قسم التشريح والهستولوجيا
كلية الطب البيطري ـ جامعة أسيوط
رئيس القسم : أ٠د/ حلمي بدوي

دراسات هستولوجية على التطور الجنيني لمعدة الماعز

جمال كامل ، أحمد حسن ، عبدالهادي محمد ، نبيل كامل

أجري هذا البحث على عدد ١٨ من أجنة الماعز يتراوح أطوالها من ٨ ـ ٤٥ سم وكذلك عدد ٣ من الماعز حديثة الولادة عمرها ثلاثة أيام وذلك لدراسة التطور الهستولوجي لمعدة أجنة الماعز ٠

وقد وجد أن الغشاء المخاطي للكرش والشبكية أملس ومغطى بقشرة اسطوانية مطبقة ، بينما ظهرت ثنيات على شكلورقات أولية وثانوية وثلاثية في أجنة الماعز التي يبلغ طولها ٨ سم ٠

وقد وجد أيضا عند هذا العمر (٨ سم) أن الغشاء المخاطي للأنفحة يحمل طيات طولية مغطاه بقشرة اسطوانية مطبقة تطبيقا موهما ٠

تبدأ حلمات الكرش في الظهور في أجنة الماعز عند طول ٢٥ سم بينما ظهرت ثنيات الشبكية عند طول ٢٢ سم ٠

وقد بدأت بشائر الغدد المعدية في الظهور في الصفيحة الأساسية للغشاء المخاطي المبطن لانفحة أجنة الماعز عند طول ٢٥ سم ٠

وفي أجنة الماعز التي يبلغ أطوالها ٣٣ سم ، أمكن تميز خلايا عنق الغدة المخاطية والخلايا الأصلية والخلايا الجدارية في الغدد المعدية ٠

وقد وجد في هذا البحث أن بشرة المعدةفي المراحل الاولى للحمل تحتوي على كميات كبيرة من المواد عديدة السكريات المخاطية ، وتقل هذه المواد تدريجيا بتقدم عمر الجنين وعند الولادة ٠

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HISTOLOGICAL STUDIES ON THE PRENATAL DEVELOPMENT OF GOAT STOMACH

(With one table & 15 Figs.)

By
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SUMMARY

The histological development of the goat stomach during the foetal and early neonatal period was studied.

At 8 cm CVR length the ruminal and reticular mucosae were smooth and covered with stratified columnar epithelium, however the omasal mucosa was thrown into various folds. The abomasum beared a longitudinally folded mucosa and was lined with pseudostratified columnar epithelium. The primordia of the reticular folds were observed as early as 22 cm CVR length. However, the primary elements of the omasal laminae were pronounced at 25 cm CVR length. The gastric glands started to develop at 25 cm CVR length. The parietal, chief, and mucous neck cells could be recognized in foetuses of 33 cm CVR length. The gastric epithelium domonstrated abundant mucopolysaccharids during the early periods of intrauterine life. However, at the end of gestation and in newborn goats the gastric epithelium contained much fewer amount of these materials. In 3 day-old goats, the gastric mucosae simulated that of afult animals.

INTRODUCTION

Developmental histological changes in the ruminant stomach have been received litle attention.

LAMBERT (1948), BECKER, et al. (1951), WARNER (1958) and ARIAS, et al. (1978) described the development of the stomach in large ruminants. WARDROP (1961) reported some preliminary observations on the histological development of the forestomach in lambs. In addition, FATH EL-BAB, et al. (1983) studied the histomorphological changes in the ovine fetal stomach, from 26th to 130th day of pregnancy. However, a preliminary study on the histological development of the fore-stomach in goats was conducted by RAMKRISHNA and TIWARA (1979).

The present work was carried out to give more information on the histogenesis of the stomach in goats in both fetal and early neonatal period.

MATERIAL and METHODS

The Material used in this study were collected from 18 goat foetuses ranging from 8-45 cm CVR length and 3 neonatal animals of 3 days age (Table 1).

The whole stomach of 8-17 cm CVR length foetuses and representative parts from the different gastric compartments of the other foetuses were fixed in 10% formalin or bouin's fluid , dehydrated in ethanol and embedded in paraffin. The sections were stained with Haematoxylin and Eosin, Periodic acid Schiff, Alcian blue (pH 2.5) Crossman's trichrome and Weigert's elastica stains. Measurements were carried out with an eye-piece micrometer which was calibrated with a stage micrometer to the nearest microne. Several specimens representing the different stages of development were injected with 1:1 Indian Ink-serum solution to bisualize the vascular supply of the gastric wall during different developmental stages (KELANY, et al. 1986).

RESULTS

The stomach of goats consisted of four compartments, the rumen, reticulum, omasum and abomasum (glandular stomach).

