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Fine Structure of the Bovine Mandibular Gland

Syusaku SUZUKI, Hayao NISHINAKAGAWA and Junichi OTSUKA
(*Laboratory of Veterinary Anatomy*)
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Introduction

The bovine mandibular gland has been well known to be different from those of other domestic animals in the following respects: The glands are larger than the parotid gland, and the mandibular duct was originated from both ventral and dorsal portions of the gland[1]. After Fahrenholz's review[4], several reports have been made public on the histological and histochemical structures of bovine mandibular gland[2, 6, 10, 15, 16]. As for the ultrastructures of bovine mandibular glands, there are only two reports[16, 17] on the calf mandibular gland which described mainly on the acini. As far as we know, transmission and scanning electron microscopies of adult bovine mandibular glands have not been attempted, yet.

This paper dealt with some of the fine structures of adult bovine mandibular glands and also discussed the secretory mechanism of ruminant mandibular gland in the structural and functional aspects.

Materials and Methods

The mandibular glands obtained from seven adult females were used in this investigation. For light, transmission and scanning electron microscopies, the tissues were removed immediately from the ventral and dorsal parts of the mandibular glands. Details concerning the preparation of tissues were reported in our previous work[25].

Results

Acinus: The acinar epithelia were composed of numerous mucous cells and a few seromucous cells. The former was basophile, and were occupied by light, coarse secretory granules and reacted strongly to periodic acid Schiff (PAS) and Alcian blue (AB), while the latter contained acidophile granules, showing a considerable affinity for PAS, and a faint one for AB. The seromucous cells were found constituted usually with numerous demilunes and a few scattered acini. On the fracture surfaces of the bovine mandibular gland, the seromucous cells noted to have contained a few smooth spherical granules and the mucous cells showed honycombed forms (Fig. 1).

At ultrastructural levels, mucous cells were dense matrix cytoplasm and were occupied by granules with less density. These secretory granules were amorophus granules containing flocculent materials of moderate density and fused with one another in most of these granules, and occasionally corpuscles of moderately dense material were observed. The apical cytoplasm was filled with these secretory granules, which were extruded from the cell by an eruptocrine typed secretion

(Fig. 2). The cytoplasmic organelles were not developed. Golgi apparatus was under developed, and granular endoplasmic reticulum (gER), free ribosomes were distributed sparsely among the secretory granules. Mitochondria were sparsely in the cellular margin or around the nucleus. The luminal surfaces of the mucous cells were lined with a few short microvilli. Intercellular canaliculi were not present between the mucous cells, and the adjacent surfaces of mucous cells were relatively flat, not showing complex interdigitation.

Seromucous cells were of light cytoplasms and contained various secretory granules; round amorophus granules containing a fine vesicular material of moderate density, a homogenous semi-lunar or fan-shaped materials of high density and a homogenous corpuscle of high density (Figs. 3, 4). Moreover, in some cells polymorphic granules were observed (Figs. 5, 6). Golgi apparatus which was composed of flattened lamellae, vesicles and vacuoles was well developed in the supra-nuclear region (Figs. 4, 5). The vesicles and vacuoles containing the flocculent and granular materials, and the small granules containing the corpuscle of high density were occasionally noted in the proximity of the Golgi apparatus. These were occasionally related to Golgi membrane. The gER which were composed of lamellae were well developed. Free ribosomes and mitochondria with flattened cristae were distributed widely throughout the cytoplasm. The luminal surfaces of seromucous cells were lined with thin microvilli as in case of mucous cells. Numerous granules were accumulated in the apical portion and were extruded into the lumen by an eruptocrine typed secretion (Figs. 2, 3). Intercellular canaliculi were present between the seromucous cells, and a few short microvilli were observed. The adjacent surfaces of seromucous cells showed a developed-interdigitation, but the basal borders of those were relatively flat.

Intercalated duct: The epithelial cells of the intercalated ducts were cuboidal, composed of only light cells and were to be stained weakly with PAS but not with AB. Myoepithelial cells were observed around the intercalated ducts. In the apical portions, light cells contained fine granules with less density and vacuoles, but there was no morphological evidence of the exsistence of secretory granules (Fig. 7). Golgi apparatus was under developed, gER and free ribosomes were scattered sparsely throughout the cytoplasm. Mitochondria were distributed relatively richly. Big number of microfilaments were observed in the supranuclear region and around the nucleus. The lateral and basal borders of the intercalated duct cells were relatively flat, and no interdigitation and basal infolding were present. In the scanning electron micrograph, short microvilli were scattered sparsely on the luminal surfaces.

