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Note on rhinoceros salivary glands

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(With 5 figures in the text)

Limited observations are submitted upon the anatomy of the hitherto undescribed salivary gland formations in the rhinoceros genera *Rhinoceros, Diceros* and *Ceratotherium*.

Contents

Introduction

Information is largely wanting concerning the major and minor salivary organs of the Rhinocerotidae. To date these structures have not been described for the African White rhinoceros, *Ceratotherium simum*, or the African Black rhinoceros, *Diceros bicornis*, and were left unmentioned for the Indian rhinoceros, *Rhinoceros unicornis*, by Parsons (1743), Thomas (1801) and Owen (1862) and for the Javan rhinoceros, *Rhinoceros sondaicus*, by both Garrod (1877) and Beddard & Treves (1887). For the Sumatran rhinoceros, *Didermocerus sumatrensis*, they were unnoticed by Beddard & Treves (1889) but received some attention from Garrod (1873), whose account remains the only description of these organs in the splanchnological literature.

It has been deemed desirable, therefore, to place on record certain limited, interim observations on this aspect of rhinoceros morphology pending its more exhaustive study. This study will, perforce, be restricted to those rhinoceros forms now well-established in the principal world zoos, since specimens of the Javan and Sumatran rhinoceroses are unlikely ever again to become available therein for anatomization.

Material and methods

The parotid gland of a young (three years old) female African Black rhinoceros was examined during the course of routine necropsy. The submaxillary, sublingual and minor salivary glands of this animal,

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together with those of an adult (11 years old) female African White rhinoceros and those of an adult (18 years old) male Indian rhinoceros were examined macro- and microscopically in the excised, formalin-hardened viscera of these animals. Where preservation permitted the making of histological preparations of the various salivary formations the sections thereof were stained with the haematoxylin-and-eosin, Mallory trichrome, Alcein blue and van Gieson stains. The material examined derived from animals in the menagerie of the Zoological Society of London.

Observations

Parotid gland

The parotid gland of the young *Diceros* specimen is a relatively small, compact, irregularly cuneiform body situated chiefly in a retromandibular "bed" but extending thence on to the retro-masseteric area of the mandibular ascending ramus (Fig. 1). Its parenchyma is finely lobulated and of brownish tint, contrasting with the pale colour of the submaxillary gland. Superficially the organ is covered by skin and a strong parotid fascia: deeply it is separated from the submaxillary gland by a band of dense fibrous tissue and is moulded upon the various elements of the parotid "bed". It presents superior, deep (medial) and superficial (lateral) surfaces and tapers inferiorly to a blunt pole or apex. The superior surface embraces the lower moiety of the cartilaginous auditory meatus, whereby it is deeply indented: the irregular deep surface lies in contact with, and is impressed by, the collum mandibulae, the temporo-mandibular joint capsule, the post-glenoid and post-tympanic processes and by the muscular and other structures constituting the retromandibular "bed": the ovoid convex superficial surface is subcutaneous and its anterior border fails to reach the

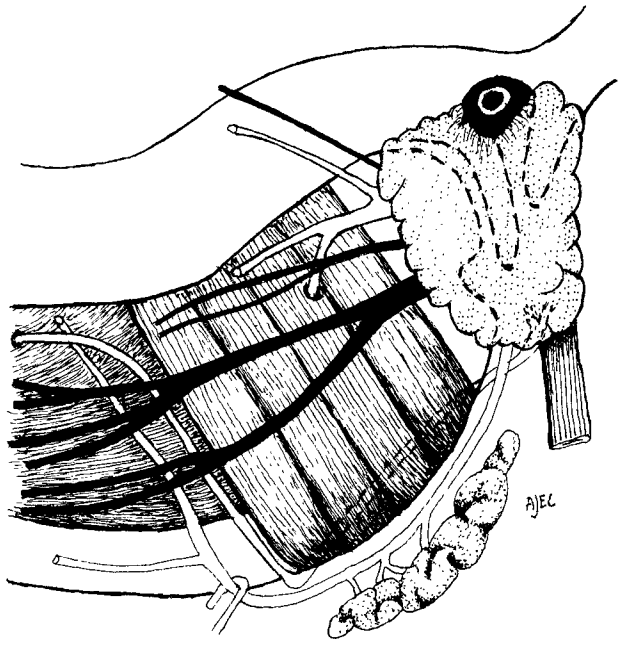

FIG. 1. *Diceros bicornis*, juv. ♀. Left parotid gland in norma lateralis. Explanation in text.