Rumen:

At the early stages of development (8-10 cm CVR length) the wall of the rumen consisted of three layers (Fig. 1); inner layer (mucosa), middle layer (muscularis) and outer layer (serosa). The mucosa was smooth and the lamina epithelialis consisted of stratified epithelium ranging from 60-130 um in thickness. This epithelium was differentiated into 2 zones, basal dark zone and light luminar zone. The basal dark zone consisted of 3-4 layers of small polyhedral cells with large oval centerally located nuclei. The deeper cell layer of this zone was of the columnar type and contained large vesicular nuclei with numerous mitotic figures. The light luminar zone consisted of 6-8 layers of large polyhedral cells with distinct outlines. Their nuclei were dark, small and eccentrically situated. The superficial layer of this zone was formed of one layer of cuboidal or columnar cells in fetuses of 8 cm CVR length and flattened in fetuses of 9-10 cm CVR length. Numerous PAS- positive granules of different sizes and shapes were demonstrated within the cells of the lamina epithelialis of the rumen (Fig. 2). These granules were increased in number and size towards the upper cell layers. The lamina propria was about 170 um in thickness and was formed of mesenchymal connective tissue. Some mesenchymal cells arranged themselves into one layer in the vicinity of the lamina epithelialis under the basement membrane.

The muscular layer was thin with an average thickness of 35 um and could be differentiated into an inner circular and outer longitudinal layers of smooth muscle fibers. The serosa consisted of an outer layer of mesothelial cells resting on a thin layer of submesothelial connective tissue.

In foetuses of 12-17 cm CVR length, the lamina epithelialis increased in thickness and ranged from 100-150 um. The lamina propria decreased in thickness (56 um) and most of the mesenchymal cell were differentiated into fibroblast cells and fibrillar elements. The muscular layers were increased in thickness, and reached about 55 um.

At 22-27 cm CVR length, the lamina epithelialis ranged from 150-525 um. The primorida of the ruminal papillae were observed in fetuses of 25 cm CVR length. They were represented

by an evagination of the lamina propria into the lamina epithelialis (Fig. 3). The core of the papillae contained connective tissue cells and blood vessels. The dark basal zone was much thiner than the light luminar zone. It consisted of 1-2 cell layers with lightly stained basophilic cytoplasm and large vesicular nuclei. The light luminar zone consisted of 15-21 layers of large polyhedral cells with vacoulated cytoplasm and peripherally situated deeply stained small nuclei. The lamina propria decreased inthickness and was about 40 um and represented by a connective tissue layer contained fine collagenous fibers, numerous connective tissue cells and blood vessels. The muscular layer was about 75 um in thickness.

At 32-33 cm CVR length the lamina epithelialis was about 30 cell layers (Fig. 4). The basal dark zone was represented by one layer of columnar cells. The lamina propria was rich in the cellular elements. The primordia of the ruminal popillae were increased in depth and number. The muscular layer was markedly increased in thickness and reached from 160 to 200 um.

At 42-45 cm CVR length, the ruminal papillae were increased in length and were covered with cornified stratified squamous epithelium of about 25 um thickness (Fig. 5). It consisted of 4-6 cell layers, the basal layer was formed of columnar cells with lightly stained cytoplasm containing large oval vesicular nuclei. The middle layer was consisted of 2-3 rows of polyhedral cells. Their nuclei were vasicular and centerally located. The cytoplasm was vacoulated and fainlty stained. The superficial layer was formed of 1-2 cornified cells. The lamina propria was consisted of loose connective tissue rich in fibroblasts and coarse collagenous fibers. The PAS- positive materials were much fewer within the lamina epithelialis than during the earlier stages of fetal development.

In three day-old goats the ruminal mucosa underwent quantitative changes represented by an obvious increase in the length of the ruminal papillae. Meanwhile the lining epithelium was irregularly oriented arround these structures (Fig. 6).

Reticulum:

The histomorphological changes which occured in the reticular wall were similar to that of the rumen. However, the primordia of the large reticular folds were observed in fetuses of 22 cm CVR length. Both large and small folds were recognized at 25 cm CVR length (Fig. 7). These folds were increased in length and number with the advancement of the fetal age.

In full term fetuses, the reticular mucosa was covered with a cornified stratified squamous epithelium. The large reticular folds showed small secondary ones.

Omasum:

At 8 cm CVR length the omasal mucosa was thrown into laminae of different lengths and shapes. The large laminae appeared finger-like and the medium ones were leaf or tongue shaped while the small laminae were either dome or pyramidal in shape. Their lengths were about 1.5, 1.0, 0.3 mm. respectively (Fig. 8).