Striated duct: The epithelial cells of the striated ducts composed of light and dark cells were PAS-positive and AB-negative (Fig. 8), and a few epithelial cells which were strongly PAS-positive were observed. No myoepithelial cells were present around the striated ducts.

Light cells composing the majority of component cells of the striated ducts contained fine vacuoles, moderately dense vesicles and a few granules. Most of these were bound by thin limiting membranes (Fig. 9), not showing any morphological evidence of secretory activity. Golgi apparatus scattered sparsely in the supranuclear region was under developed. GER and free ribosomes were sparsely observed but occasionally a few cells contained numerous free ribosomes. Numerous mitochondria and microfilaments were observed in the supranuclear region. The typical basal infoldings were well developed and numerous mitochondria were laid in close relationship to basal infoldings. The lateral borders of the striated duct cells were relatively flat, in some portions showing weak interdigitation.

Dark cells were few in numbers, containing many vacuoles in the supranuclear and apical portions. Golgi apparatus was relatively well developed, being lamellae in shapes. GER were

quite few, free ribosomes were relatively numerous, and mitochondria were far more numerous than those of light cells in the supranuclear regions (Figs. 8, 10).

In transmission and scanning electron micrographs, the luminal surfaces of the epithelial cells of striated ducts were similar to those of the bovine and goat parotid glands reported previously, and were characterized by two features, one was the flat or fold-like structures, the other was the variously sized spheroidal protrusions (Figs. 11, 12).

No specific basal cells noted in the striated ducts of goat, and bovine parotid glands reported previously were detected in the bovine mandibular glands.

Discussion

The acini of bovine mandibular glands were composed of the acini having seromucous demilunes, seromucous acini and mucous acini. Seromucous acini and demilunes were stained weakly with PAS and AB.

In about 1900, it was known according to the Fahrenholz's review[4] that the bovine, goat and sheep mandibular glands are mixed glands. Henceforward, Kay[6] and Chauncey and Quintarelli[12] described the mandibular gland of the cattle and sheep as mixed glands, and Wilson and Tribe[27] reported that the lamb mandibular glands were mixed gland having the demilunes. Moreover, Mori[10] and Shackleford and Klapper[15] classified, as seromucous in nature, the bovine mandibular demilunes which, heretofore, were categorized as serous cells. Quintarelli[12] reported that the demilunar cells of sheep mandibular glands are different from the serous cells of other salivary glands and are stained with AB. Henceforward, Shackleford and Wilborn[16] and Suzuki and Otsuka[20] reported that the acini of the mandibular glands in the cattle, sheep and goats are composed of the mucous cells and a few seromucous cells. According to these reports and the present observations, the demilunar cells and a few serous cells of the bovine mandibular glands are seromucous in nature as in case of the demilunar cells of goats and sheep. Therefore, it may be asserted that the bovine mandibular gland are composed of the mucous acini having the demilune which are of seromucous cells, a few pure mucous acini and only a few seromucous acini.

In the bovine and sheep mandibular glands, Shackleford and Wilborn[16, 17] observed the presence of mucous granules of low density in the mucous cells and described of the granules seen occasionally in close proximity of the Golgi membranes. They stated, however, that intercellular canaliculi are not present in the mucous acini. In the present study, the seromucous cells of the bovine mandibular gland contained the granules various both in density and in shape. These granules were observed in close relation to the lumen and intercellular canaliculi. In the parotid glands of cattle[25], goats[19] and rabbits[21], as described previously, the granules with various densities are heterogenous, respectively, and are looked upon as mature forms of granules, while polymorphic granules may be looked upon as immature forms of granules as described in mice[8], rats[7] and rabbits[21]. The granules of mucous cells and these mature granules of seromucous cells were extruded from the cell by the working of eruptocrine type (KUROSUMI'S IV type[9]) as in case of the mucous granules of goat[20], horse[22] and dog[20], and as in that of seromucous granules of the horse[22], rabbit[23] and dog[20] mandibular glands. The demilunes and seromucous acini showed intercellular canaliculi, and intercellular tissue spaces were well developed in comparison with mucous acini. These structures were similar to those of the mandibular glands in other domestic animals[20, 22].