masseter muscle. Deep to the gland lie the ectocarotid artery, the origin of the jugular vein and the facial nerve whose branches run underneath, rather than through, the gland substance. From the convex anterior border of the gland emerge: (a) the common stem of the pre-auricular and transverse facial arteries, (b) the relatively slender temporal and infra-orbital branches of the facial nerve and (c) the notably large buccal branch of this nerve which soon subdivides into superior and inferior moieties.

The whitish, thin-walled parotid duct (Steno's duct) has a lumen diameter of 4–5 mm throughout its facial course. It is formed on the deep aspect of the gland's inferior portion by the union of two very short emergent channels; thence it pursues a distinctive, angulated course anteriorly. It runs at first antero-inferiorly underneath the angulus mandibulae and the external maxillary artery to gain the mandibular lower border immediately in front of the masseter muscle; it there turns sharply upwards underneath the facial artery and vein and ascends the face almost vertically between these vessels and the masseter muscle; short of the zygomatic arch it makes a rectangular forward bend underneath the facial artery and terminates by piercing the buccinator muscle alongside the third maxillary molar tooth. Its ostium in the vestibulum oris lies on the summit of a low papilla which is rendered inconspicuous by a forest of prominent elevations besetting the buccal mucosa.

The *Didermocerus* parotid gland, according to Garrod (1873), manifests a conformation comparable to that described here for *Diceros* and the parotid duct (350 mm long) is of similar origin and disposition.

Submaxillary gland

The submaxillary gland of the *Rhinoceros* specimen is an irregularly trihedral, coarsely-lobulated body, 80 mm long by 50 mm broad, of pale buff colour and potato-like consistency. Somewhat flattened laterally it lies mainly posterior to the angulus mandibulae in contact medially with the musculature of the pharyngeal wall and the thyroid cartilage. Its deep surface is embedded in a dense fascial bed and is grooved by the facial artery. The blood supply of the gland comes, however, not from this artery but from the ectocarotid by a specific a. submaxillaris. The organ is thickly encapsulated by collagenous tissue and lies in intimate contact with the smallish submaxillary lymph nodes and with various oropharyngeal and lingual blood vessels.

The submaxillary (Wharton's) duct is some 340 mm long. Formed by the intraglandular confluence of numerous interlobular ducts it emerges from the deep aspect of the gland's anterior extremity. Thence it passes forwards, amid small bloodvessels and lymph nodes, to gain the posterior border of the hyoglossus muscle. It crosses the superficial surface of this muscle postero-anteriorly lying above the hypoglossal nerve but below the lingual nerve. It passes thence on to the genio-glossus muscle, having above it the most distal fasciculi of the stylo-glossus muscle and the genio-hyoid muscle below. It here lies below the mucosa of the mouth floor, which it raises into a plica sublingualis: laterally the sublingual gland lies in direct contact with the duct and separates it from the terminal branches of the lingual nerve. The duct terminates in a small conical papilla (caruncula sublingualis) at the anterior extremity of the plica sublingualis. Despite its contiguity with the sublingual gland the submaxillary duct receives no tributaries from that gland.

Though of mixed histological composition the gland is predominantly serous in nature, mucous acini being restricted to discrete islands scattered throughout an obtrusively serous parenchyma. The organ is notably compact, with interlobular septa appreciably thinner

than those of the sublingual gland. The number of ducts observable in the average microscopical field suggests a relatively great length of the gland acini. The intralobular ducts and the interlobular ducts of the interlobular septa are alike lined by a simple columnar epithelium.