The lamina epithelialis resembeled that in rumen and reticulum but was much thiner and formed of about 4 cell layers. The lamina propria consisted of mesenchymal connective tissue. Some mesenchymal cells aggregated in the lower third of the large omasal lamina. The muscular wall and serosa resembled that described in the wall of the rumen and reticulum.

At 9-10 cm CVR length the lamina epithelialis was consisted of 5-7 layers and appeared into two zones, dark basal and light luminar zones. These zones were approximately equall

in thickness. The lamina epithelialis showed strong PAS-positive material. This material was more abundant within the upper layers than in the basal ones. The lamina propria consisted of fibroblasts and fine collagenous fibers. Stripes of smooth muscle fibers connected with the inner circular layer representing the premordia of the middle muscular bands, were observed in the lamina propria of the large omasal laminae (Fig. 9). The muscular layer and serosa resembled that described in fetuses of 8 cm CVR length.

At 22-27 CVR length, the omasal laminae were increased in length and differentiated into 4 different orders. Their lengths were about 8.0, 4.5, 1.5 and 0.4 mm, respectively. The lamina epithelialis increased in thickness and consisted of 11-15 cell layers. The dark basal zone and the light zone were formed of about 2-3 and 9-19 cell layers respectively. The lamina propria decreased in thichness and was consisted of loose connective tissue rich in fibroblasts and collagenous fibers. A thin layer of smooth muscle fibers representing the primordia of muscularis mucosa of omasal laminae was demonstrated under the basement membrane of the lamina epithelialis. The middle muscular band was prominent within all the omasal laminae. These muscular bands were clearly demonstrated at 25 cm CVR lenght (Fig. 10). The large omasal folds beared lateral projections. Thin submucosal layer was observed and composed of loose connective tissue.

At 32-33 cm CVR length, the omasal mucosa was covered with thick stratified squamous epithelium. The superficial squamous layer demonstrated signs of cornification.

At 42-45 cm CVR length the lamina epithelialis was of the cornified stratified squamous varirty and consisted of 8-10 cell layers.

Abomasum:

In fetuses fo 8-10 cm CVR length the mucosa of the abomasum was thrown into large and small folds which showed apical and lateral depressions (Fig. 12). The lamina epithelialis was of the pseudostratified columnar type. The cell boundaries were clear and the cytoplasm was vacuolated. Their nuclei were arranged at the apical portion of the cells. PAS-positive materials were more abundant in the lower portion of the lamina epithelialis. Mitotic figures could be demonstrated in most cells of this lamina.

The lamina propria was formed of mesenchymal cells filling the core fo the abomasal folds.

At 9-10 cm CVR length the connective tissue core of the abomasal fold showed highly cellualr area in the vicinity of the lamina epithelialis while the deeper portion was less cellular, more fibrous and contained small PAS-positive granules.

At 22-25 cm CVR length, the gastric pits were demonstrated in the abomasal mucosa (Fig. 13). The lamina epithelialis was consisted of tall columnar cells with large oval vasicular nuclei locating towards the basement membrane. The cell boundaries were clear and the cytoplasm was vacuolated. Mitotic figures could be demonstrated within these cells. The lamina propria consisted of fibroblasts and fine collagenous fibers. At 25 cm CVR length, the bases of the gasteric pits showed basophilic cellular masses located in the lamina propria. The latter cells appeared to be of the columnar type containing large vesicular nuclei and highly basophilic cytoplasm, (Fig. 14). The muscularis mucosae was demonstrated as one layer of smooth muscle fibers. The submucosa was formed of loose connective tissue containing blood vessels and nerves.

At 32-33 cm CVR, length, the gastric gland could be demonstrated as simple tubular glands distributing throughout the lamina propria of abomasal mucosa. The mucous neck cells

of the gastric glands as well as the chief and parietal cells could be recognized in fetuses of 33 cm CVR length.

At 42-45 cm CVR length (full term) fetuses, the gastric glands were recognized as simple or branched tubular glands. They had mainly three types of cells. Mucous neck cells, were distributed in the neck region. They showed positive reaction to both PAS and Alcian blue stains. Chief cells were distributed mainly at the bottom of the glands and their cytoplasm were stained blue with H&E and dark red by Crossman's Trichrome stain. Parietal cells were distributed both at the body or at the bottom of the gland. They were stained red with H&E and pale red by trichrome. The chief and parietal cells were negatively stained with PAS or Alcian blue (Fig. 15).

DISCUSSION

The present investigation revealed that the ruminal and reticular mucosae at 8 cm CVR length goat foetuses simulated that described at 113-130 mm CVR length in sheep foetuses (FATH EL-BAB, et al. 1983) as the mucosae were smooth and covered with stratified columnar epithelium. On the other hand, WARDROP (1961) in lambs, described a stratified cuboidal epithelium during all the prenatal life.

