs of a number of mammals, several of which are widely separated generically.

uniform breadth throughout, and have an average depth of about 1 mm. The folds do not culminate in a rounded or flattened crest, as is usual, but are prolonged into, or surmounted by, rather coarse, sharp, retroverted spines. These spines are from 0.25 to 0.50 mm. in height, their basal diameter being generally a little less than their height. The epithelium covering them is imbricated in arrangement, and in the superior part of the spine is either partly or wholly cornified.

From their structure it is evident, I think, that the function of these spines is a purely mechanical one; and it is probable that they serve to arrest particles of gustable matter that come in their way long enough for them to fall into the furrows, where they are bathed in the secretion of the serous glands, and come in direct contact with the free ends of the taste-cells.

The folds are, for the most part, simple in construction. Serous glands and ducts are fairly abundant about their base, and the latter usually open at the bottom of a furrow. Sections through some regions of these papillæ reveal now and then a furrow which is completely closed at its upper part by stratified pavement epithelium. In the crypt-like space thus formed bulbs are numerous lining the sides, and serous ducts discharge at the bottom of the crypt. The inferior part of the foliate papilla, or that portion nearest the under lingual surface, is the most irregular in its development. The folds lack symmetry of form, the spines are wanting, and the furrows are of varying width and shallow.

The taste-bulbs of this area are in general confined to the lower half of the folds, although detached bulbs not infrequently occur on the free upper surface. They are very numerous, there being sometimes twenty or more tiers of them. I was unable to obtain good horizontal sections of this papilla, and am thus unable to state the approximate number of bulbs distributed to this area. The bulbs do not differ save in size (being a trifle smaller) from those of the circumvallate papilla.

The Fungiform Papillæ.—These papillæ are numerous, and are distributed quite regularly over the dorsum and sides of the tongue. Some of them rest in a shallow depression of the mucous membrane, and resemble, in some degree, papillæ of the circumvallate type. Taste-bulbs are present in the epithelium of the

upper part of these papillæ. In a horizontal section I counted nine bulbs which had been divided transversely to their long axis. They measure 0·038 to 0·045 mm. in length and 0·021 to 0·024 in breadth. Most of the bulbs examined communicate freely with the surface either directly or by means of a tube or neck leading to an opening in the outer layer of epithelium. Many of the bulbs appear not to touch the mucosa at any point, but to be entirely epithelial in position.

TABLE.¹

	Number of Circumvallate Papillæ.	Number of Bulbs in Circumvallate Papillæ.	Mean Dimensions of Bulbs.		Papilla Foliata.	Number of Bulbs in Papilla Foliata.	Mean Dimensions of Bulbs.	
			Length.	Greatest Transverse Diameter.			Length.	Greatest Transverse Diameter.
			mm.	mm.			mm.	mm.
Bandicoot (<i>P. nasuta</i>).	3	2,160	0·070	0·043	Wanting	...	...	...
Bat (<i>V. subulatus</i>).	2	800	0·026	0·014	Do.	...	...	...
Musk-Rat (<i>F. zibethicus</i>).	1	520	0·050	0·027	Present	800	0·046	0·027
Rabbit, . . .	2	2,400	0·050	0·033	Do.	14,500	0·055	0·036
Horse, . . .	2	...	0·080	0·070	Do.	...	...	...
Pig, . . .	2	10,760	0·092	0·036	Do.	4,800	0·066	0·033
Sheep, . . .	24	9,600	0·085	0·045	Wanting	...	...	...
Calf, . . .	24	35,200	0·100	0·040	Do.	...	...	...
Goat, . . .	12	15,400	0·062	0·030	Do.	...	...	...
Cat, . . .	6	600	0·070	0·032	Do.	...	...	...
Dog, . . .	4-6	...	0·071	0·040	Present	...	...	...
Fox (<i>V. vulgaris</i>).	4	9,500	0·042	0·020	Do.	...	0·045	0·021
Skunk (<i>M. mephitica</i>).	2	4,000	0·045	0·028	Wanting	...	...	...
Mink (<i>P. vison</i>).	4-5	2,000	0·039	0·024	Rudimentary	...	...	...
Man, . . .	9	6,000	0·079	0·040	Present	3,000	0·070	0·038

¹ The Ornithorhynchus, although omitted from the Table for want of sufficient data, should be mentioned on account of its highly ancestral character. At the posterior region of the tongue of this mammal are two pairs of taste-areas. The anterior pair lie below the surface in a furrow, the floor of which is invaginated upwards into a ridge, which bears the taste-bulbs. The ridges of the posterior pair reach the surface. On one of the ridges Poulton estimated the number of bulbs, to the square millimetre of surface, at about 500.

