

دراسة تشريحية وهستولوجية للتجويف الأنفى فى الجمل

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الملخص

يشتمل البحث على دراسة التركيب التشريحي والهستولوجى للتجويف الأنفى فى الجمل ومدى ملاءمته بالظروف البيئية التى يعيش فيها هذا الحيوان .

١ - تتكون الغضاريف الأنفية فى الجمل من الجزء الأمامى من الحاجز الأنفى والغضروف العلوى الوحشى والغضروف الثانوى الوحشى والانسى .

٢ - يفتقر الجلد المبطن للجزء الأمامى من الدهليز الأنفى للغدد العرقية بينما توجد به غدد دهنية صغيرة الحجم .

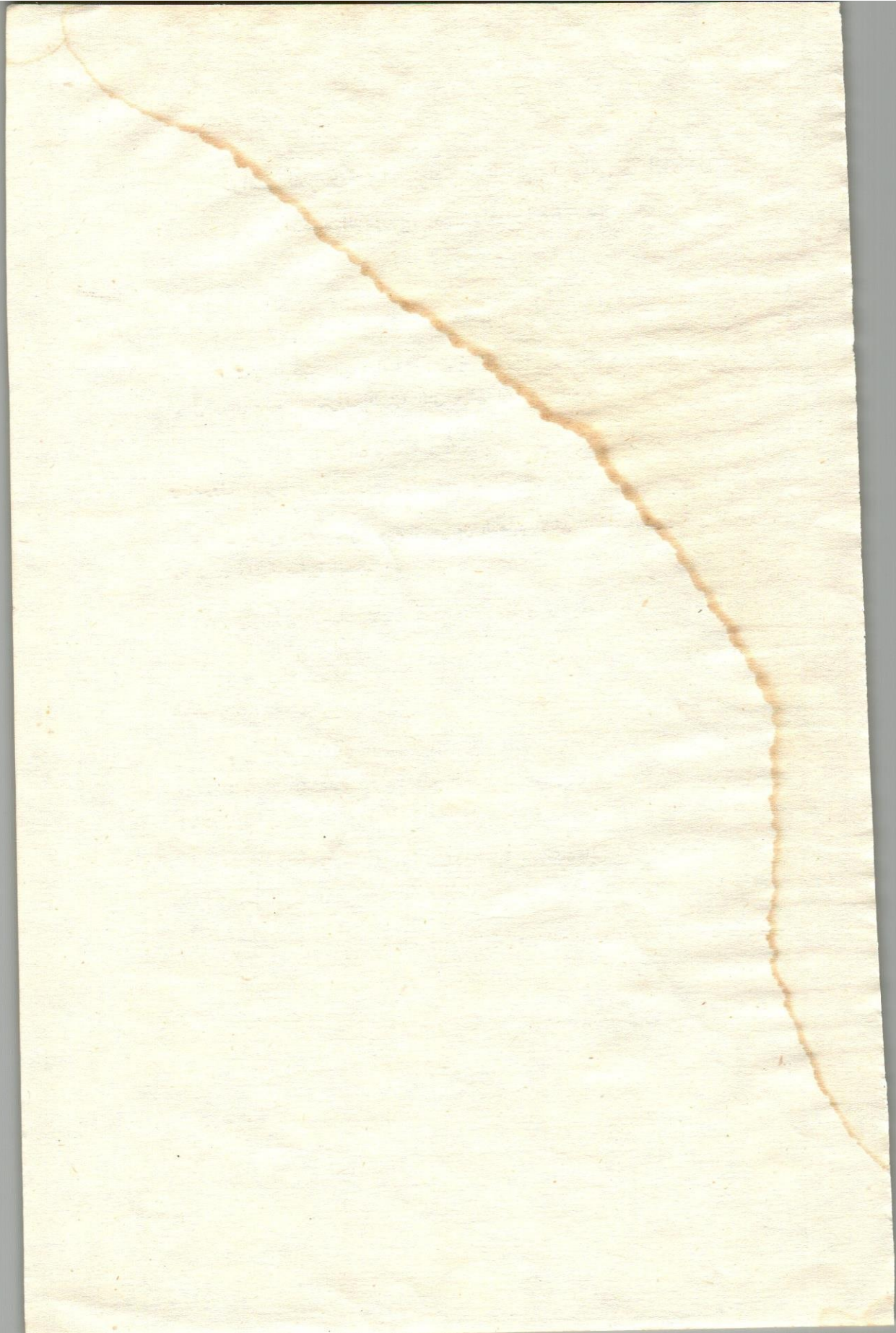
٣ - تتكون المحارات الأنفية من المحار العلوى والسفلى والأوسط والمصفاوى .

٤ - تزداد الخلايا الكأسية ازديادا مضطربا نحو الجزء الخلفى من التجويف الأنفى .

٥ - تتركز الخلايا العصبية الخاصة بالشم فى الجزء الخلفى للمحارات الأنفية المتصلة بالمظم المصفاوى وتوجد هذه الخلايا فى نسيج طلائى سميك كما وجدت هذه الخلايا أيضا فى هزيمات .

٦ - يختلف توزيع وطبيعة الغدد الأنفية من مكان الى آخر كما وجدت أنها تقل تدريجيا نحو الجزء الخلفى للتجويف الأنفى .

٧ - للجمل أربعة تجاويف جنب أنفية وهى الجيبى والدمعى والوتدى والوجنى .



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ANATOMICAL AND HISTOLOGICAL STUDIES ON THE NASAL CAVITY OF THE CAMEL

(Camelus dromedarius)

By

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(With 13 figures)

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SUMMARY

The macro- and micromorphological study of the nasal cavity of the camel revealed the following :

1. The cartilagenous support of the nostrils of the camel are represented only by the mobile part of the nasal septum, dorsal lateral nasal cartilage, medial and lateral accessory nasal cartilages.
2. The skin lining the oral part of the nasal vestibule lacks sweat glands, while the sebaceous glands are distinctly small in size.
3. The nasal conchae are represented by the dorsal, ventral, middle and ethmoidal conchae.
4. The goblet cells increase gradually in number towards the interior of the nasal cavity as well as in the lining mucosa of the nasal conchae.
5. The olfactory region is restricted only to the caudal portion of the ethmoidal conchae. The lining mucosa presents cryptlike depressions which contain numerous olfactory cells. The olfactory glands of Bowman are of the pure mucous variety. They present melanin pigments especially at their basal portion.
6. The nasal glands which are of the sero-mucous type form a rather discoidal glandular mass at the mobile part of the nasal septum and small lobules distributed on the ventral, lateral and dorsal walls of the nasal vestibule.
7. The paranasal sinuses of the camel are the frontal, lacrimal sphenoidal and maxillary sinuses each opens independantly into the nasal cavity except the lacrimal and maxillary sinuses which open together by the naso-maxillary opening into the sinus meatus.

INTRODUCTION

The description of the nasal cavity of the camel given by GEORGE (1951) and TAYEB (1964) was found to be incomplete. The first author did not give a detailed description of the nasal cartilages and conchae. The paranasal sinuses were missed completely in his work.

Although TAYEB (1964) tried to adopt new nomenclature in his study, the description of the cartilagenous support of the nostrils, septum nasi, turbinates and paranasal sinuses was found to be unsatisfactory.

The data given by VALLON (1886), LESBRE (1903) and DROANDI (1936) on the nasal cavity of the camel was found to be superficial and incomplete.

The paranasal sinuses of the camel were also studied by MOUSTAFA and KAMEL (1964).

The histological structure of the respiratory system of domestic animals was studied by TRAUTMANN and FIEBIGER (1960) EL-HAGRI (1967). The nasal glands were described by STENO, (1662); JACOBSON (1813); BROMAN (1921); BOJSEN-MLLER (1964); NICKEL, SCHUMMER and SEIFERLE (1960); and EL-HAGRI (1967).

MATERIAL AND METHODS

The present study was conducted on the nasal cavity and the paranasal sinuses of ten single-humped camels (low-land dromedary) of different ages. The specimens were collected from the slaughter houses at Assiut province. They were preserved into 10% formalin solution. Sagittal as well as transverse sections of the heads were performed to study the arrangements of the different structures found into the nasal cavity and their topographical relations. The paranasal sinuses were described on five other skulls of camels of different ages.

For histological study the specimens were collected from the different regions of the nasal cavity and paranasal sinuses, and were fixed in 10% neutral formalin. Decalcification of the nasal canchae was carried out

after the method recommended by EBNER (1875). Paraffin sections were made 7-10 microns in thickness. The following stains were adopted :

- a) HARRIS's Haematoxylin and eosin stain for general histological examination.
- b) CROSSMAN's modification for the demonstration of the collagenous fibres and muscle cells.
- c) HEIDENHAIN'S AZAN modification for the demonstration of the collagenous fibres and muscle cells.
- d) Alcian blue and PAS routine for demonstration of mucopolysaccharides.
- e) Nile blue stain for melanins and lipofuchsin.

RESULTS

The nostrils (Nares) of the camel are curved, slit like openings which are situated at a caudal level than the mouth opening. The longitudinal axis of each nostril is directed orally and medially so that the ventral commissures of both nostrils meet at the median labial fissure. The lateral nasal wing (Ala nasalis lateralis) is thicker than the medial one (Ala nasalis medialis) and presents numerous coarse setae on its flat triangular inner surface. Both wings meet at a dorsal and a ventral commissure (Angulus nasalis dorsalis et ventralis). The latter is more acute than the dorsal one.

The cartilagenous support of the nostrils of the camel is composed of : The mobile part of the nasal septum (Pars mobilis septi nasi), dorsal lateral nasal cartilages (Cartilagine nasales laterales dorsales) and medial and lateral accessory nasal cartilages (Cartilagine nasales accessorii mediales et laterales). The mobile part of the nasal septum (Pars mobilis septi nasi) is long due to the relative shortness of the nasal bone. Its slightly convex dorsal border widens laterally forming the dorsal parietal nasal cartilages. The oral border of the mobile part of the nasal septum is deeply concave and does not extend to the apex of the nose. Here, the separation between the two nostrils is completed by a muco-muscular partition.

