The Main Excretory Duct (Stensen's) of the Human Parotid Gland: A Transmission and Scanning Electron Microscope Study*

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Summary. The epithelial cells of the human parotid main excretory duct (Stensen) were studied by transmission (TEM) and scanning (SEM) electron microscopy through a variety of procedures that allowed the visualization of their three-dimensional microanatomy. Stensen's duct in humans is lined, in its distal portion, with a pseudostratified epithelium with tall principal cells and smaller basal cells, while the epithelium becomes progressively stratified cylindrically toward the oral stoma. Goblet cells are scattered among the other epithelial cells. The principal cells exhibit, on their lateral surfaces, numerous flattened laminar folds probably involved in transporting processes. A well-developed smooth endoplasmic reticulum intermingled with mitochondria occupies the cellular apices. Some vesicles are recognized on the cytoplasmic surfaces of the apical and lateral plasmalemma when cytoplasmic organelles are removed. All these features are interpreted as being involved in the process of endocytosis.

In both TEM and SEM, the principal cells show a relevant number of irregular apical protrusions that may represent a kind of apocrine secretion. Thus, with regard to function, the human Stensen's duct seems to modify the composition of saliva by processes of resorption and secretion, the latter coming from goblet cells as well. The basal cells have a surface microanatomy completely different from that of principal cells. They exhibit, in fact, only sparse microvilli and smooth areas on their lateral aspect, while their stromal surface is greatly augmented by irregular thin ramified processes. The role of basal cells is also discussed.

By the use of microdissection coupled with techniques that remove the connective tissue and the basal lamina (EVAN et al., 1976; MILLER et al., 1982; TAKAHASHI-IWANAGA and FUJITA, 1986) and facilitate the exposure of lateral cell surfaces (LOW and MCCLUGAGE Jr., 1984; GATTONE and CONFORTI, 1985; LOW, 1989; MAGGIONI et al., 1989; RIVA et al., 1991), it is possible to visualize the three-dimensional microanatomy of a cell. Moreover, a newly introduced procedure (RIVA et al., 1993a) for the study of bi-optical material by the OsO₄ maceration method (TANAKA and MITSUSHIMA, 1984) provides more details on the three-dimensional shape and arrangement of cellular organelles even in human tissues. With these improved procedures, new information has been added recently to the three-dimensional architecture of human salivary glands (RIVA et al., 1991, 1992, 1993b; RIVA, 1992). In particular, RIVA et al. (1993b) report that cells of each glandular segment possess their own three-dimensional microanatomy, and suggest that they may play a distinct, particular role in the mechanisms of saliva production. In experimental animals, micropuncture studies have in fact demonstrated that salivary glands have portions endowed with different transport properties (SCHNEYER et al., 1972). In contrast with the main excretory duct (MED) of the submandibular gland (TESTA RIVA et al., 1981, 1987), only a few scattered reports are available on the human parotid MED (PUXEDDU et al., 1988; RIVA et al., 1990, 1993b; TANDLER, 1993), which has received less attention in animals as well (HAND, 1981; SATO, 1982; SATO and MIYOSHI, 1988). The aim of this work is to describe the fine structure of the main excretory duct epithelium of the human parotid

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gland by combining scanning (SEM) and transmission (TEM) electron microscopic findings. In an attempt to give a functional meaning to the structures seen here, our results will be compared with those observed in transporting epithelia of experimental animals.

MATERIALS AND METHODS

Specimens were collected from 10 female and 8 male subjects aged 27–75 years at the time of operation for the removal of tumors of the parotid gland. All the patients were under general anesthesia and had been treated with small doses of atropine and muscle relaxants. All tissues looked normal on routine histological analysis.

For TEM studies, specimens were treated according to the protocol reported in our previous papers (TESTA RIVA et al., 1981; RIVA et al., 1988). For SEM studies, besides the standard procedure (TESTA RIVA et al., 1981), the methods for the visualization of basal and lateral cell surfaces and those for the three-dimensional study of intracellular organelles were used. For the former purpose we employed the NaOH maceration method by TAKAHASHI-IWANAGA and FUJITA (1986). Specimens fixed for a minimum of 6 h with a mixture of 1% paraformaldehyde and 1.25% glutaraldehyde in 0.1 M cacodylate buffer were cut into 150 μm thick sections by a Sorvall TC2 tissue sectioner. The sections were treated with 6 N NaOH for 8–20 min at 60°C, washed with phosphate buffered saline and, in some cases, sonicated at 50 Hz for 1 min (LOW and McCLUGAGE Jr., 1984; GATTONE and