At the early stage of pregnancy in goat foetuses (8-10 cm CVR length) the epithelium of the fore-stomach could be differentiated into 2 zones, basal dark and light luminar zones. Similar findings were mentioned by FATH EL-BAB, et al. (1983) in sheep and ARIAS, et al. (1978) in bovines. The thickness of the dark zone was showen to be decreased with the advancement of development which could be attributed to the decreased mitotic activities of these cell layers.

The lining epithelium of the goat foetuses stomach contained abundant PAS- positivœ substance. Such reactive substances appeared to be decreased gradually as the development progressed. This phenomenon was also recorded in the dog fetal epidermis (MOUSTAFA, 1986), the level of glucose concentration in the epidermal cells is not limited and mainly depend on the blood sugar level (HALPRIN & OHKOWARA, 1967). Since during the first half of foetal life, the liver has not yet assumed the glucose metabolism (ROTHMAN, 1954), the increased accumulation of PAS-positive substance in the epithelium of goat foetuses stoamch during this period of intrauterine life might be required for energy production as well as significant barrier to gastric mucosa.

In the present sutyd, the primordia of the ruminal papillae were observed at 25 cm CVR length while in sheep foetuses, it was observed at 185 cm CVR length (SPAMER, 1907), and at 39.3 cm CVR length (FATH EL-BAB, et al. 1983). However, in bovine foetuses the ruminal papillae primordia were demonstrated at the mid-gestation period (ARIAS, et al. 1973). Although the reticular folds anlage of goat were observed in foetuses of 22 cm CVR, these folds were demonstrated in sheep foetuses of either 18.5 cm CVR length (SPAMER, 1907) or at 24.5 cm CVR length (FATH EL-BAB, et al. 1983). The results of the present work indicated that the histogenesis of omasum was earlier than rumen and reticulum, such findings support the earlier studies in sheep fetuses (WARDROP, 1961 and FATH EL-BAB, et al. 1983). and in bovines (BECKER, et al. 1951).

In the present study the mucosa of the omasum was thrown into laminae with 3 orders at 8 cm CVR length which became 4 orders at 22 cm CVR length. These findings are similar

to those observed in sheep fetuses of 52 and 78 days old, respectively (FATH EL-BAB, et al. 1983). However, RAMRISHNA and TIWARA (1979) demonstrated five orders of omasal laminae in goat fetuses. In addition, the muscular bands were demonstrated in the first, second and third orders of the omasal laminae at 25 cm CVR length. Similar findings were recorded in goat by RAMKRISHNA and TIWARA (1979).

In the present investigation, the gastric pits were demonstrated at 22 cm CVR length and were lined by tall columnar cells. Since these cells are mainly producing mucin and appeared earlier than any other glandular cells, it may be suggested that they are correlated with protective mechanism against forthcoming HCL and pepsin by the parietal and chief cells respectively (ASARI, et al. 1985).

In the work herein the histogenesis of the abomasum coincided to great extend the findings of FATH EL-BAB, et al. (1983) in sheep foetuses. The primary elements of gastric glands within the abomasal mucosa of goat fetal specimens were recorded in 25 cm CVR long goat faetuses. These glands were not demonstrated less than 245 mm CVR length, in sheep foetuses (FATH EL-BAB, et al. 1983) and in 185 mm CVR length sheep foetuses (SRAMER, 1907).

REFERENCES

Arias, J.L.; R. Lanbrera and A. Valentia (1978): Observations on the histological development of the bovine rumen papillae. Morphological changes due to age Zbl. Vet. Med. C. Anat., Histol. Embryol. 7, 140-151.

Asari, M.; H. Oshige; S. Wakui; K. Fukaya and Y. Kano (1985): Histological development of Bovine Abomasum Anat ZNZ., Jena. 159, 1-11.

Becker, R.B.; P.T. Dix Arnold and S.P. Marshal (1951): Development of the bovine stomach during fetal life. J. Dairy Sci., 34, 329-332.

Fath El-Bab, M.R.; R. Schwarz and A.M.A. Ali (1983): Micromorphological studies on the stomach of sheep during prenatal life. Zbl. Vet. Med. C. Anat. Histol. Embryol. 12, 139-153.

Halprin, K.M. and Ohkowara, A. (1967): II. The penetration of glucose into the human epidermis in vitro. J. Invest. Dermatol. 49, 561-568.

Kelany, A.; Fath-El-Bab, M.R.; Schwarz, R.; Kamel, G. and Selim, A.A. (1986): The morphogenesis of the vasculature in fetal skin of goat. XVI Congress of the European Association of Veterinary Anatomists. Budapest 1986.