The epithelial cells of intercalated ducts in bovine mandibular glands were weakly reacted to

PAS, but not stained with AB. In light microscopy, several reports have been made about the intercalated ducts of goat[20], horse[22], rabbit[3,5,15,23], dog[16,19] and cat[16] mandibular glands, but there are very few reports about the intercalated duct of bovine mandibular glands[15]. A lot of authors[3,5,15,16,20] reported that the epithelial cells of the intercalated ducts showed a slightly PAS-positive substance, not showing AB-positive one. In electron microscopy, Shackleford and Wilborn[17] described that in calf mandibular gland, the intercalated ducts are lined with simple cuboidal epithelial cells containing electron lucent vesicular structures and a few moderately electron dense granules, both of which might be some secretory substances. In the present study, the intercalated duct cells of bovine mandibular glands showed no morphological evidence of the existence of secretory granules though in apical portion the fine vacuoles and granules were contained. These are looked upon as secretory materials as described in the calf[17] and rat[14] mandibular intercalated duct cells and in the goat[19] parotid intercalated duct cells.

Concerning the striated ducts, Reifel and Travill[13], Shackleford and Klapper[15], Shackleford and Wilborn[16] and Suzuki and Otsuka[20] reported that the epithelial cells of striated ducts in bovine, sheep, goat, dog and cat mandibular glands are well developed and are reacted with PAS, but not stained with AB. Moreover, on the cat mandibular glands, Tachii[26] described that the epithelial cells of striated ducts contain neutral mucopolysaccharide, not containing acid one. In the present study, the striated duct cell of the bovine mandibular glands showed a light-microscopically similar structures. At ultrastructural levels, the epithelial cells of the striated ducts contained the vacuoles and fine granules in apical portion. Concerning these vacuoles and fine granules, there are similar reports in calf[17] and cat[18] mandibular glands, but no report mentions the point that these structures are either secretory granules or absorption substances. In the present study these structures were not fixed either secretory granules or absorption substances. From the specialization of the apical surfaces of striated duct cells as described previously in bovine[25] and goat[19] parotid glands, however, these vacuoles and fine granules are considered to be secretory materials.

As described in the previous reports, the bovine[25] and goat[19,24] parotid gland were considered to have been closely related with the secretory mechanism of saliva in ruminants, but the bovine mandibular glands did not show such morphological evidence as suggested enormous amount salivation as in case of the mandibular glands of the other non-ruminants. Therefore, it was assumed that the results of the present investigation support the assertions made by Kay[6] that sheep mandibular saliva is less than 1/8 of parotid saliva in volume, and that the concentrations of Na^+ and HCO_3^- of chemical composition of mandibular saliva are less than 1/10 of parotid saliva. Moreover, from the histological observations made by Otsuka and Deguchi[11] that the density of small blood vessels of mandibular gland in goats is less than 1/2 of parotid glands, it may reasonably be concluded that the bovine mandibular glands do not produce such enormous quantity saliva as parotid glands in ruminants.

Summary

The bovine mandibular glands were examined with the use of transmission, scanning electron- and light-microscopes.

The bovine mandibular glands were composed of the acini having the demilune which are of seromucous cells, a few mucous acini and only few seromucous acini. The mucous cells were basophile and were occupied by light coarse secretory granules and reacted strongly to PAS and

AB. The seromucous cells contained acidophile granules, showing a considerable affinity for PAS, and a faint affinity for AB. The mucous cells contained granules of less density. Between the mucous cells, intercellular canaliculus was absent. The seromucous cells contained various granules. Intercellular canaliculus was present between the seromucous cells.

Intercalated ducts were lined with simple cuboidal epithelial cells, which were composed of only light cells and were to be reactive to PAS, but not to be stained with AB. The vacuoles and fine granules were observed in the apical portion of the epithelial cell, but showed morphological evidence of secretory activity.

Striated duct cells were PAS-positive and AB-negative, and were composed of light and dark cells. These cells contained relatively numerous fine vacuoles and granules, but showed no morphological evidence of secretory activity. The luminal surfaces of the epithelial cells were characterized by two features: The one was the flat or fold-like structures, the other was ovoidal or spheroidal protrusions of various sizes.

Myoepithelial cells were found around the acini and intercalated ducts.

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Explanation of figures

Fig. 1. A scanning electron micrograph of the acinar cells in the bovine mandibular gland. Mucous cells showing honycombed forms and seromucous demilunar cells containing a few smooth spherical granules are observed.