Fig. 1. Survey TEM image of the duct epithelium in its distal portion, showing tall principal cells (pc) and smaller basal cells (bc). A membrane bounded cytoplasmic fragment (arrowhead) apparently in the act of being detached is present in the lumen. The arrows indicate some lipid droplets and a lipofuscin granule. ×1,600

Fig. 2. Section of the duct epithelium which, in its proximal portion, has become cylindrically stratified. ×1,600
CONFORTI, 1985; LOW, 1989; MAGGIONI et al., 1989; RIVA et al., 1991). They were then dehydrated and subjected to critical point drying with CO₂. Some of the dried sections were mounted on stubs and micro-dissected by fine needles using a Narishige micro-manipulator.

For the demonstration of intracellular organelles, specimens fixed for 20 min in a mixture of 0.2 paraformaldehyde and 0.25 glutaraldehyde in 0.1 M cacodylate buffer were treated according to our maceration technique (RIVA et al., 1993a) which, unlike the original method (TANAKA and MITSUSHIMA, 1984), was carried out on sections of approximately 150 μm obtained at room temperature by a tissue sectioner. Maceration with 0.1% OsO₄ was carried out either at room temperature for 60 h or at 45°C for 3 h.

Dried specimens were coated at 2 kV and 1.5 A for 4 min with gold palladium in a Polaron E 5100 cool sputtering apparatus. Observations were made with a FE Hitachi S 4000 SEM operated at 20 kV.

RESULTS

The main excretory duct of the human parotid gland collects the secretion from intraglandular excretory ducts. The distal portion of the MED is typically lined with a pseudostratified epithelium with tall principal cells and smaller basal cells (Fig. 1), while toward the oral stoma the epithelium becomes progressively stratified cylindrically (Fig. 2). Some scattered goblet cells also are found among the other epithelial cells.

Principal cells

The principal cells are tall prismatic in shape and extend from the lumen to the basal cells (Figs. 1–3), reaching the basal lamina only at a few points by slender processes. At SEM after fracture and micro-dissection, the lateral cell surfaces exhibit numerous

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Figs. 5-8. Legends on the opposite page.
flattened laminar folds irregularly oriented and, in the apical portion, a narrow smooth band (Fig. 3) corresponding to the zone where in TEM junctional complexes are seen (Fig. 4). These latter constitute well developed zonulae occludentes and adhaerentes followed by spot desmosomes. Below the junctional apparatus, TEM shows the lateral contours of adjacent cells as highly pleated plasma membranes (Fig. 4), extensively interdigitated with each other, and joined by spot desmosomes only where the two faced membranes show a fairly straight course. Typical desmosomes also link principal and basal cells. When the principal cells reach the basal lamina, their basal plasmalemma appears regularly thickened on the cytoplasmic aspect. True hemidesmosomes are not seen (Fig. 5).

In macerated specimens subjected to sonication, cytoplasmic organelles are removed and the cytoplasmic surface of lateral plasmalemma becomes accessible to inspection, revealing some smooth irregular folds oriented toward the insides of cells and clefts (Fig. 6) corresponding to the pilections seen on the lateral cell surface (confer with Figs. 3, 4). Sparse small rounded structures (Fig. 6) which are often attached to the cytoplasmic surface of the lateral plasmalemma might represent vesicles in transit across the membrane.

Many short microvillusities and irregular cytoplasmic protrusions of different sizes appear by SEM on the luminal surfaces of principal cells (Fig. 7). By TEM the protrusions (Fig. 4) generally contain an homogeneous cytoplasm, devoid of or with scarce organelles. Clear vesicles of variable numbers and sizes, though generally small, are present in the apical cytoplasm (Fig. 4). They may be either empty or contain a faint filamentous material. Some of these vesicles seem to be about to fuse their membrane with the apical plasmalemma, in the process of a progressive constriction of the base of the projection (Fig. 4) until its detachment (Fig. 1) from the cell (apocrine secretion). Occasional membrane bounded cytoplasmic fragments are observed in the lumen without any apparent connections with the cells. In macerated specimens, the apical plasmalemma viewed from the inside appears riddled with small round holes corresponding to the origin of microvillosities and some large irregular cavities corresponding to the inside of the apical protrusions (Figs. 6, 8, 9). Spherical or oblong small bodies (vesicles ?) are also seen attached to the cytoplasmic surface of the apical membrane (Figs. 6, 8).