Lambert, P.S. (1948): Development of the stomach in the ruminant. Brit. Vet. J. 104, 302-310.

Moustafa, Moustafa, M.N.K. (1986): Studies on the histogenesis of the skin of the dog with special reference ot its vasculature Ph.D. Thesis, Fac. Vet. Med., Assiut University, Egypt.

Ramkrishna, V. and G.P. Tiwara (1979): Histological and histochemical observations on the fore-stomach of goat during prenatal life. Acta Anat. 103, 292-300.

Rothman, S. (1954): Physiology and histochemistry of skin. University of Chicago-Press, Chicago Illinosis.

Spamer, G. (1907): Beitrage Zur Entwicklung des wiedekauermagens. Gieben, Universitat, Diss. Med. Vet.

Wardrop, I.O. (1961): Some preliminary observations on the histological development of the fore-stomachs of the lamb. I. Histological changes due to age in the period from 46 days of foetal life to 77 days of postnatal life. J. Agric. Sci. 57, 335-341.

Warner, E.D. (1958): The organogenesis and early histogenesis of the bovine stomach. Am. J. Anat. 102, 33-63.

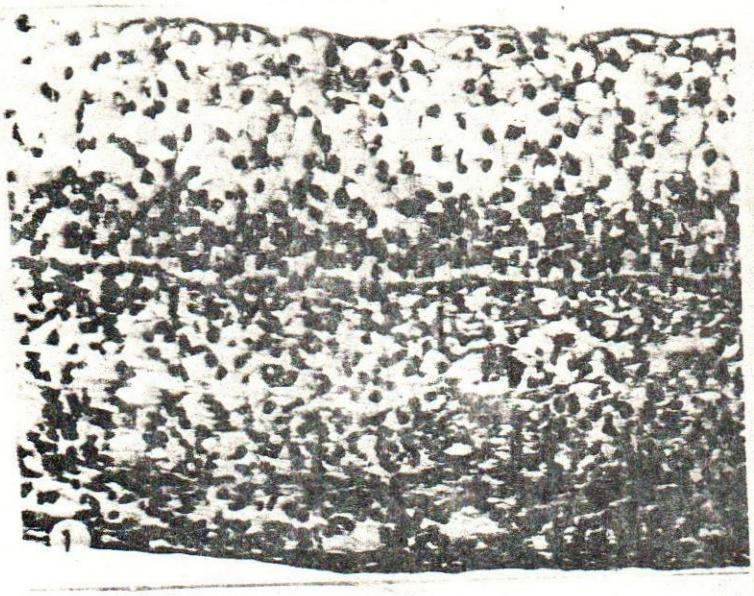
LEGENDS OF FIGURES

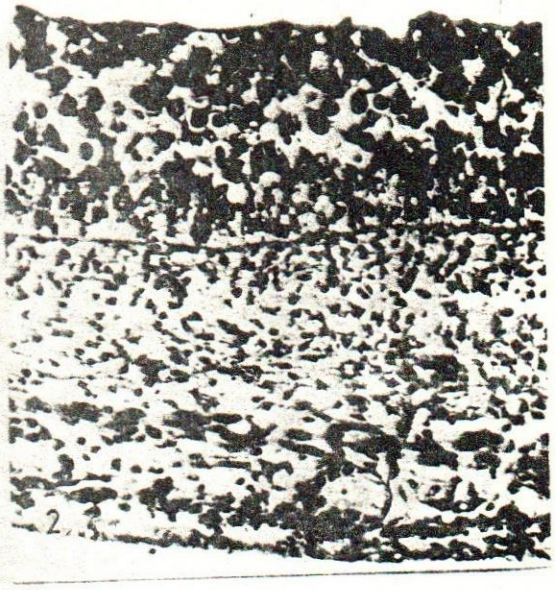
Fig. (1): The wall of the rumen at 9 cm CVRL (Hx & E. 250 X).
Fig. (2): The wall of the rumen at 9 cm CVRL (PAS & Hx, 250 X).
Fig. (3): The wall of the rumen at 22 cm CVRL,
Showing the primordium of ruminal papilla (arrow) (Hx & E. 250 X).
Fig. (4): The wall of the rumen at 33 cm CVRL (PAS & Hx, 160 X).
Fig. (5): The wall of the rumen at 42-45 cm CVRL (PAS & Hx, 160 X).
Fig. (6): The wall of the rumen at 3 days after birth (Hx & E. 160 X).
Fig. (7): The wall of the reticulum at 25 cm CVRL, showing two types of teticular folds (Hx & E. 100 X).
Fig. (8): The wall of the omasum at 8 cm CVRL, showing the types of omasal folds (PAS & Hx. 100 X).
Fig. (9): The large omasal fold demonstrating strips of smooth muscle fibers originating from the inner circular layer of the muscular wall in foetus of 10 cm CVR length (Hx & E. 160 X).
Fig. (10): The omasal fold demonstrating 3 bands of smooth muscle fibers at 25 cm CVR length (PAS & Hx. 160 X).
Fig. (11): Omaso-abomasal Junction at 10 cm CVR length (PAS & Hx. 100 X).
Fig. (12): The mucosa of the abomasum at 10 cm CVR length (Hx & E. 100 X).
Fig. (13): The mucosa of the abomasum demonstrating numerous gastric pits, primordia of gastric glands in foetuses of 25 cm CVR length (Hx & E. 160 X).
Fig. (14): The mucosa of the abomasum demonstrating primordia of gastric glands in foetuses of 25 cm length (Hx & E. 400 X).
Fig. (15): The mucosa of the abomasum at full term foetuses (PAS & Hx. 160 X).