The dorsal lateral nasal cartilages (Cartilagine nasales laterales dorsales) are relatively narrow. Each is represented by a flattened cartilagenous plate of uniform breadth of 9-11 cm long and 0.5-1.2 cm width.

The dorsal lateral nasal cartilage (cartilago nasalis lateralis dorsalis carries orally a naric part (Pars narica) which supports the internal portion of the medial wing. It is represented by a double curved, flattened elongated cartilage which terminates aborally by enlarged oval cartilagenous plate. It extends caudally 1-1.2 cm behind and below the lateral commissure of the nostrils (Fig. 1). The medial accessory nasal cartilage (Cartilago nasalis accessoria medialis) is a small curved rod which is embedded within the alar fold of the ventral turbinate. The lateral accessory nasal cartilage (Cartilago nasalis accessoria lateralis) supports the lateral wing of the nostrils, and is represented by a triangular flattened cartilage with its base directed caudally. It has no connection with any of the nasal cartilages (Fig. 1).

The nostrils of the camel are covered by relatively thin, hairy skin which is continued on the oral portion of the nasal vestibule. It changes suddenly at the vestibular fossa to cutaneous mucous membrane which lines the whole aboral portion of the vestibular region of the nasal cavity. The sebaceous glands are distinctly small in size, and each is represented by two small lobules lying on each side of the neck of the hair follicle (Fig. 2). Sweat glands could not be demonstrated either in the outer covering skin or in the inner lining coat of the nose. Errector pili muscles are found associated with hair follicles in the skin lining the oral part of the nasal vestibule. Some hair follicles may even be associated with two arrector pili muscles (Fig. 3). The nasal glands, at the vestibular region of the nasal cavity increase peculiarly in amount forming a prominent discoidal mass within the mobile part of the nasal septum (Pars mobilis septi nasi). They are composed of collection of rounded or oval macroscopic lobules held together by fibrous connective tissue. Additional scattered lobules can be followed in the dorsal, ventral and lateral walls of the nasal vestibule. The glands are found also for a little extent into the oral portion of the dorsal and ventral nasal conchae. Histological studies reveal that these glands consist of major lobules Supported by dense fibro-elastic connective tissue. These lobules are arranged into two rows parallel to the lamina epithelialis of the corresponding side. Each major lobule is subdivided into 2-7 minor lobules held together by loosely interwoven connective tissue fibres. The minor lobule consists of 1-2 intercalated ducts surrounded by coiled tubular end-pieces. These glands are of the sero-mucous compound tubular variety (Fig. 4). The secretory units are embedded within highly cellular and vascular stroma.

The nasal cavity (Cavum nasi) of the camel is narrow orally and wide behind. The two nasal cavities are completely separated from each other by the nasal septum (Septum nasi).

The nasal septum (Septum nasi) is relatively short, of 11-18.5 cm long. The ventral part of the cartilage of the nasal septum (Septum nasi) is about 13 mm, the middle part about 4mm and the dorsal part about 6 mm in thickness.

The dorsal and middle nasal meatuses (Meatus nasi dorsalis et medius) are narrow. The latter divides at the junction of the middle and aboral third of the nasal cavity into dorsal and ventral branches: The dorsal branch is bounded dorsally by the aboral part of the dorsal nasal concha (Concha nasalis dorsalis) and ventrally by the middle nasal Concha (Concha nasalis media). The ventral branch, however is found between the middle nasal concha (Concha nasalis media) and the narrow aboral part of the ventral nasal concha (Concha nasalis ventralis) (Fig. 5). The ventral meatus (Meatus nasi ventralis) is relatively capacious.

The dorsal nasal concha (Concha nasalis dorsalis) is narrow along the greater part of its length, but becomes wide in its aboral fourth (Fig. 5a). The cranial two thirds of the dorsal nasal concha (Concha nasalis dorsalis) is supported only by a basal lamella. The latter extends cranially forming the nasal straight fold (Plica recta). The caudal third of the dorsal nasal concha has a spiral lamella which forms the dorsal nasal conchal sinus (Sinus conchae dorsalis). The latter extends laterally and ventrally in front of the lateral nasal concha and opens into the middle nasal meatus (Meatus nasi medius).

The ventral nasal conchal bone (Os concha nasalis ventralis) is the largest of the nasal conchae in the camel. It increases in size gradually from before backwards, till it reaches its maximum width at its middle portion, then it constricts suddenly and continues as a narrow aboral extension below the middle nasal concha (Fig. 5 b). Orally, the ventral nasal conchal bone is prolonged by the alar fold (Plica alaris). The latter is crescentic in shape with its concavity faces dorsally. The basal lamella of the ventral nasal concha splits into two spiral lamellae: the dorsal spiral lamella (Pars dorsalis) surrounds the dorsal maxilloturbinate recess (Recessus maxilloturbinalis dorsalis) which contains the dorsal maxilloturbinate bulla. However, the ventral spiral lamella (Pars ventralis) circumscribes the corresponding recess (Recessus maxilloturbinalis ventralis).

and bulla. The dorsal maxilloturbinate recess extends backwards and downwards ventral and slightly lateral to the middle nasal concha (*Concha nasalis media*). However, the caudal portion of the ventral spirial lamella extends laterally beyond its basal lamella to occupy a recess which is bounded laterally and ventrally by the maxilla and caudally and dorsally by the maxilloturbinate crest.

The middle nasal concha (*Concha nasalis media*) is relatively larger, quadrilateral and occupies the space between the aboral portions of both the dorsal and ventral nasal conchae (*Conchae nasalis dorsalis et ventralis*) (Fig. 5e). It extends laterally oral to the dorsal nasal conchal sinus (*Sinus conchae dorsalis*) and in some cases it conceals the nasomaxillary opening (*Apertura nasomaxillaris*) by a lateral projection. The spiral lamella of the middle nasal concha encloses a sinus (*Sinus conchae media*). The latter opens into the nasal fundus (*Fundus nasi*).

The ethmoidal conchae (*Conchae ethmoideae*) are 5-6 in number and project into the aboral part of the nasal cavity ventral to the middle nasal concha (Fig. 5d). They are supported by conical shape ethmoturbinates. The spiral lamella of each ethmoidal concha encloses a sinus, which opens into the nasal fundus (*Fundus nasi*). The ethmoidal conchae are arranged into medial, intermediate and lateral groups. The medial group consists of two conchae, while the intermediate group is composed of 2-3 smaller conchae. The lateral group consists of one large nasal concha (Fig. 6e). The latter extends laterally and orally between the aboral portion of the dorsal nasal concha and the basal lamella of the ventral nasal concha. It is related medially to the middle nasal concha and laterally to the mucous membrane forming the medial wall of the maxillary sinus (*Sinus maxillaris*). It has a lateral projection which enters into the nasomaxillary orifice (*Apertura nasomaxillaris*). The latter nasal concha encloses a sinus which communicates through an opening with the nasal fundus (*Fundus nasi*).

The straight and the alar folds of the dorsal and the ventral nasal conchae are covered orally by noncornified stratified squamous epithelium and aborally, by pseudostratified ciliated columnar variety with relatively few goblet cells. At the middle of the nasal cavity, the dorsal and ventral nasal conchae are covered by high and or lined by relatively low pseudostratified ciliated columnar epithelium (Fig 7). The goblet cells gradually

increase in number towards the middle portion of the nasal cavity. The lamina epithelialis covering and lining the nasal conchae, at the caudal portion of the nasal cavity, is generally thinner than that found at the middle portion. The goblet cells are numerous in the outer covering and constitute the only type of cells in the inner lining mucosa (Fig. 8). The mucosa in both the straight and alar folds contains numerous compound tubular sero-mucous glands greatly resembling those found within the mobile part of the nasal septum. The glands decrease gradually towards the middle portion of the nasal conchae. They are of the simple tubular muco-serous type. The glands are found to be relatively few in the mucous membrane covering the conchae at the aboral portion of the nasal cavity. They subside gradually in the lining mucosa of the spiral lamellae of the dorsal and ventral nasal conchae. The glands at the aboral portion of the nasal cavity, are of the simple tubular mucous variety.

The olfactory mucosa occupies only a small area of the aboral part of the ethmoidal conchae. The epithelium is thick (100-160 microns) and evaginates at different points forming flask-shaped crypts (Fig. 9) Each crypt contains about 50 olfactory cells, lying at different levels. Their dendretic processes extend to the surface via the pore of the crypt. The Bowman's glands are simple branched tubular mucous glands, and contain melanin pigments into their cells.

The nasolacrimal duct (Muctus nasolacrimalis) courses obliquely cranio-ventral and medially into the osseous nasolacrimal canal (Ostium nasolacrimal) on the lateral wall of the lacrimal sinus. The membranous duct leaves the latter canal at the caudal portion of the ventral meatus (Meatus nasi ventralis) ventral to the maxilloturbinate crest. Then it proceeds forwards under the mucous membrane lining the ventral nasal meatus (Meatus nasi ventralis) medial to the maxilla. The duct presents slight dilatation before it opens into the medial wall of the nasal vestibule (Vestibulum nasi) at the junction between the skin and the mucous membrane. The naso-lacrimal duct is lined by two layers of cuboidal cells, which change to the stratified squamous variety near its external orifice at the nasal vestibule (Fig. 10).

The posterior naris (Choanae) is single. The incisive duct (Ductus incisivus) ends blindly into the submucosa of the hard palate. The vomeronasal organ (Organum vomeronasale) ranges about 19 cm in length. It increases in diameter towards its middle portion where it is about 0.4 cm in thickness.