The nucleus (Figs. 1, 2) has a central position and is generally ovoidal in shape with more or less pronounced indentations. Its chromatin is dispersed aside from small clumps of heterochromatin along the inner side of the nuclear envelope and scattered in the nucleoplasm. A well developed nucleolus is often present. Several small stacks of Golgi cisternae are placed around the nucleus, especially above its apical pole.

The mitochondria are numerous and particularly abundant in the apical cytoplasm (Figs. 9–11). Both in TEM and in the sectioned specimens in SEM, they appear ovoidal or rod-shaped with cristae oriented in all directions (Fig. 11). On the other hand, entire mitochondria look—by TEM—as twisted, sometimes bifurcated tubuli (Figs. 9, 10).

Only a few sections of rough endoplasmic cisternae can be commonly found. The smooth endoplasmic reticulum, on the other hand, is well represented chiefly in the apical third as seen by SEM. With the osmium maceration procedure, it fully displays its three-dimensional morphology and its extensive development. The smooth endoplasmic reticulum appears to constitute a network of anastomozed tubules which, in the apical cytoplasm, are tightly

**Fig. 5.** TEM image showing a portion of a principal cell (pc) and its relation to basal cells (bc) and to the basal lamina. Many hemidesmosomes stud the basal plasmalemma of the basal cell; they are lacking in principal cells. In the zones of the basal cell plasmalemma devoid of hemidesmosomes, sparse caveolae (arrows) are evident. ×16,000

**Fig. 6.** SEM image of principal cells in a macerated specimen subjected to sonication for the removal of cytoplasmic organelles. The cytoplasmic surface of lateral plasmalemma exhibits some smoothed irregular folds, sparse small vesicles attached to it, and clefts (arrow) corresponding to the lateral pilections seen in TEM in Figure 4. In the upper left portion of this picture the apical plasmalemma, seen from its cytoplasmic side, shows small holes corresponding to the inside of microvilli and some rounded structures, probably vesicles, attached to it. ×7,700

**Fig. 7.** SEM panoramic view of the luminal surfaces of principal cells. Many short microvilloisities and irregular protrusions are noticeable. ×2,700

**Fig. 8.** Cytoplasmic surface of the apical plasmalemma seen at high magnification by SEM. Note the small holes corresponding to the origins of microvillosities and larger and irregular cavities (asterisks) representing the insides of apical protrusions. Some rounded structures, probably vesicles, appear attached to the plasmalemma. ×33,000
intermingled with numerous mitochondria (Figs. 9-11). The cytoplasmic surface of this reticulum exhibits small spherical vesicles attached to it. Membrane-bounded bodies of peculiar features were encountered in some specimens. They consisted of multiple series of lamellae tightly packed in para-cristalline arrays with different orientations (Fig. 12a, b), as was better appreciable in transverse sections (Fig. 12b). Several rounded lipid droplets of variable size and lipofuscin granules were commonly encountered (Fig. 1). Myelin figures, dense bodies, and lysosome-like vesicles also are found in the cytoplasm.

A kinetosome-like structure is frequently observed by TEM in the apical cytoplasm (Figs. 4, 13) longitudinally oriented according to the vertical axis of the cell. It may exhibit cross striated rootlets merging from its proximal extremity toward the cell base and lateral projections from its distal third (Figs. 4, 13). Only very seldom did we happen to find a pair of centrioles lying perpendicular to each other, either near the nucleus or in the cellular apex.

**Basal cells**

The basal cells evidently rest on the basal lamina and are linked to the principal cells by means of desmosomes (Fig. 1). By TEM, their lateral membranes exhibit short cytoplasmic processes which interdigitate with those of adjacent basal cells and with the folds of principal cells. This arrangement is more noticeable in those specimens where sporadic basal or principal cells are more electron dense (dark cells).