Fig. 2. Mucous cells and seromucous cell of the bovine mandibular gland. Mucous cells are occupied by the amorophus granules containing flocculent materials and corpuscle of moderately dense material. These granules are extruded into the lumen by an eruptocrine typed secretion. Seromucous cell contains various secretory granules.

Fig. 3. Seromucous cells of the bovine mandibular gland. These cells contain secretory granules extruded from the cell by an eruptocrine typed secretion.

Fig. 4. Secretory granules of the seromucous cell in the bovine mandibular gland. Some round corpuscles of high density are observed in the moderate matrix of secretory granules. Golgi apparatus is well developed.

Figs. 5, 6. Secretory granules of the seromucous cells in the bovine mandibular gland. The polymorphic granules reveal various substructures. Golgi apparatus is well developed.

Fig. 7. Intercalated duct cells of the bovine mandibular gland. Granules of less density and vacuoles are present in the apical portions.

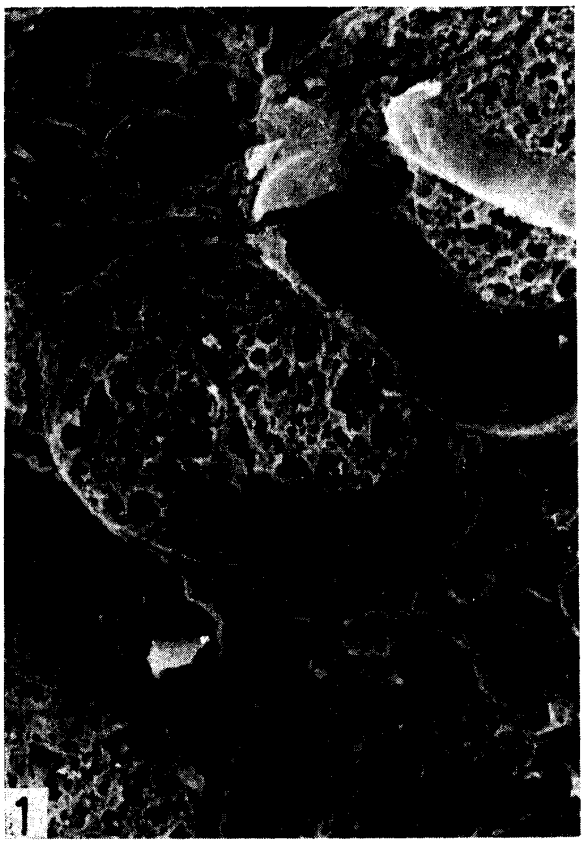
Fig. 8. Striated duct cells of the bovine mandibular gland. Light cells and dark cell are observed.

Fig. 9. Light cells of the striated duct in the bovine mandibular gland. Numerous fine vacuoles, moderately dense vesicles and granules are observed in the apical portion.

Fig. 10. Dark cell of the striated duct in the bovine mandibular gland. Dark cell contains many vacuoles in the apical portion and numerous mitochondria are present in the supranuclear regions.

Fig. 11. A scanning electron micrograph of luminal surface of the striated duct in the bovine mandibular gland. The surface shows flat, fold-like structures and protrusions with numerous short microvilli.