The *Didermocerus* submaxillary gland, according to Garrod (1873), is an irregularly cuboidal mass situated underneath the angulus mandibulae: the 340 mm long submaxillary duct adheres to the deep aspect of the sublingual gland and opens upon a papilla alongside the frenum linguae: the histological nature of the gland is not recorded.

In the *Ceratotherium* specimen the submaxillary gland (Fig. 4) presents as a laterally-compressed, coarsely-lobulated, ovoid body, some 90 mm long by 60 mm broad, situated under cover of the angulus mandibulae against the muscles clothing the thyroid cartilage. Its buff-coloured parenchyma is thickly encapsulated by collagenous tissue and the organ reposes in a dense fascial bed, traversed by largish vessels passing to or from the tongue. Immediately anterior to the gland lies a compact cluster of submaxillary lymph nodes. The submaxillary duct emerges from the forepart of the gland and passes forwards, deep to these lymph nodes and a local tangle of veins, to gain the posterior border of the hyoglossus muscle. It courses anteriorly across the superficial surface of this muscle, accompanied by a lingual vein tributary, having the hypoglossal nerve above it and the lingual nerve still further above. Towards the anterior border of the hyoglossus muscle one at least of the terminal branches of the lingual nerve comes to lie lateral to the duct. Accompanied by a small artery the duct next passes forwards on to the genio-glossus muscle, having the genio-hyoid muscle inferior and the sublingual gland lateral to it. Here it lies immediately below the mucosa of the mouth floor, adherent to the deep surface of the sublingual gland. It terminates by a rounded ostium on the summit of a small, conical papilla sublingualis alongside the beginning of the pars libera linguae.

Histologically the gland is of mixed but predominantly mucous type. Of branching tubulo-acinar disposition its parenchyma shows a thin scattering of small serous demilunes throughout its substance. The finest radicles of its intrinsic duct system are lined by a cubical epithelium, the largest by a pseudostratified columnar epithelium.

The submaxillary gland of the *Diceros* specimen is a pale-coloured, compact, lobulated organ of elongated ovoid shape occupying the sub- and retromandibular regions. Its principal topographical relationships agree essentially with those of its counterpart in *Rhinoceros* and *Ceratotherium*. Its deep surface is separated from the parotid gland by a dense fascia and accommodates the facial artery which provides some relatively large branches to the gland substance. From this same surface anteriorly emerges the submaxillary duct, which passes forwards under the facial artery and the vein to cross the hyoglossus muscle above the hypoglossal nerve. Here the dividing lingual nerve becomes a lateral relation. The duct then comes to lie on the genio-glossus muscle, with the styloglossus muscle above, the genio-hyoid muscle below and the sublingual gland lateral to it. It passes across the medial surface of the sublingual gland to open upon the mouth floor by a small papilla at the anterior extremity of a feeble plica sublingualis. Histologically the gland is thickly encapsulated and is of mixed, but predominantly mucous, type.

Sublingual gland

The sublingual gland of the *Rhinoceros* specimen (Fig. 2) is a lobulated, fusiform, laterally-flattened organ, some 115 mm long, 20 mm broad and 16 mm in maximal thick-