The basal cells are coarsely cuboidal or low pyramidal in shape, extending, from the cell base, very irregular thin ramified processes (Fig. 14). These
latter greatly increase, with a complicated pattern, the stromal surface of the cell and rest on a continuous basal lamina which closely follows their irregular contours. Many hemidesmosomes quite regularly stud the basal plasmalemma of these cells which are easily distinguishable, for this reason, from every possible adjacent process of principal cells (Fig. 5). The zones of basal plasmalemma devoid of hemidesmosomes may exhibit sporadic caveolae, or flask-shaped membrane invaginations and clear vesicles (Fig. 5).

The nuclei have irregular indented contours and some deep notching; peripheral clumps of heterochromatin and a nucleolus are often present. Numerous dense filaments (Figs. 5, 14) run through the cytoplasm and are frequently aggregated in bundles; some of them emanate from the desmosomal and hemidesmosomal cytoplasmic plaque. A small Golgi apparatus and several rod-like mitochondria also are evident.

When the epithelium has been denuded of its usual covering of fibrous connective tissue and basal lamina, the stromal surfaces of basal cells become evident and exhibit hollow areas with irregularly protruding narrow contours (Fig. 15). These latter seem to correspond to the thin ramified basal processes observed in Figure 14 by TEM. Microdissection techniques allow the demonstration of even the complementary connectival surface (Fig. 16) that shows deep grooves (in which the processes of basal cells fit) and rounded irregular protrusions (which fit into the hollow areas of basal cells). At higher magnification, the surface of connective tissue abutting on the epithelium appears comprised of a close fibrillar network that probably corresponds to the pars fibroreticularis of the basal membrane (Fig. 17).

By SEM the apico-lateral surfaces of basal cells become apparent in fractured and microdissected specimens. With this method the plasmalemma exhibits, on its external aspect, only sparse short microvillocities and smooth areas, giving the basal cells a surface morphology wholly different from those of principal cells (Figs. 3, 18).

Goblet cells

By TEM, most of the goblet cells encountered abut on the lumen and are crowded with mucous droplets.
Fig. 13. A longitudinally sectioned kinetosome-like body in the apical cytoplasm of a principal cell. Striated rootlets and a lateral projection (*arrow*) are evident. × 30,000

Fig. 14. TEM view of irregular ramified processes of basal cells resting on a continuous basal lamina. Many hemidesmosomes dot the basal plasmalemma. Bundles of dense filaments run through the cytoplasm. × 16,000
Fig. 15. Stromal surface of basal cells seen by SEM after removal of the connective tissue and of the basal lamina. Hollow areas (asterisk) are delimited by irregularly protruding contours corresponding to the ramified basal cell processes illustrated in Figure 14. ×1,200

Fig. 16. This microdissected connectival surface is complementary to the stromal surface of basal cells seen in the previous picture. ×1,200

Fig. 17. Enlargement of the connectival surface showing a close fibrillar network probably corresponding to the pars reticularis of the basal membrane. ×5,500

Fig. 18. Basal cell (bc) seen by SEM in a fractured and microdissected specimen. The external surface of its plasmalemma appears covered with sparse short microvillosities, markedly different from the long flattened folds of the principal cells (arrow). ×5,500
(Fig. 19). At the cellular apex the mucous droplets may fuse in large masses which in turn fuse with the apical plasmalemma by a mechanism of exocytosis. This process brings the forming of channels into continuity with the lumen. The general features of goblet cells are similar to those described in other human epithelia. By SEM some goblet cells appear evident in panoramic views of the epithelial apical surfaces seen from the lumen. They are easily recognizable for the prominence of their apices (Figs. 20, 21), probably engaged in the process of discharging their secretion. In contrast with the neighboring apices of principal cells, those of goblet cells appear devoid of microvillae and exhibit only irregular reliefs.

We have encountered some myelinated and non-myelinated axons in the stroma around the duct epithelium, whereas hypolemmal fibers have not been noticed.