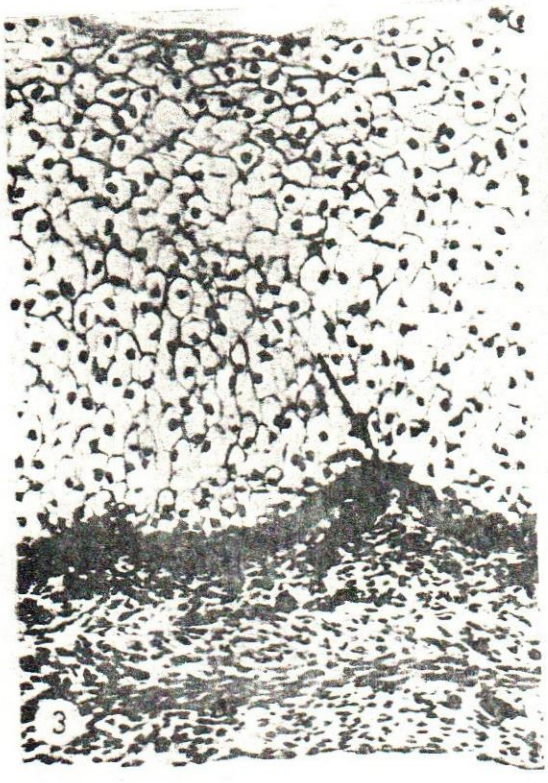
Table (1)
Material available for study

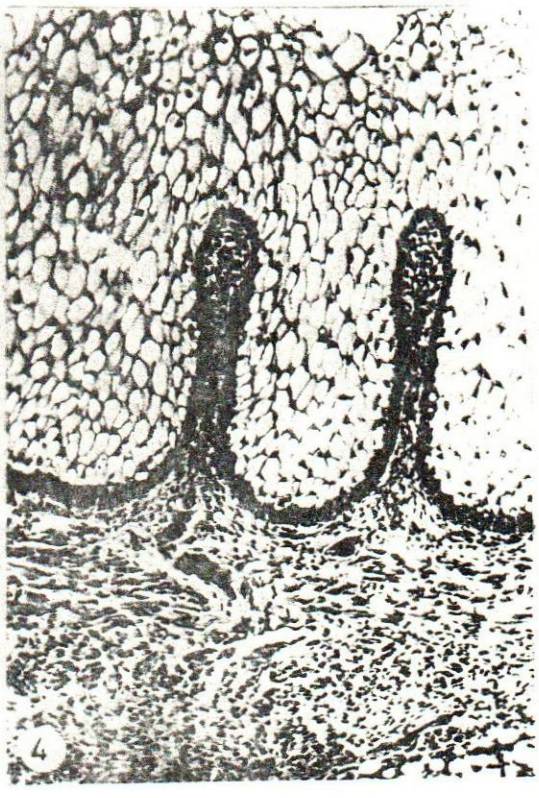
Material No.	CVR (cm)	Weight (g)	Sex
1	80	20	M
2	90	25	M
3	90	25	F
4	100	24	F
5	100	28	F
6	120	37	M
7	160	70	M
8	170	85	M
9	220	180	F
10	250	200	F
11	270	850	M
12	270	800	F
13	320	605	M
14	320	620	F
15	330	880	M
16	420	1250	M
17	420	1300	F
18	450	1290	F