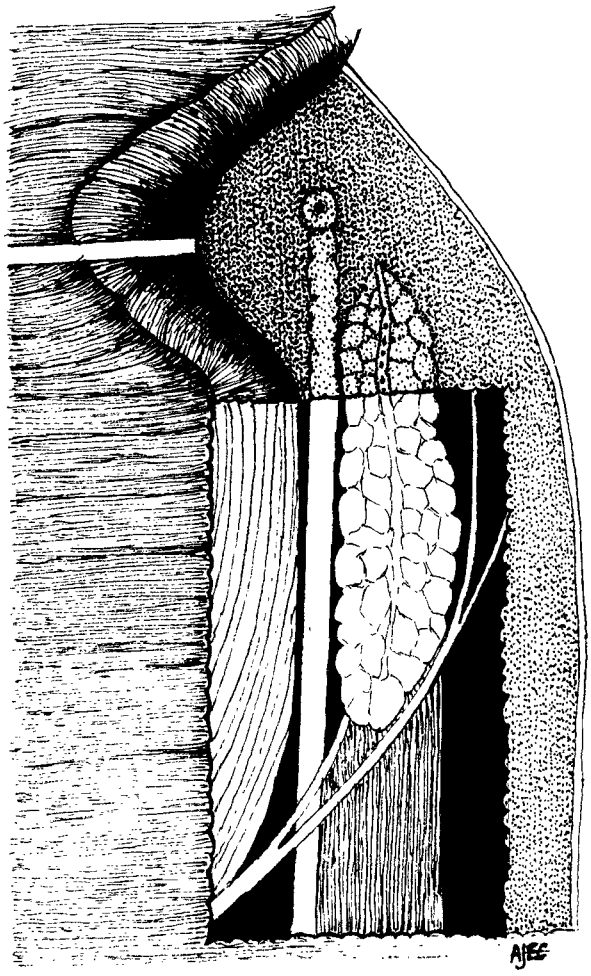

FIG. 2. *Rhinoceros unicornis*, ad. ♂. Sublingual gland in norma dorsalis. Tongue retracted medially and mucosa removed to show gland relationship to submaxillary duct medially, m. geniohyoid inferiorly and lingual nerve branches postero-laterally. Semi-diagrammatic.

ness. It is less compacted and of softer consistency than the submaxillary gland, and of darker (reddish brown) colour. Its posterior extremity is somewhat diffuse, consisting of a number of small and semi-discrete parenchymal nodules. The upper border of the gland mass lies below the mucosa of the mouth floor, its lower rests upon the genio-hyoid muscle: its medial surface is related to the genioglossus and styloglossus muscles and has the submaxillary duct adherent to it: infero-lateral to its substance lies at least one terminal branch of the lingual nerve, more laterally still the mylo-hyoid and mylo-glossus muscles. The gland's upper border raises a paralingual mucosal ridge upon which open its 25 or so ducts: these range from 10–20 mm in individual length and their macroscopic ostia tend to be somewhat crowded together. Histologically this gland proves to be of mixed but predominantly mucous type, each microscopical field showing a scanty distribution of serous demilunes throughout

a preponderance of mucous acini. The interlobular septa contain some fat, the intralobular septa none.

The *Didermocerus* sublingual gland, according to Garrod (1873), is of frankly diffuse composition and comprises "several small portions which open separately . . . about half an inch apart below the sides of the tongue, parallel with the ramus of the jaw". The histological nature of this organ remains unrecorded.

The sublingual gland of the *Ceratotherium* specimen (Figs 3, 4, 5) is an elongated almond-shaped structure of lobulated appearance and darkish tint. It is 110 mm long, 15 mm broad and 13 mm in maximal thickness and agrees in all topographical essentials with its *Rhinoceros* counterpart. Its deep (medial) surface is grooved by the submaxillary duct. Its