The paranasal sinuses (Sinus paranasales) of the camel are the frontal, lacrimal, sphenoidal and maxillary sinuses.

The frontal sinus (sinus frontalis) is the largest paranasal sinus into the camel. It excavates into the frontal bone only. A complete median inter-frontal septum separates the right and left sinuses. The frontal sinus extends cranially to the level of the nasofrontal suture, while caudally it reaches nearly the frontoparietal suture where it overlies the oral fourth or third of the roof of the cranial cavity. The frontal sinus (Sinus frontalis) excavates laterally, into the supraorbital process of the frontal bone and reaches, in old specimens, the border of the orbital cavity (Fig. 11 F). Ventrally the sinus is separated from the dorsal nasal conchal sinus and the lateral nasal concha by an oblique, thin osseous lamina which is directed craniodorsally. An oblique osseous plate divides the frontal sinus (Sinus frontalis) into a small medial and a large lateral compartments : the medial compartment is triangular in outline with its base directed dorsally. It is divided into five irregular loculi. The largest loculus is situated abnasally (Fig. 6 F). Each loculus joins the oral part of the lateral compartment by an independent foramen. The medial compartment extends orally to the nasofrontal suture, while aborally it reaches nearly the frontoparietal suture. The lateral compartment is incompletely subdivided into a large nasal and a small abnasal portion by the supraorbital canal. Both portions are subdivided into many loculi by several osseous lamellae. It extends orally up to the level of the frontomaxillary suture, while aborally it extends to the cranial border of the temporal fossa. The abnasal part of the lateral compartment of the frontal sinus communicates freely with its nasal part. The latter opens into the nasal fundus (Fundus nasi) at the dorsal branch of the sinus meatus by an independent opening situated below the dorsal nasal conchal sinus (Sinus conchae dorsalis).

The lacrimal sinus (Sinus lacrimalis) is relatively the smallest paranasal sinus into the camel (Fig. 11 & 12 L). It is contained into the lacrimal bone and is partially separated from the underlying maxillary sinus (Sinus maxillaris) by an incomplete horizontal osseous plate through which the bony nasolacrimal canal courses. The lacrimal sinus (Sinus lacrimalis) is more or less prismatic in shape with its base directed medially. It is bounded caudally by the orbital surface of the lacrimal bone and dorsolaterally by the lacrimal bone and ventrally by the osseous nasolacrimal canal. It is communicated with the maxillary sinus (Sinus maxillaris) through the aditus maxillo-lacrimalis.

The sphenoidal sinus (*Sinus sphenoidalis*) is single and excavates into the presphenoid bone (Fig. 5e & 11 S). In adults it extends upwards nasal to the cranial cavity. It is more wide distally and is related, nasally, to the perpendicular plate of the ethmoid, and laterally to the orbital and pterygoid process of sphenoid bone and the optic canal. It measures 1.5-2.3 cm ro-caudally and is 4.2-4.6 cm dorsoventrally. The sphenoidal sinus opens independantly by the small aditus nasosphenoides into the nasal fundus (*Fundus nasi*).

The maxillary sinus (*Sinus maxillaris*) is relatively small in size and is contained into the maxilla and malar bones (Fig. 11 & 12 M.). It lies ventral to the lacrimal sinus (*Sinus lacrimalis*) with which it is freely communicated through the aditus maxillo-lacrimalis. The maxillary sinus (*Sinus maxillaris*) is more or less pyramidal in shape with its apex directed caudally. It is bounded laterally by the maxilla, medially by the maxilloturbinate crest and extends caudally into the zygomatic process of the malar bone. It is divided into two to three loculi. The major loculus is the most caudal one. In aged camels the maxillary sinus (*Sinus maxillaris*) extends more caudally into the zygomatic process of the malar bone. It measures 3.3-3.7 cms, ro-caudally and 2.6-2.9 cms dorsoventrally. The maxillary sinus (*Sinus maxillaris*) opens into the dorsal branch of the middle nasal meatus (*Meatus nasi medius*), by the aditus nasomaxillaris (Fig. 13a). The latter is rounded in shape of about 0.6 cm in diameter. It is situated lateral to the middle nasal concha (*Concha nasalis media*). It is oftenly lodged by a protrusion of the middle nasal concha (*Concha nasalis media*). The paranasal sinuses are lined by pseudostratified ciliated columnar epithelium with goblet cells. The latter cells are relatively abundant into the maxillary and lacrimal sinuses. The lamina propria contains a relatively few mucus secreting glands. The latter are exception-ally abundant at the enterance of the maxillary sinus.

DISCUSSION

The present study reveals that the nostrils of the camel are of the cutaneous type. Its cartilagenous support however, is made up of the mobile part of the nasal septum, a peculiarly narrow dorsal lateral nasal cartilage, an elongated strip-like pars narica and the lateral accessory nasal cartilage. The latter cartilage, not similar to that found in other ruminants, is not continuous with the pars narica and supports only the inner portion of the lateral wing of the nostrils NICKEL *et al.*, 1960

and EL-HAGRI, 1967). This peculiar arrangement led to the narrowing of the nares and thus enables this animal to withstand the adverse climatic conditions. In agreement with the observations of LESBRE (1903) and GEORGE, (1951) the nostrils of the camel are covered by a relatively thin hairy skin which is continued on the oral portion of the nasal vestibule. In this respect the camel differs from other ruminants and greatly resembles the horse (EL-HAGRI, 1967). The sebaceous glands in the skin covering the nostrils of the camel are distinctly small in size. In other ruminants, however, the sebaceous glands are absent from the nasolabial plane of the bovines and the nasal plane of the small ruminants (TRAUTMANN and FIEBIGER, 1960). Sweat glands could not be demonstrated either in the outer covering skin or in the inner lining coat of the nose of the camel. The presence of arrector pili muscles in association with some of the hair follicles found in the skin covering the nostrils of camel enables the vibrissae to erect properly. The erected vibrissae act as a sieve that assists in keeping dust and sand particles away from the inspired air. The double nature of the arrector pili muscle was stated to occur also in swines by TRAUTMANN and FIEBIGER (1960). The nasal glands, found within the mobile part of the nasal septum, being of the sero-mucous type, help in keeping the nostrils moistened in hot climatic conditions and seem to be an accommodation which substitutes the decreased amount of serous end-pieces of the nasal glands observed in the camel.

The nasal conchae of the camel, with exception of the ventral nasal concha, enclose a sinus. This peculiarity may slow the passage of air within the nasal cavity and consequently enables the inspired air to be conditioned to the body temperature. A structural accommodation which is needed by such an animal which survives hot climates. The arrangement of the dorsal and ventral nasal conchae of the camel is similar to that found in other ruminants (WILKENS, 1958 and LOEFFLER, 1958). The middle nasal concha of the camel, however, encloses a sinus. The septum nasi in camel forms a complete partition between the two nasal cavities. In other ruminants, however, the nasal cavity is not completely divided into two cavities due to the separation of the nasal septum from the floor of the nasal cavity by an increasing space in its caudal part (NICKEL *et al.*, 1960 & EL-HAGRI, 1967). The tremendous amount of goblet cells demonstrated within the respiratory region of the nasal cavity of the camel is needed for the production of a sufficient quantity of mucin necessary for the protection of the nasal mucosa against sand and dry inspired air.

The nasal glands found within the lamina propria of the lateral wall of the respiratory region of the nasal cavity of the camel, resemble in distribution the anterior nasal glands described in pig (BOJSEN-MOLLER, 1967). The Bowman's glands in the camel, are of the mucous variety. In this respect they resemble those of cat, dog and rabbit (SLOTWINSKI, 1932). In other ruminants, however, the latter glands are of the mucoserous variety. The Bowman's glands of the camel present abundant melanin granules to which the colour of the olfactory epithelium is attributed. The nasolacrimal duct, in the camel, is lined by two layers of cuboidal cells which changes to stratified squamous variety near its external opening at the nasal vestibule. The duct is found to be lined by stratified columnar epithelium in other domestic animals (TRAUTMANN and FIEBIGER, 1960).

The paranasal sinuses of the camel are relatively smaller in size than those of cattle, but they are further divided into several loculi, a pattern which increases to some extent the surface area of these sinuses. The present investigation shows also that the palatine sinus is not developed in camel. In ruminants, however, the latter sinus is markedly developed (WILKENS, 1958 and LEOFELER, 1958). The maxillary and lacrimal sinuses of the camel open together into the middle nasal meatus by a common nasomaxillary opening. However, each of the sphenoidal and frontal sinus opens independantly into the nasal cavity, an arrangement which is more similar to that found into other ruminants (WILKENS, 1958 and LEOFFLER, 1958). As in other domestic animals the lateral nasal glands are found at the enterance of the maxillary sinus of the camel (STENO, 1962, JACOBSON, 1813 ; BROMAN, 1921 ; NICKEL *et al.*, 1960 and EL-HAGRI, 1967).