DISCUSSION

It is generally accepted that the isotonic primary saliva, elaborated in the secretory endpieces, is modified as it passes down the duct system, with a decrease in its osmolality through a mechanism of ion transport (SCHNEYER et al., 1972; MARTINEZ, 1987; BRADLEY, 1991; TANDLER, 1993). Microperfusion and micropuncture studies of the submandibular MED from experimental animals (MARTINEZ et al., 1966; SCHNEYER, 1968; MARTINEZ, 1987) have provided evidence that, like striated and excretory ducts, the main duct is also implicated in electrolyte transport. Owing to the absence of experimental physiological data on the human salivary duct system, the functional results obtained from laboratory animals (mainly the rat) have generally been extrapolated to humans as well. However, if we compare the morphology of human salivary duct epithelia (RIVA et al., 1976; TESTA RIVA et al., 1981; RIVA et al., 1990; LANTINI et al., 1990; RIVA et al., 1992) with that of the rat (SHACKLEFORD and SCHNEYER, 1971; SATO, 1980, 1982; HAND, 1981; SATO and MIYOSHI, 1988) we can find remarkable differences. Since human saliva also is modified as it flows along the duct system (BRADLEY, 1991; TANDLER, 1993), in view of the close relationship between structure and function in transporting epithelia (BERRIDGE and OSCHMAN, 1972), we can hypothesize that the mechanisms involved in humans for these modifications are somewhat different from those implicated in salivary ducts of the rat. On the other hand, it seems useful to compare the individual cytoarchitectural characteristics of the human parotid MED epithelium with similar structures of other transporting epithelia whose function has been elucidated by experimental studies.

The principal cells of human parotid MED, at variance with light Type I and dark cells of the rat (SATO and MIYOSHI, 1988), are completely devoid of basal plasmalemma plications and show, instead, considerable lateral interdigitations like those found in cat (TANDLER and POULSEN, 1976), human (TESTA RIVA et al., 1981), or Japanese monkey (SATO et al., 1993) submandibular MED and in human salivary excretory ducts (LANTINI et al., 1990). These lateral plications unquestionably increase the lateral membrane surface area which can be engaged in enzymatic and transporting processes (RHODIN, 1974), while the abundant mitochondria can provide the necessary energy supply, as discussed, for analogous arrangement, in human salivary excretory ducts (LANTINI et al., 1990). Similar functions have been ascribed to the
lateral interdigitations of cells in Japanese monkey submandibular MED (Sato et al., 1993) which exhibits ultrastructural features more like those of the Stensen's duct epithelium in humans. Thus, the process of changing the osmolality of final saliva through some kind of ion or molecular transport in the highly folded lateral plasmalemma is also likely in the principal cells of the parotid MED, even if the mechanisms by which this happens in humans are, at present, not elucidated.

A well developed smooth endoplasmic reticulum, associated with many mitochondria, is revealed by the osmium maceration method at SEM in the apices of the principal cells in human parotid MED. A fairly well developed smooth endoplasmic reticulum was observed in the same zone of rabbit submandibular (Toyoshima and Tandler, 1986) and rat parotid (Coleman and Hand, 1985) striated duct cells, where it was considered to be involved in the uptake of materials from the lumen. Moreover, Mollgard and Rostgaard (1978) demonstrated, in some sodium transporting epithelia, a system of smooth endoplasmic reticulum considered a transcellular pathway for ion transport. Small apical vesicles intermingled with elements of the smooth endoplasmic reticulum were described in striated, excretory, and main excretory duct epithelium of salivary glands in man (Riva et al., 1990) and in a variety of animals (Shackelford and Schneyer, 1971; Tandler and Poulsen, 1976; Toyoshima and Tandler, 1986; Sato and Miyoshi, 1988; Sato et al., 1993). With regard to man, the existence of two populations of apical vesicles, secretory and absorptive, has been postulated (RIVA et al., 1990; Lantini et al., 1990). Particularly, in relation to the uptake of proteins from the lumen, Hand et al. (1987) demonstrated that the internalized proteins are localized in apical vesicles, vacuoles and tubules. In the apical cytoplasm of the principal cells in the parotid MED we have documented, by the osmium maceration method, a close relationship between smooth endoplasmic reticulum and several vesicles which appear associated with its surface. Other vesicles are seen—by SEM with the same procedure—on the cytoplasmic aspect of the apical plasmalemma. All these features, hidden till now to inspection because of the unavailability of appropriate techniques, are here revealed by our modification (Riva et al., 1993a) of the osmium maceration method (Tanaka and Mitsushina, 1984). They may represent the morphological counterpart of the endocytotic system.
described in striated (HAND et al. 1987) and excretory (COLEMAN and HAND, 1987) ducts of the rat parotid gland.

Some apical vesicles could represent the products of a secretory process as has been suggested for those of human salivary excretory ducts (LANTINI et al., 1990) and of human submandibular MED (TESTA RIVA et al., 1981). Along these ends, HAND (1979) demonstrated in the striated duct cells of rat salivary glands that some apical granules incorporate secretory glycoproteins.