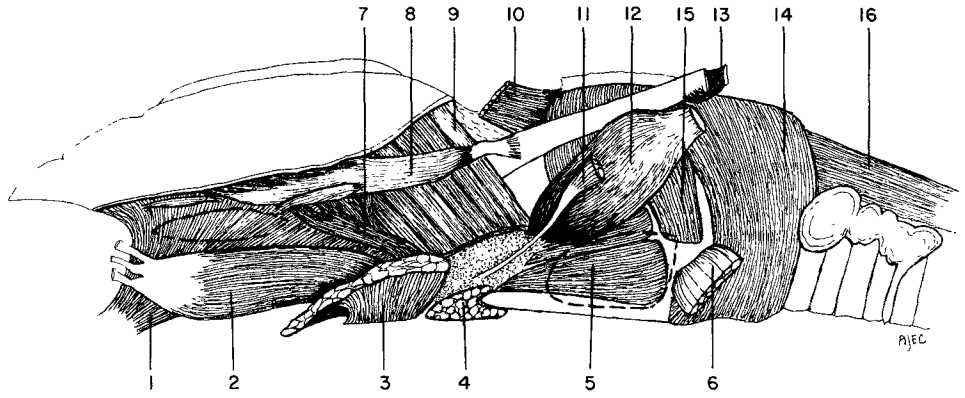

FIG. 3. *Ceratotherium simum*, ad. ♀. Dissection of lingual and pharyngeal musculature to show (broken line) the "beds" of the sublingual and submaxillary glands. 1, m. genioglossus; 2, m. geniohyoideus; 3, m. mylohyoideus; 4, m. sternohyoideus; 5, m. thryrohyoideus; 6, m. cricothyroideus; 7, m. myloglossus; 8, m. styloglossus; 9, m. hyoglossus; 10, m. palatopharyngeus; 11, m. stylohyoideus; 12, m. digastricus; 13, m. jugulohyoideus; 14, m. cricopharyngeus; 15, m. thryopharyngeus; 16, oesophagus.

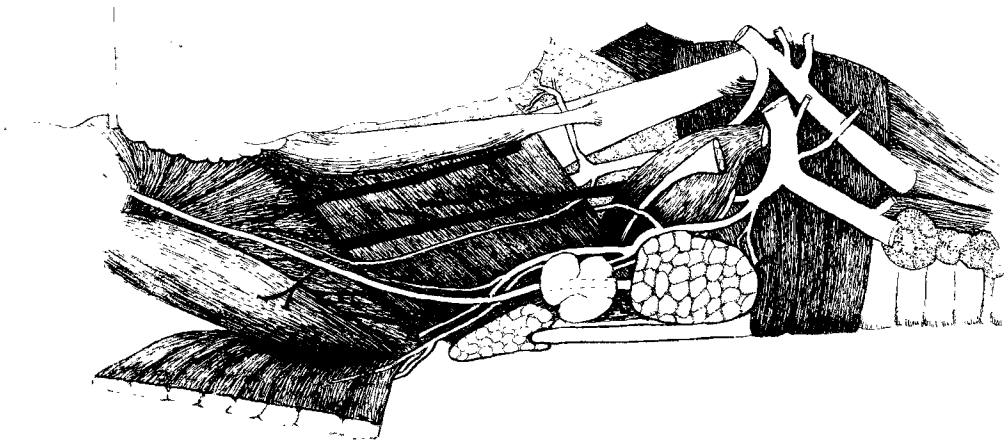

FIG. 4. *Ceratotherium simum*, ad. ♀. Dissection of left submaxillary gland and duct in norma lateralis. Lingual apical structures separated and sublingual gland retracted dorsally. Explanation in text.

FIG. 5. *Ceratotherium simum*, ad. ♀. Undersurface of tongue dissected to show topography of sublingual gland. Left gland retracted laterally showing relationship to m. styloglossus, submaxillary duct and branches of lingual nerve. Right gland shown in contact medially with m. genioglossus, m. geniohyoid being cut short but m. mylohyoid undisturbed.

own ducts, about 39 in number, range in individual length from 9–20 mm: they issue from the superior border of the gland and open upon the floor of the mouth cavity by a succession of macroscopic orifices disposed at regular intervals alongside the pars libera linguae. Histologically the gland is of mixed but predominantly mucous, type and of tubulo-acinar structure: any microscopical field reveals a few serous demilunes randomly disposed

throughout a mucous parenchyma. A thick collagenous capsule provides a series of delicate interlobular septa which, in places, are associated with a quantity of highly diffuse lymphoid tissue. The smaller (intrinsic) gland ducts are lined by a simple columnar epithelium, the principal (extrinsic) ducts by a pseudostratified columnar epithelium.

The sublingual gland of the *Diceros* specimen is too poorly preserved for satisfactory anatomical study but, topographically at least, it appears not to differ from the corresponding organ in the *Rhinoceros* and *Ceratotherium* specimens.