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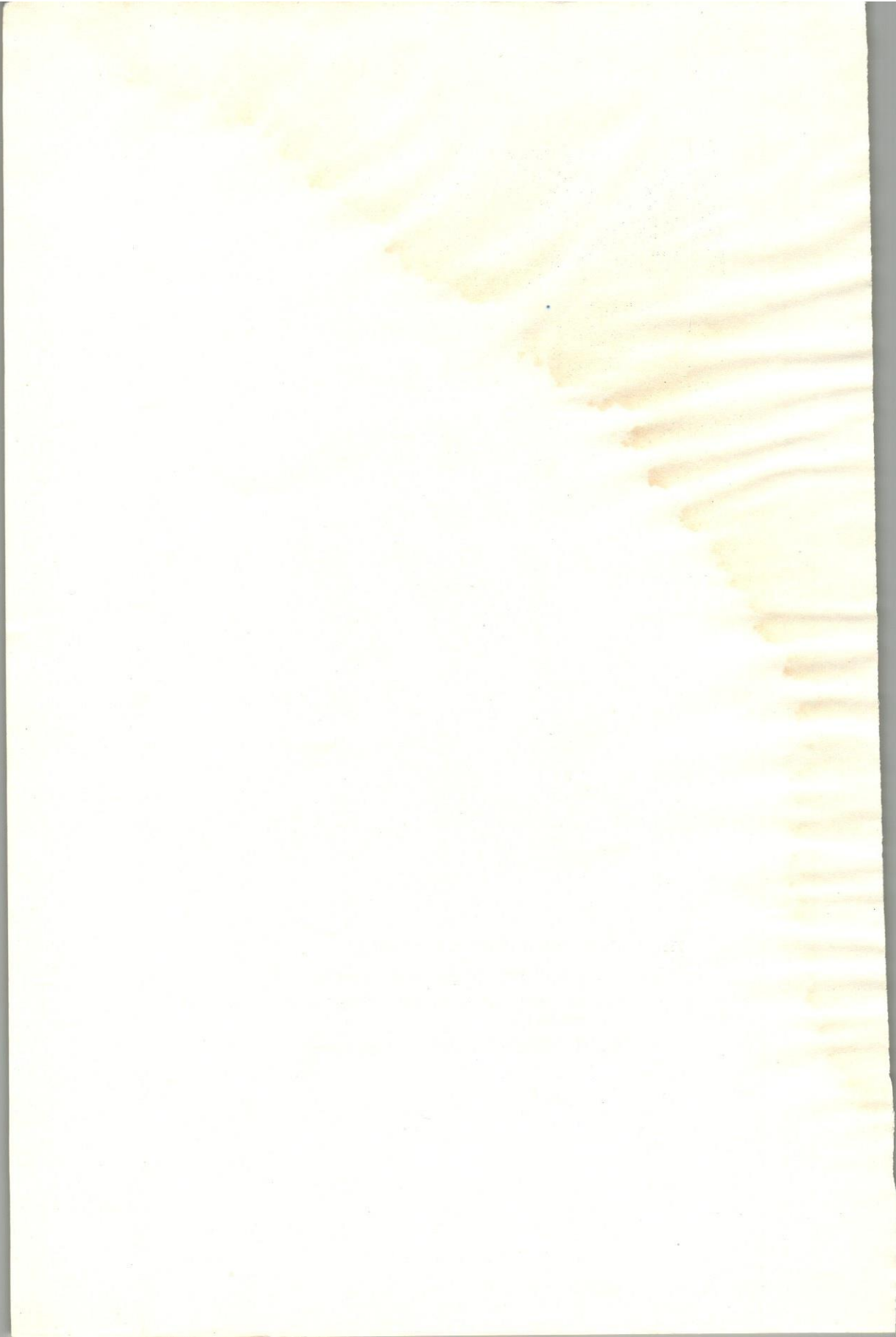
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Fig. 1.—The nasal cartilages of the camel :

1. The dorsal lateral nasal cartilage.
2. The naric part of the dorsal lateral nasal cartilage.
3. The lateral accessory nasal cartilage.



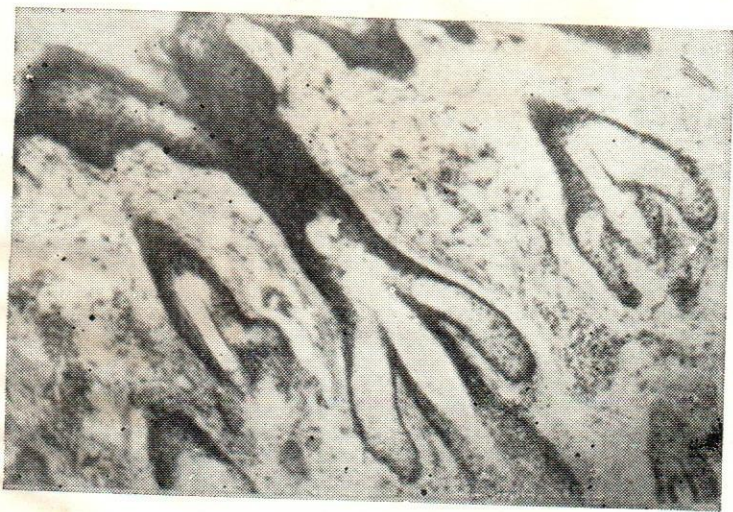


Fig. 2.—The covering skin of the nostrils, showing the characteristic arrangement of the sebaceous glands (H and E. $\times 100$).

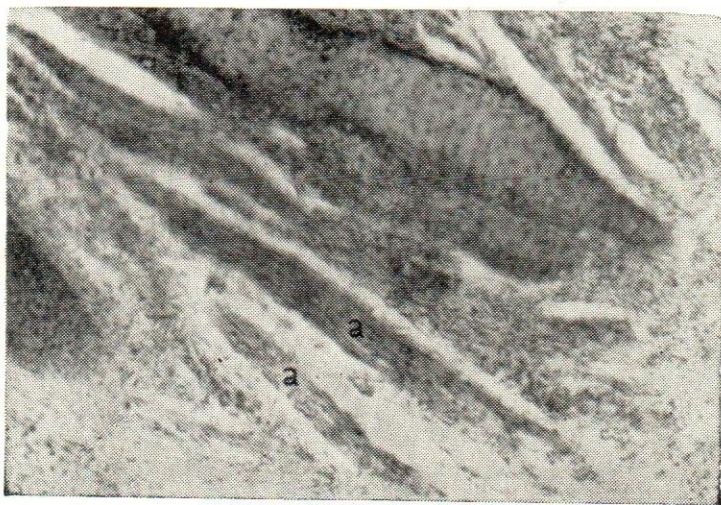


Fig. 3.—The lining skin of the nostrils, showing two arrector pili muscles (a) associating a hair follicle (H and E. $\times 500$).

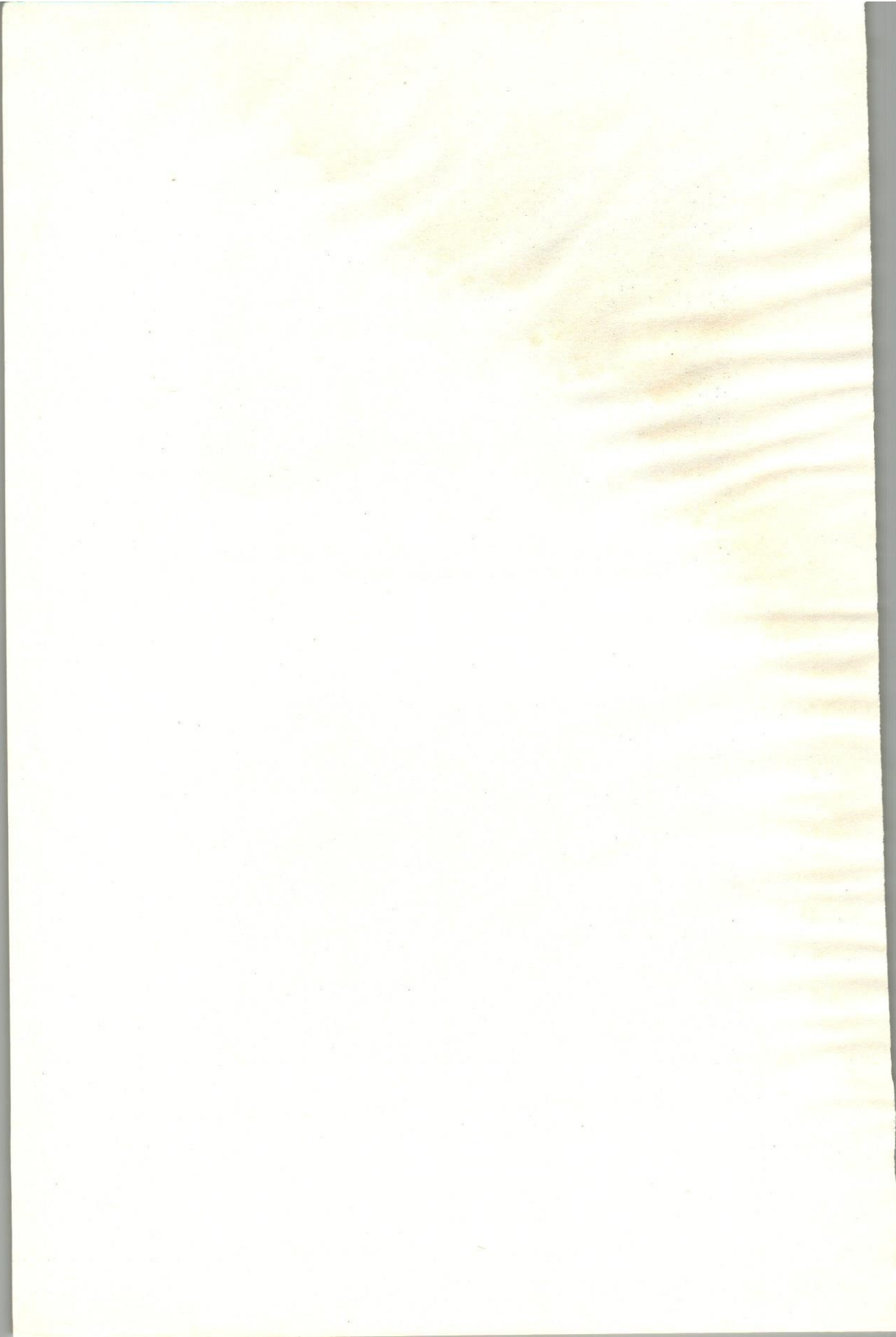




Fig. 4.—Major lobule of the nasal gland at the mobile part of the nasal septum, showing, mucous end-pieces (m), serous (s) and interlobular ducts (d) (Alcian blue and PAS, $\times 160$).