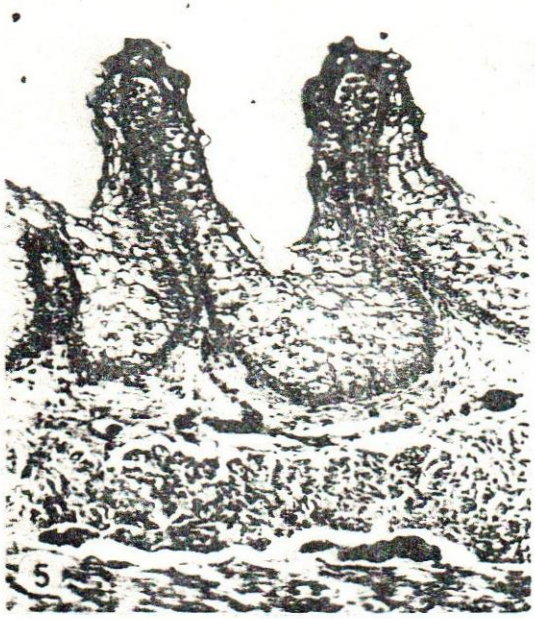
M = Male. F = Female.











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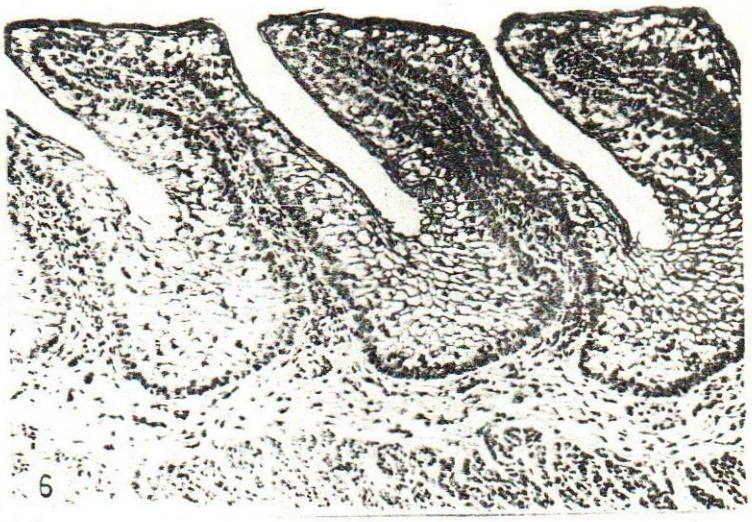

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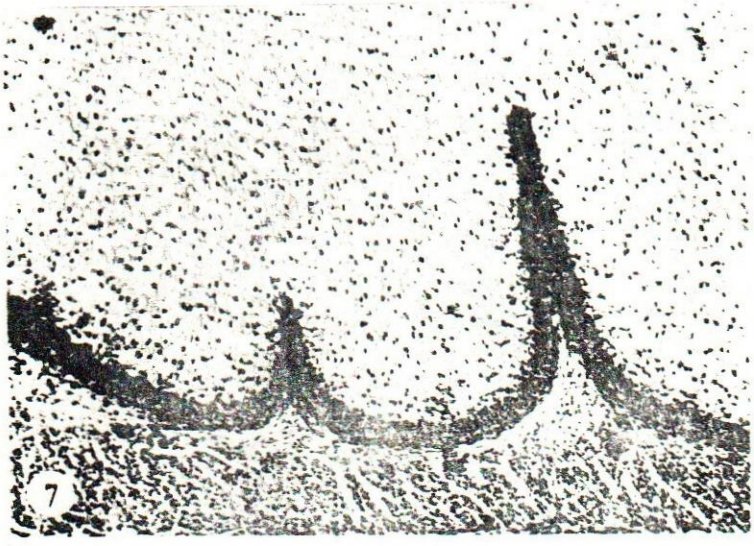

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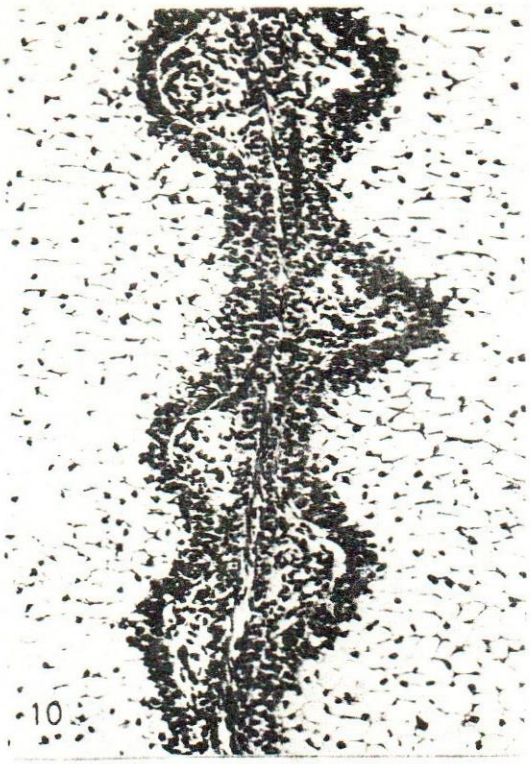