Minor salivary glands

The minor salivary (pseudosalivary) glands are small formations of serous, mucous or mixed histological type distributed in great abundance throughout the oral mucosa. Primarily they maintain a constant secretion of mucus and moisture within the mouth cavity but secondarily they augment the volume of saliva available for the trituration and initial digestion of food material. The largest of them are macroscopic, dissectable structures, with ostia recognizable by the naked eye. In the rhinoceros specimens presently examined they manifest a remarkable uniformity of pattern in structure, number and topographical distribution and are concentrated particularly in the palatal, buccal and lingual mucosae. These accessory salivary formations were accorded passing reference by Owen (1862) in *Rhinoceros unicornis* and received fuller notice by Garrod (1873) in *Didermocerus sumatrensis* but for *Rhinoceros sondaicus* they were unmentioned by both Garrod (1877) and Beddard & Treves (1887).

Palatal glands

In the *Rhinoceros, Ceratotherium* and *Diceros* specimens some three-fourths of the thickness of the velum palatini is represented by small glands of mixed salivary type, the largest of which form a compact submucosal layer on its undersurface. These glands are recognizable macroscopically as white-walled, ovoid sacs measuring (in the adult specimens) some 8–13 mm in length by 6–9 mm in maximal width: they are short-necked, flask-shaped structures whose ostia cover the whole undersurface of the velum within a mucosal "pile" of extremely fine filiform papillae. Histologically these palatal glands are salivary formations of mixed nature: they are, however, predominantly mucous in type, with serous cells discernible within their parenchyma. Each gland is closely invested with a fine venous plexus and the entire gland-layer is notably vascular. Gland relationship to the palato-faucial musculature suggests that the discharge of gland secretion is facilitated by the virtually continuous activity of the velum palatini.

In *Didermocerus* likewise, according to Garrod (1873), minor salivary glands of macroscopic proportions occur abundantly in the palatal mucosa and large mucous follicles are plentiful in the tonsillar (faucial) region.

Buccal glands

In the *Rhinoceros* and *Ceratotherium* specimens the buccal mucosa is rendered notably thick by its content of minor salivary glands, disposed in a compact, continuous subepithelial layer. These glands are of mixed histological type but are predominantly mucous and are relatively large, individual glands having a length of 5–6 mm. In the *Diceros*

specimen the entire buccal mucosa is carpeted by low, mammilliform elevations covering a layer of salivary glands of macroscopic size and mucous type. In *Didermocerus*, according to Garrod (1873), the buccal mucosa projects as a "prominent triangular pad" covered by "smooth thick epithelium" an arrangement almost certainly due to a localised aggregation of well-developed minor salivary glands.

Lingual glands

In the *Rhinoceros* and *Ceratotherium* specimens the pharyngeal aspect of the tongue displays a diffuse distribution of pinpoint orifices representing the ostia of very small, salivary-type glands of serous nature. Similar orifices are present, more sporadically, on the lateral aspect of the tongue and in the linguo-alveolar sulcus. In the *Diceros* specimen poor preservation precludes determination of the presence of comparable formations. The presence of lingual glands in *Didermocerus* is not referred to by Garrod (1873).

Commentary

The limited observations presently submitted suggest at least that the principal salivary glands of the Rhinocerotidae manifest a uniform pattern of topography, one not dissimilar from that obtaining in the horse. The examination of additional material is, however, desirable both to confirm or modify present observations and to determine to what extent the gross structure of the sublingual gland is influenced by individual or generic variation. It remains also to determine whether the *Rhinoceros* submaxillary gland is invariably of serous type, as in the single specimen presently studied.

The rhinoceros minor salivary formations are generally glands of mixed histological composition: the more abundant mucus-secreting glands appear to be concentrated in the palatal and buccal mucosa, the relatively fewer serous glands to be largely confined to the mucosa of the tongue and the mouth floor.

Gratitude is hereby tendered to the Council of the Zoological Society of London for the rhinoceros material reported on herein, to Mr V. J. A. Manton, Curator, Whipsnade Park, for its preservation and to Dr F. J. Aumonier for opinion upon histological preparations.

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