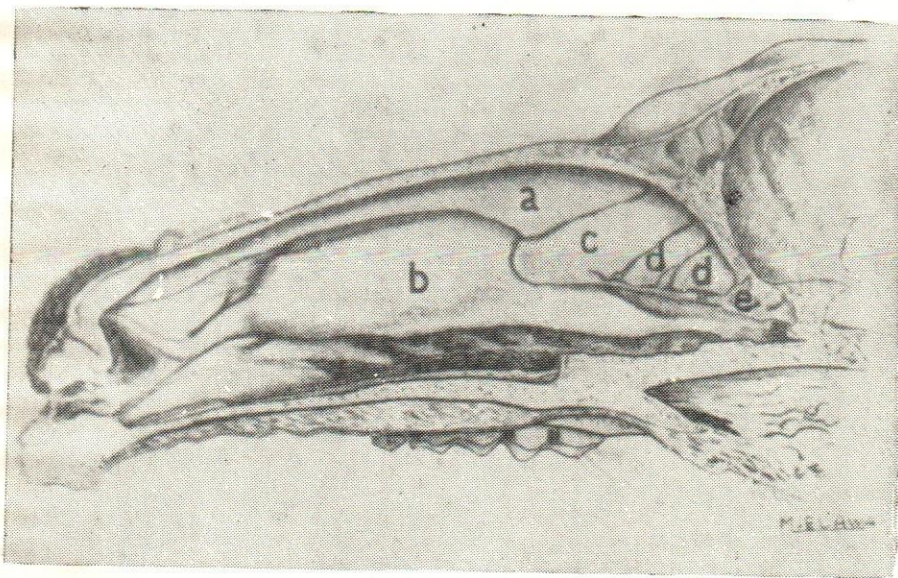
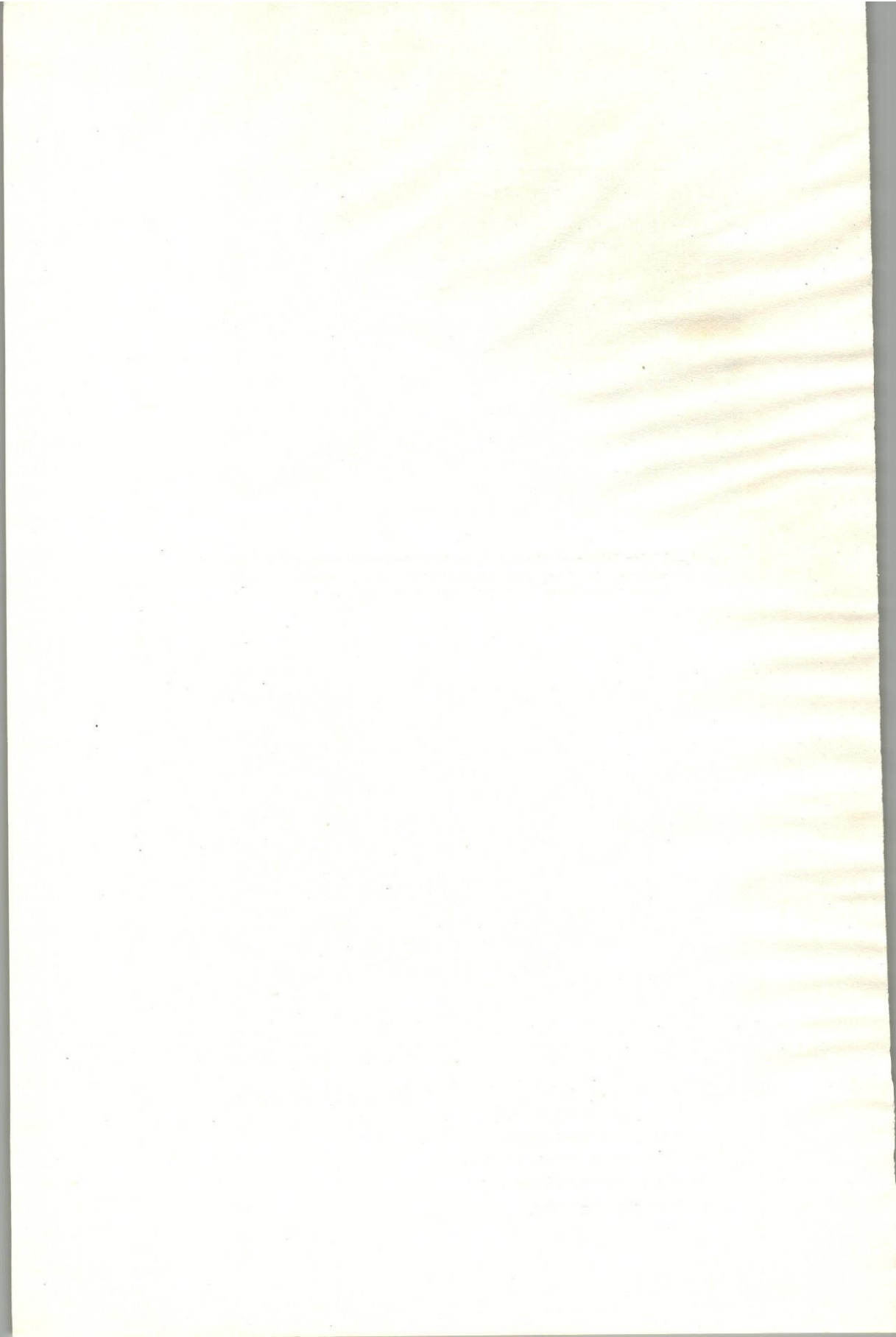


Fig. 5.—Sagittal section into the head of the camel, showing :
 a) The dorsal nasal concha,
 b) The ventral nasal concha,
 c) The middle nasal concha,
 d) The ethmoidal conchae, and
 e) The sphenoidal sinus.



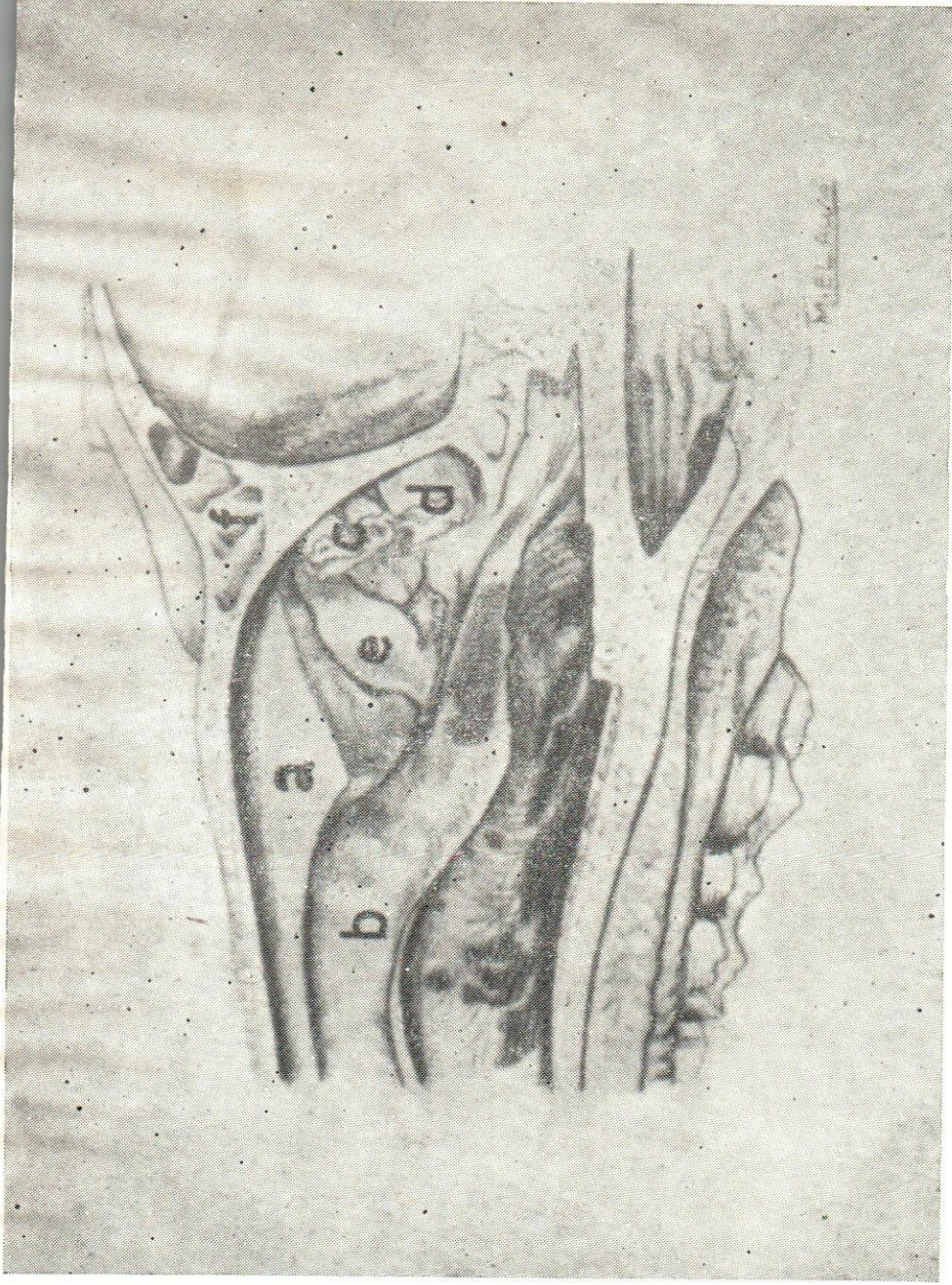
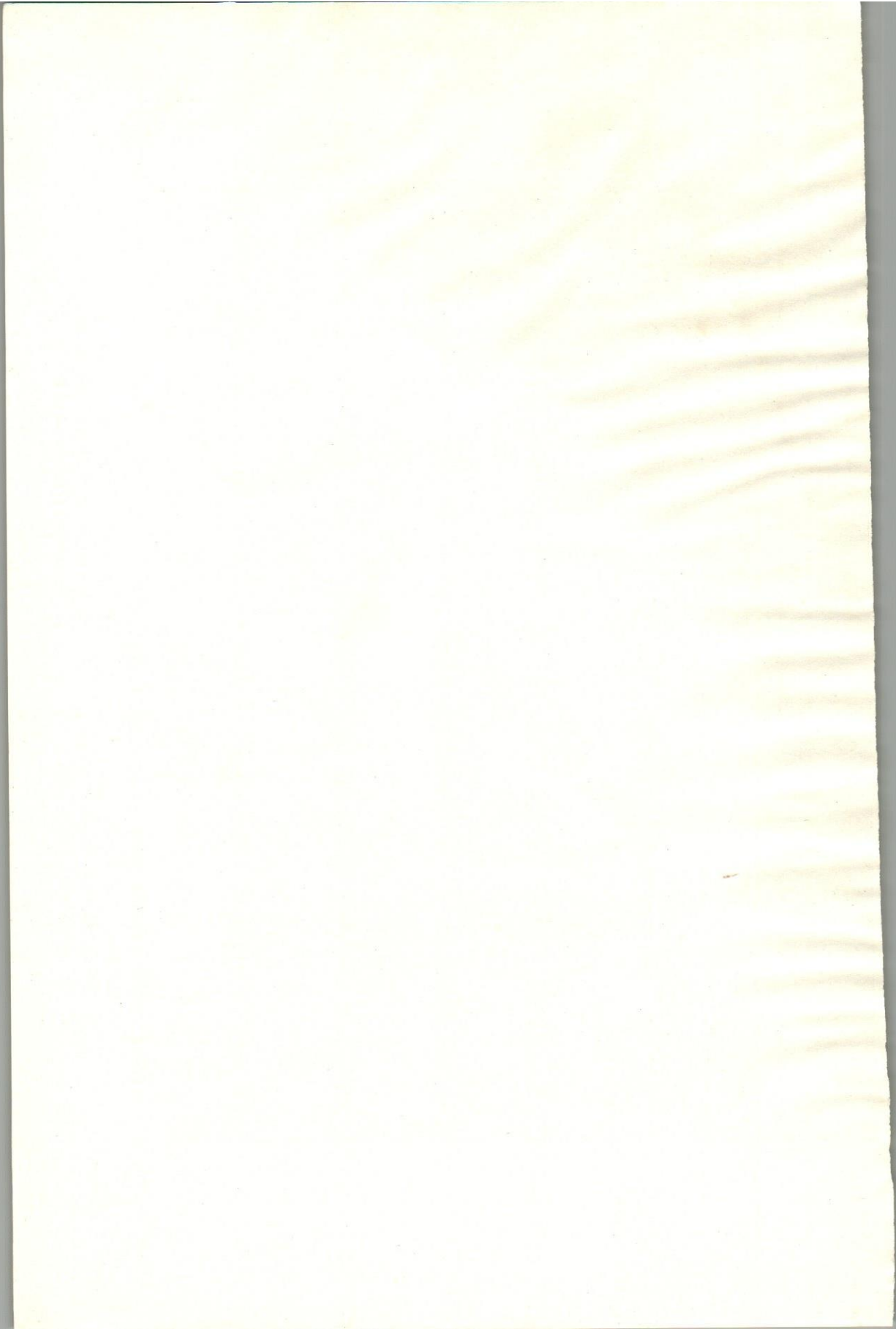