Fig. 12. A scanning electron micrograph of the striated duct and acini in the bovine mandibular gland. The luminal surface of the striated duct shows numerous protrusions.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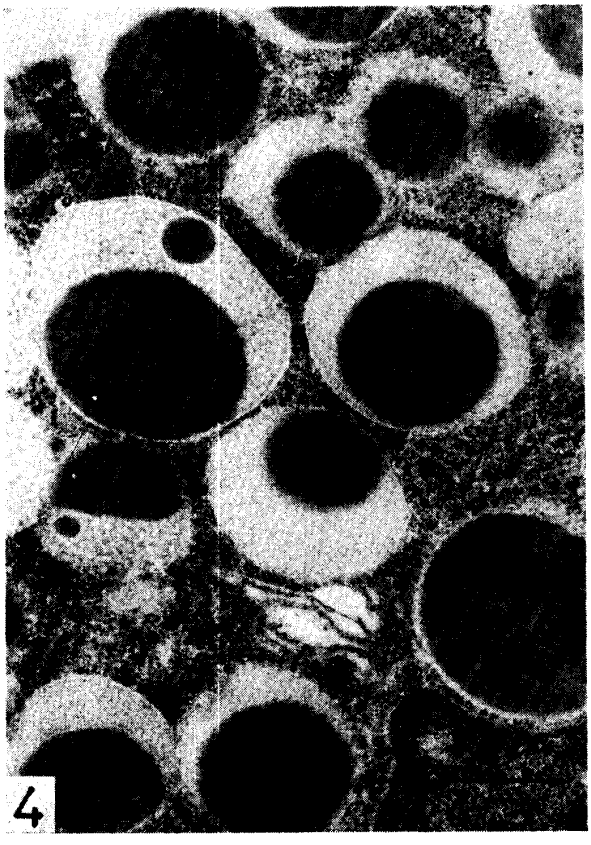
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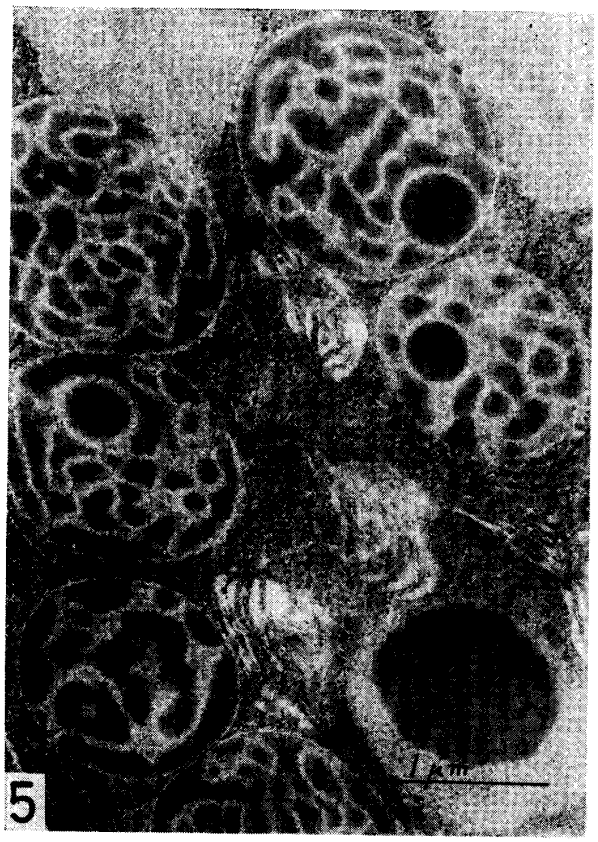

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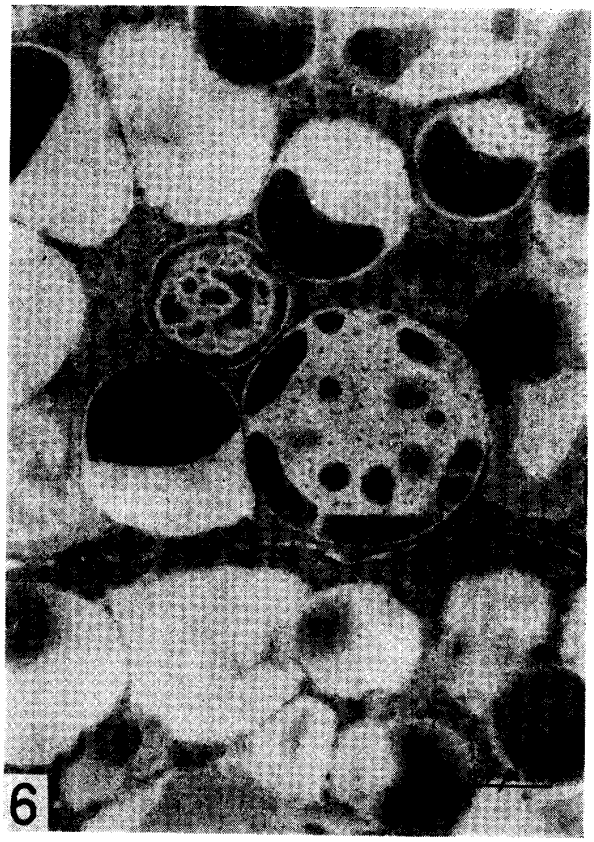