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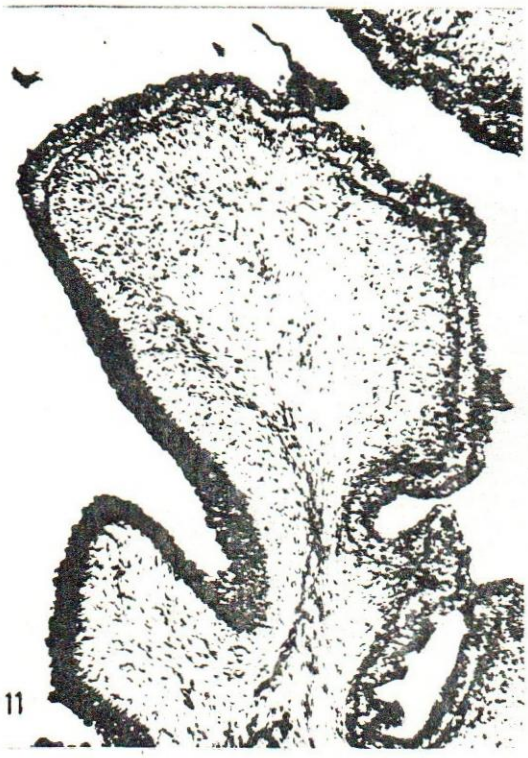

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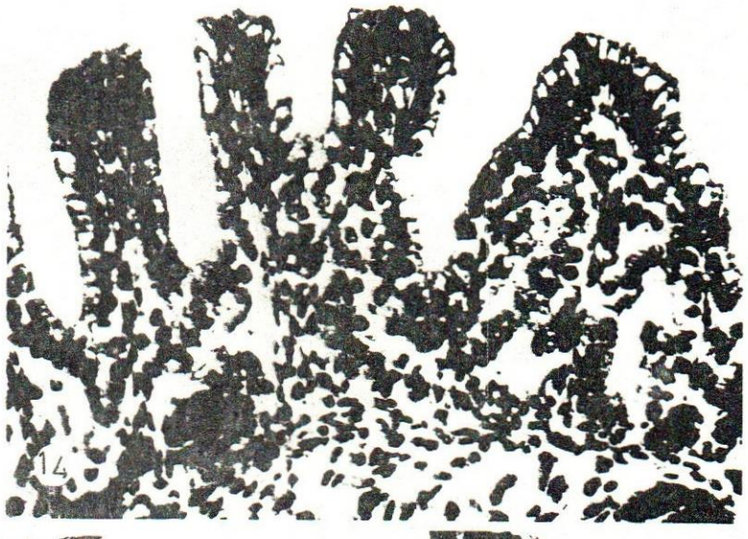
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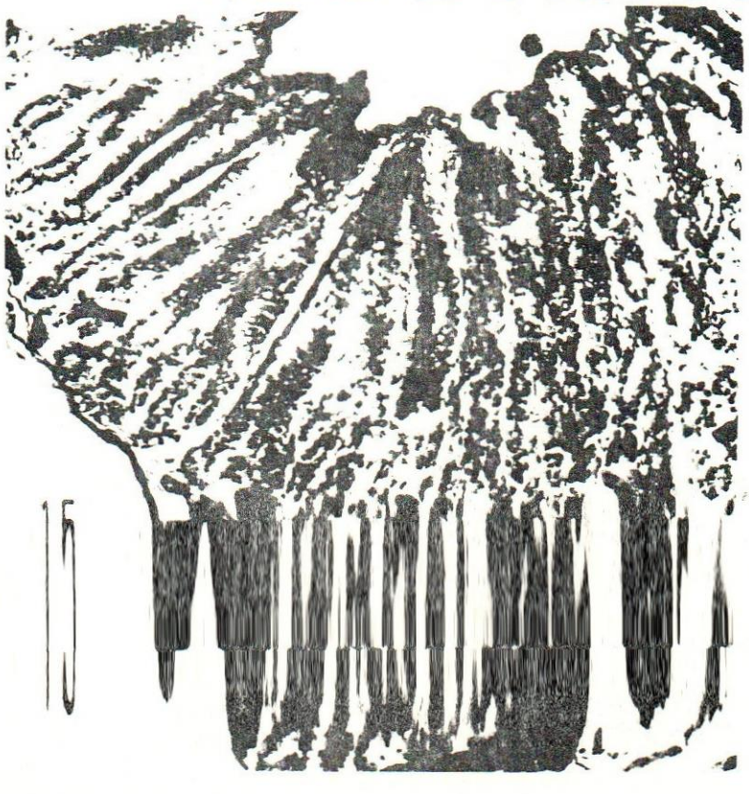
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