Fig. 6.—Sagittal section into the head of the camel, showing :

- a*) The dorsal nasal concha,
- b*) The ventral nasal concha (cut),
- c*) The middle nasal concha (cut),
- d*) The ethmoidal conchae (cut),
- e*) The lateral group of the ethmoidal conchae, and
- f*) The medical compartment of the frontal sinus.



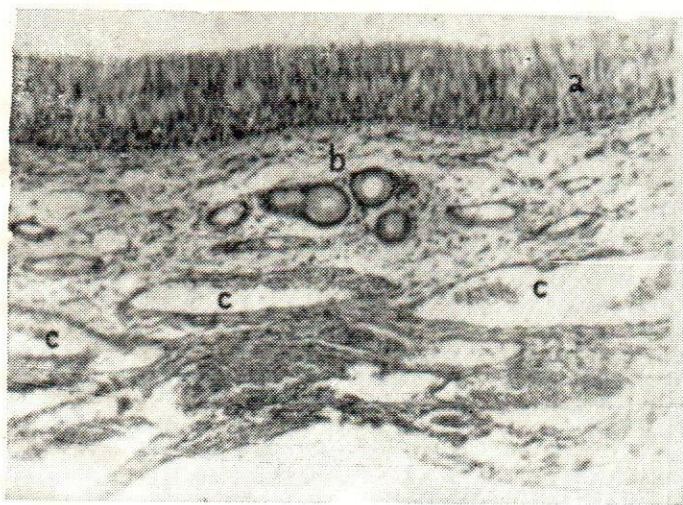


Fig. 7.—The covering mucosa at the middle portion of the dorsal nasal concha, showing :

- a) Pseudostratified ciliated columnar epithelium with goblet cells,
- b) Mucous glands, and
- c) Venous plexuses. (H and E. $\times 160$).

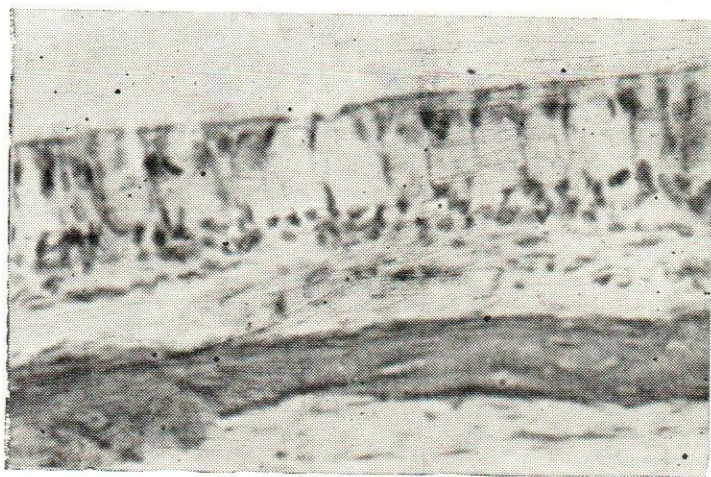
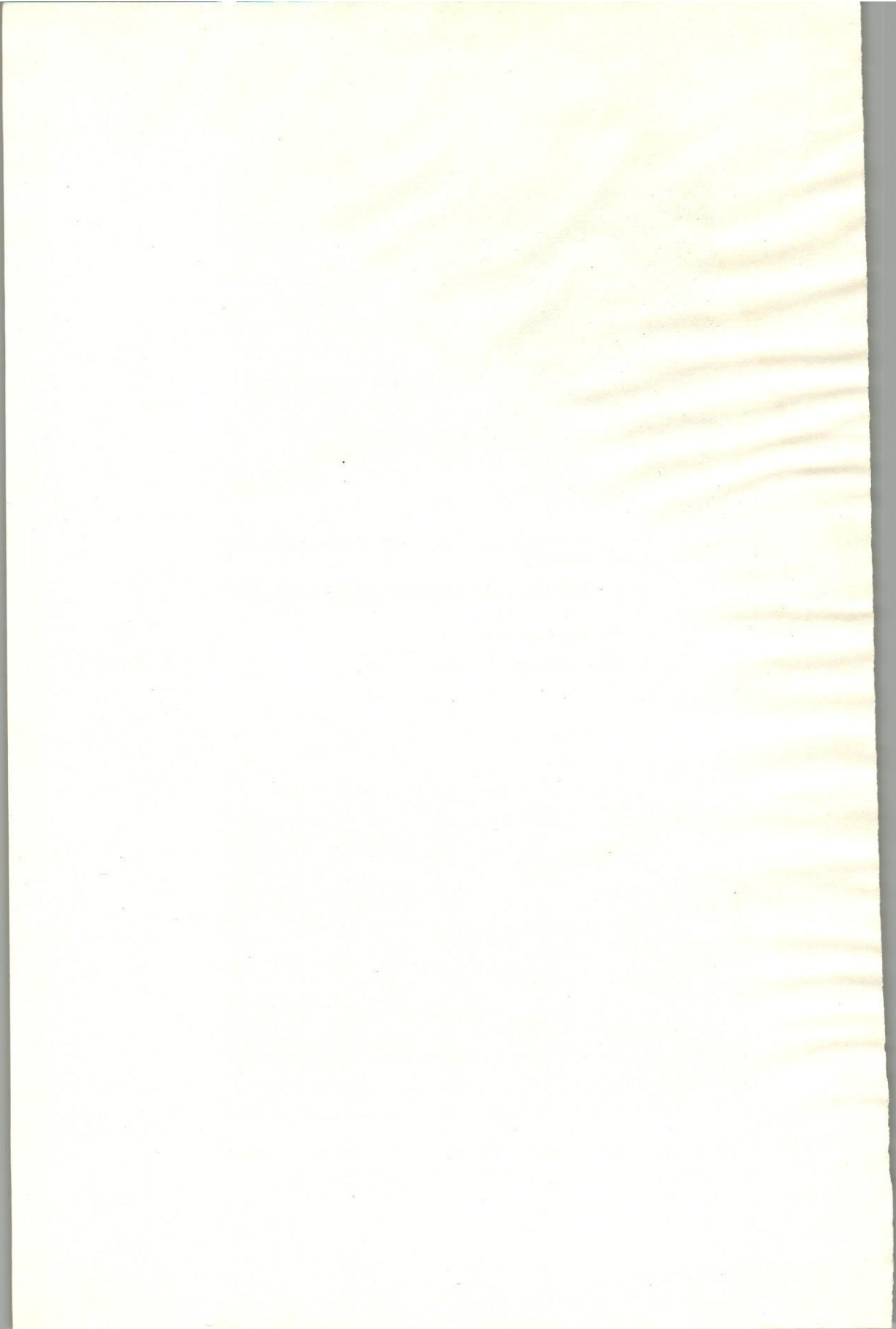


Fig. 8.—The internal mucosa of the ethmoturbinate showing abundant goblet cells in the lamina epithelialis (H. and E. $\times 500$).