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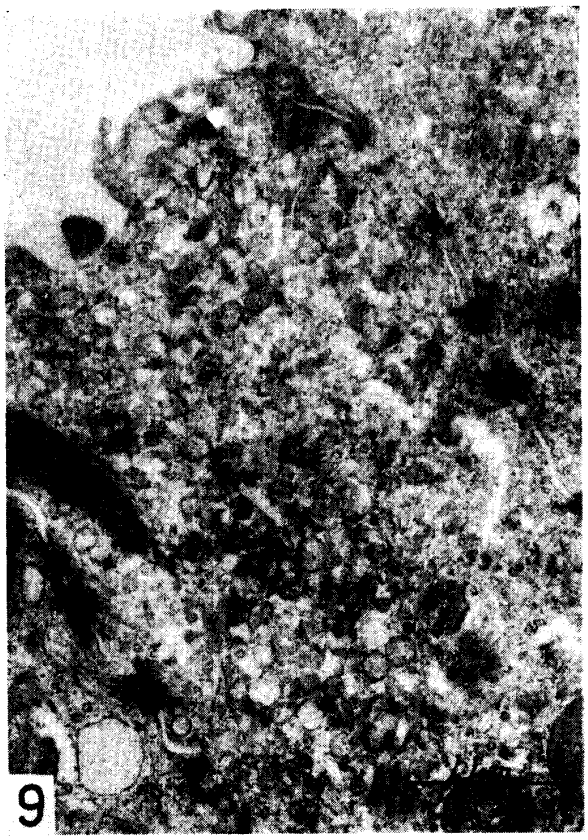
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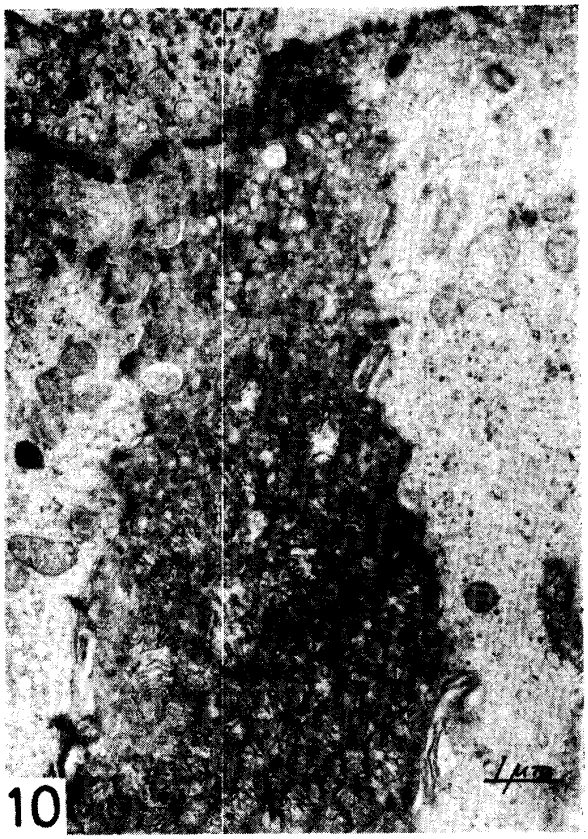
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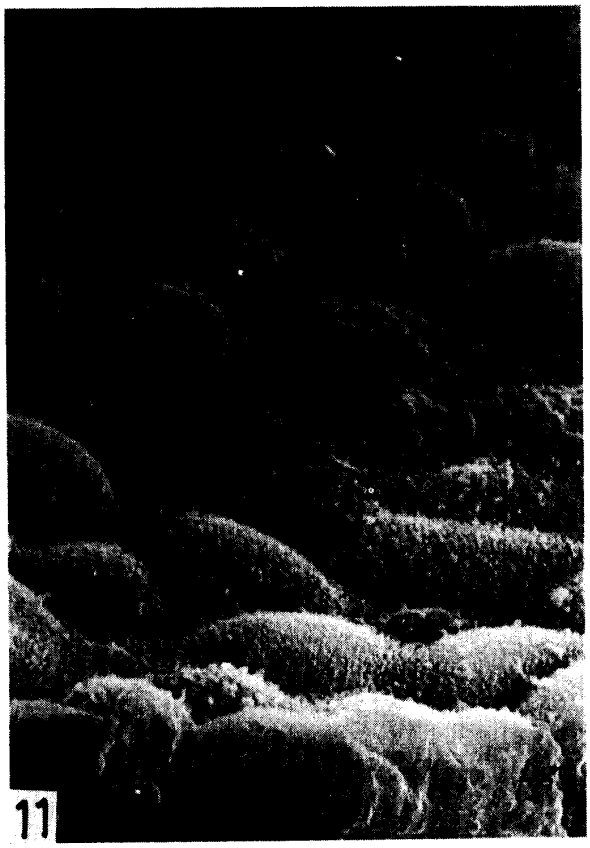
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