In previous papers we showed that salivary excretory ducts (LANTINI et al., 1990) and submandibular MED (TESTA-RIVA et al., 1981) of man frequently exhibit, in their principal cells, apical protrusions suggestive of an apocrine secretion. As already discussed in those papers, this statement results from similarities between the salivary apical protrusions and those described in apocrine glands (TESTA-RIVA and PUXEDDU, 1980). Our SEM and TEM observations made on human parotid MED epithelium have shown as well, irregular apical projections probably implicated in the process of apocrine secretion. The relevant number of these protrusions, appreciable in SEM panoramic views, might testify to a contribution to the composition of final saliva much greater than has been hitherto considered.

In summary, with regard to function, we may conclude that human parotid MED epithelium, like that of human submandibular MED (TESTA RIVA et al., 1981), is probably involved in the modification of saliva by resorption of ions and other substances, and by adding secretory components to it. The latter are derived from the goblet cells (TANDLER, 1993), in greater numbers than in submandibular MED (TESTA RIVA et al., 1981), and from the apocrine secretion of principal cells. The apical vesicles observed in the principal cells may also contribute, as discussed above, to the final composition of saliva via secretory (HAND, 1979) and absorptive processes (HAND et al., 1987). The lateral plasmalemma too is probably implicated in the exo- and/or endocytotic processes since some vesicles can be observed by SEM on its cytoplasmic surface.

Kinetosome-like bodies were noticed in the apical cytoplasm of a number of human epithelial cells lining a lumen (LANTINI et al., 1990; TESTA RIVA, personal observations). Numerous principal cells of human Stensen's duct also exhibit such structures, often observed at the same level in two or three adjacent cells, vertically oriented in their apical cytoplasm. Since we have never noticed any cilium merging from these organelles, we cannot consider them basal bodies. On the other hand, the absence of an identical perpendicular structure and the presence, instead, of striated rootlets and of lateral projections make this organelle very similar to a kinetosome but quite different from centrioles.

The role of basal cells in the salivary excretory ducts is still debated. In fact, BATSAKIS (1980) proposed that basal cells may act as stem cells, but BARKA (1965) showed that these cells have very little proliferative activity. Moreover, DARDICK et al. (1988) demonstrated that the population of basal cells, in striated and excretory ducts, varies in the expression of certain cytokeratins, and suggested that not all basal cells may be considered as stem or reserve cells. In fact, it has been estimated that stem cells represent about 10% of the basal layer (POTTEN, 1979; DRAEGER et al., 1991). From a morphological point of view, we have demonstrated in this paper that basal cells are endowed with ultrastructural and three-dimensional characteristics very different from those of principal cells. At variance with those of excretory ducts, the basal cells of the MED are arranged in an almost continuous layer. Since the basal cells are provided with abundant cytofilaments and are tightly linked to the basal lamina by very numerous hemidesmosomes, they form a supporting and protective system for the more fragile principal cells (DRAEGER et al., 1991).

The presence of dark cells has been reported in a variety of salivary ducts (SHACKLEFORD and SCHNEYER, 1971; RIVA et al., 1976; SATO, 1980; SATO and MIYOSHI, 1988; LANTINI et al., 1990; RIVA et al., 1990; TANDLER, 1993) and is variously interpreted. With regard to human parotid MED epithelium, we have found dark cells endowed with ultrastructural features exactly identical to those of principal or basal cells. Therefore, dark cells may be considered here not as a different type, like the dark cells of submandibular (SATO, 1980) and parotid (SATO and MIYOSHI, 1988) MED of the rat, but as a reflection of the cell functional state or even as a product of preparation techniques.

Membrane-bounded lamellar bodies identical to those noticed in the principal cells of human parotid MED were demonstrated also in cat (TANDLER and POULSEN, 1976) and in human (TESTA RIVA et al., 1981) submandibular MED and were correlated with lysosomes, though without histochemical evidence. The significance of these lysosome-like bodies remains obscure since only morphological data are available.

In conclusion, it is worth noting that the preparation techniques used here for SEM have clearly shown in the MED epithelial cells hidden surface structures and unexplored cytoarchitectural charac-
ters besides those easily observed with classic methods. These latter can represent bases for future physiological experiments which may assign to each morphological feature its corresponding function, including in humans.

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REFERENCES


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