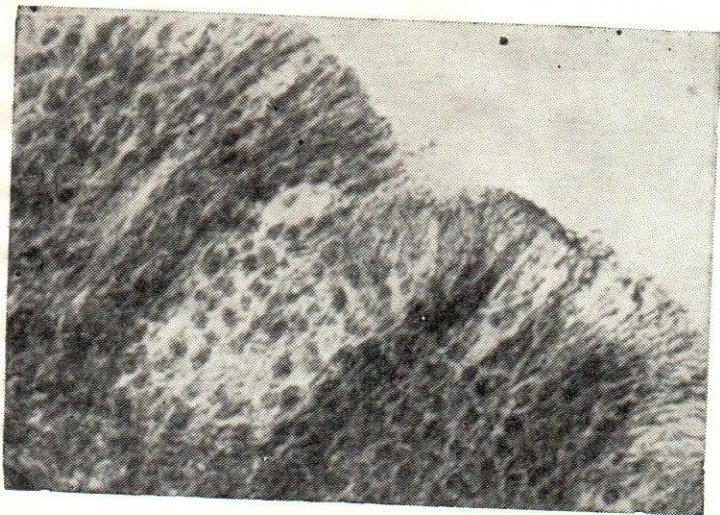


Fig. 9.—The olfactory epithelium showing a cryptlike depression containing numerous olfactory cells (Crossman's Trichrome. $\times 500$).

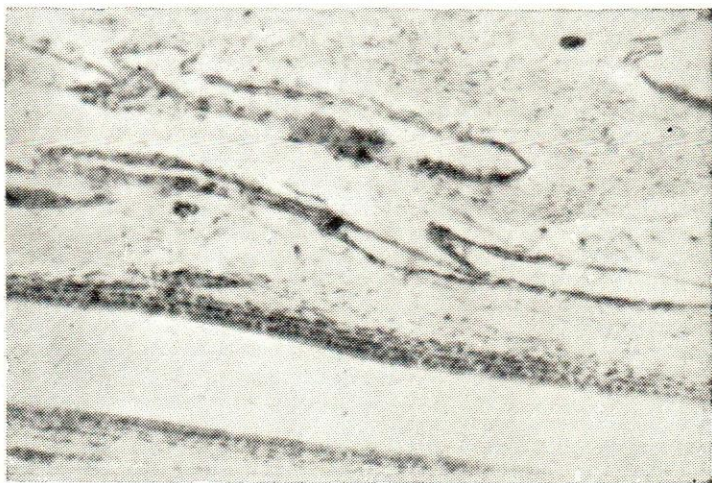
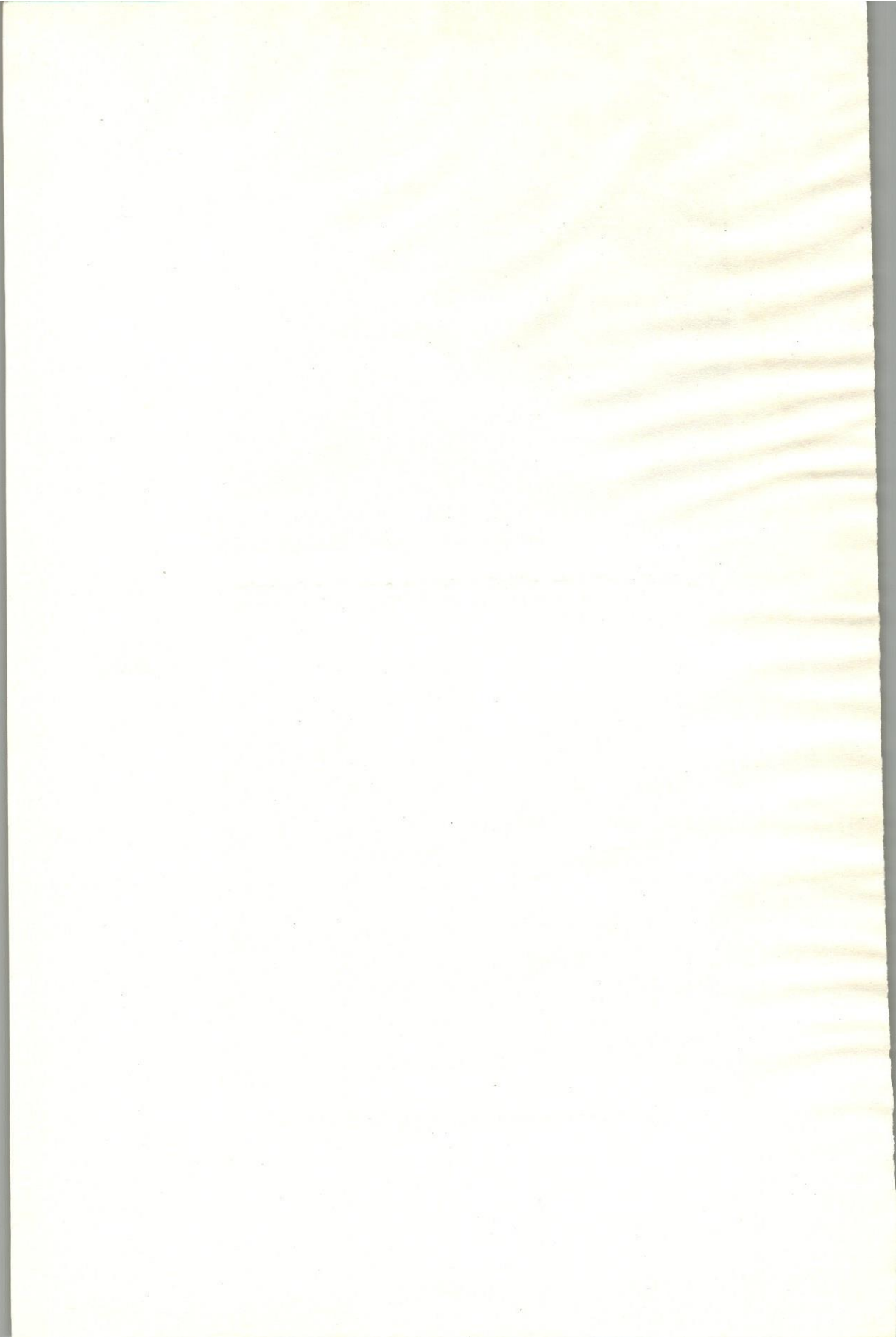


Fig. 10.—The nasolacrimal duct. (H. and E. $\times 160$).



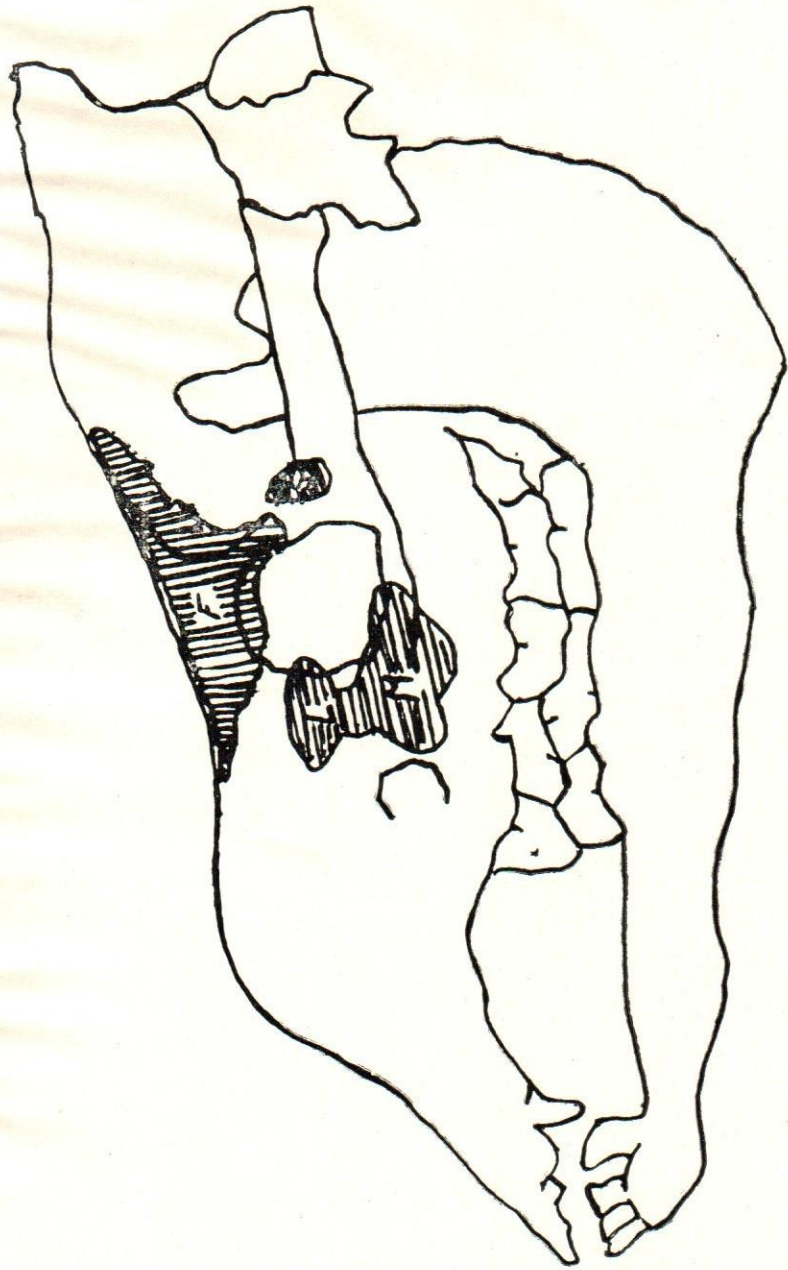
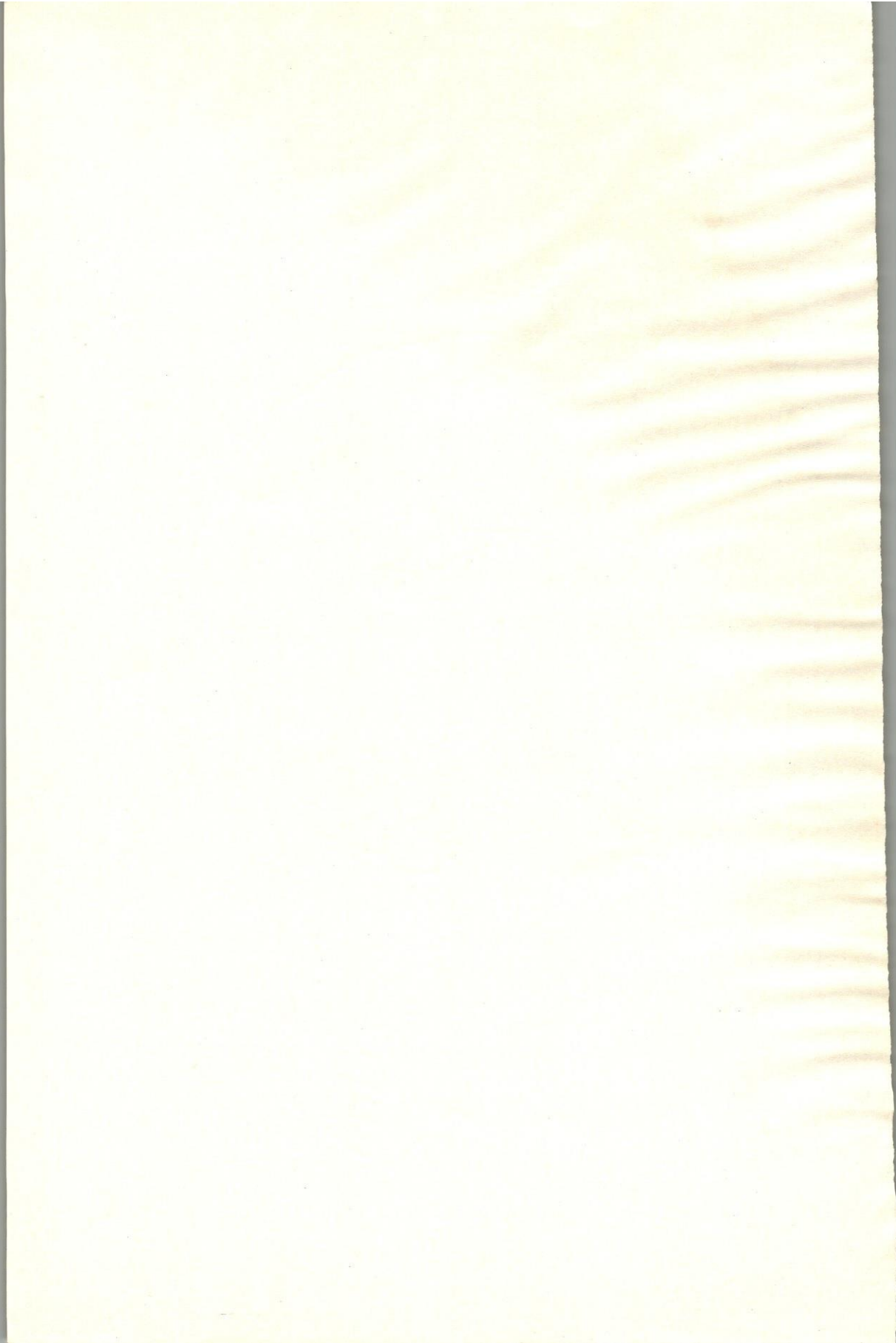


Fig. 11.—Outline of the skull of the camel to show the position of the frontal sinus (F), the lacrimal sinus (L), the maxillary sinus (M) and the sphenoidal sinus (S).



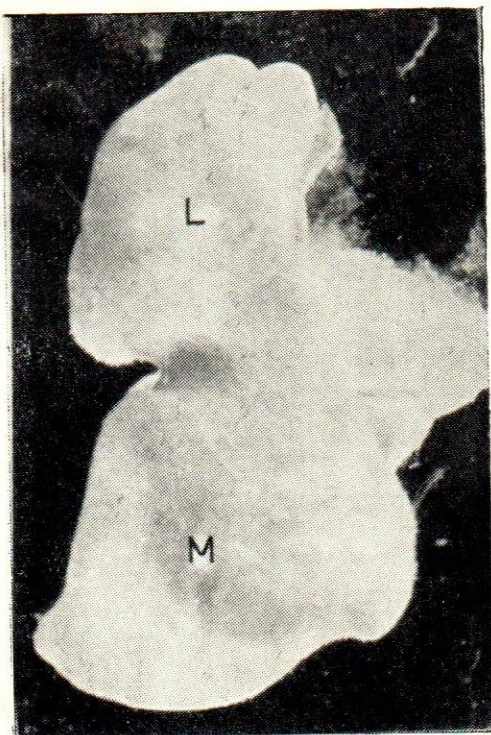


Fig. 12.—The detached mucous membrane of the lacrimal sinus (L) and the maillary sinus (M) (Lateral view).

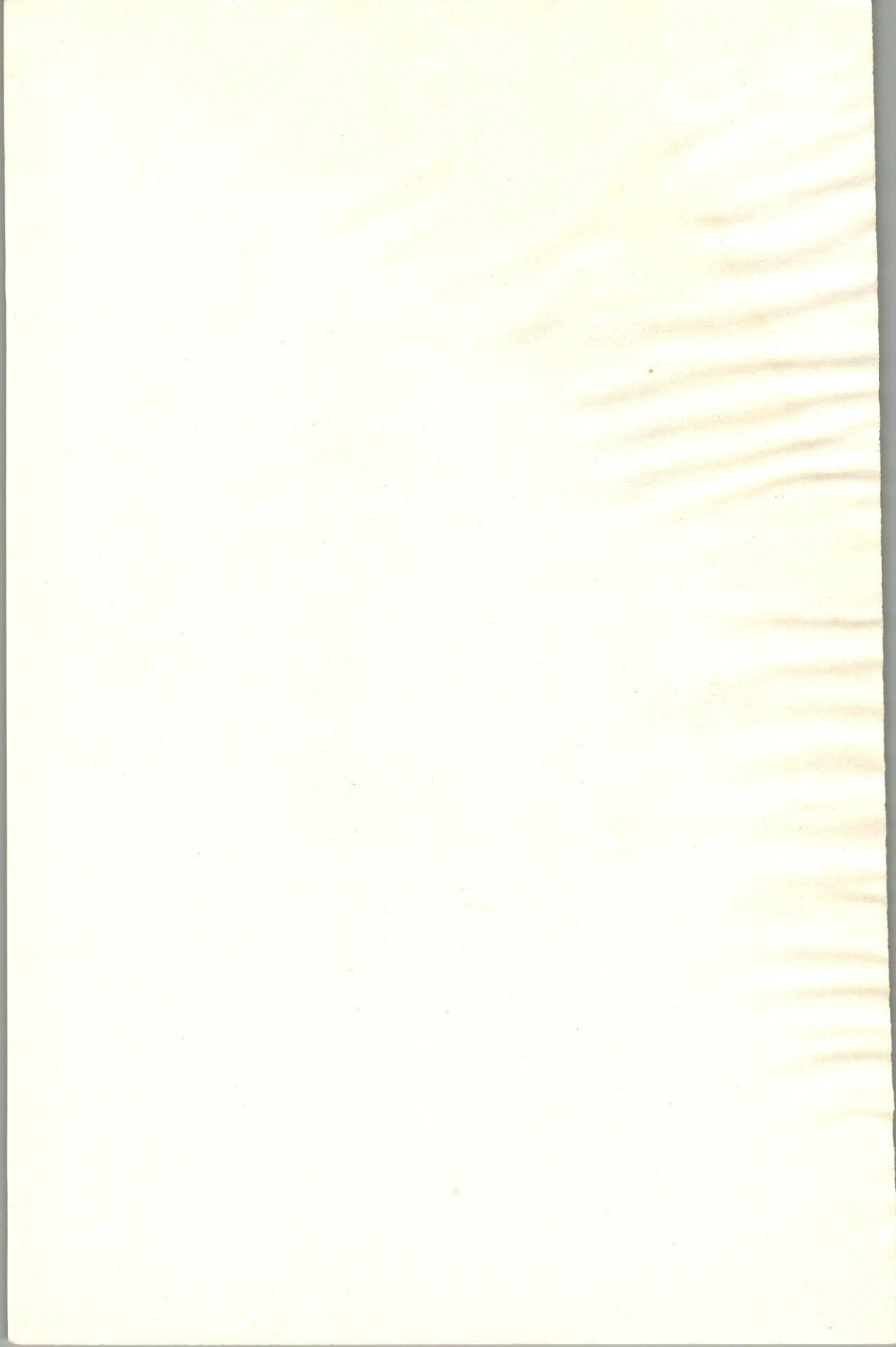




Fig. 13.—Sagittal section into the head of the camel, showing :

- a) The nasomaxillary opening.
- b) The posterior

nares.

