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THE FINE STRUCTURE OF NERVE ENDINGS IN HUMAN BUCCAL MUCOSA

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Summary—Meissner's corpuscles, discrete mechanoreceptors and free nerve endings were identified in the lamina propria of the buccal mucosa in five patients with the erosive type of lichen planus. Meissner's corpuscles were approximately 30 × 25 μm in dimension. Discrete mechanoreceptors were approximately 10 × 5 μm and were loosely encapsulated. The lamellar cell associated with Meissner's corpuscles and the capsular cell associated with discrete mechanoreceptors showed marked pinocytotic activity. Nerve endings were recognized by the presence of synaptic-like vesicles and neurotubles. Certain of the synaptic-like vesicles contained electron-dense cores and suggesting that the presence of these cores indicate the storage of the transmitter substance or its precursor. It is proposed that the appropriate stimulus could cause release of the transmitter substance with depolarization of the axonal plasma membrane.

INTRODUCTION

Little is known about the structure of receptors in oral mucosa. Coiled nerve endings have been described in the lamina propria of the oral mucosa, gingiva and hard palate (Dixon, 1961; Tolman, Winklemann and Gibilisco, 1965). Munger (1973) described Meissner's corpuscles and glomerular corpuscles in the lamina propria of the primate tongue and Gairns and Aitchison (1950) observed Meissner's corpuscles and intra-epithelial nerve endings in the human gingiva. Jayaraj, Quilliam and Tilly (1973) described intra-epithelial nerve terminals in the mouth of sheep and Chouchkov (1972) demonstrated two types of nerve endings in the lamina propria of the oral mucosa, digital skin and rectum. One type consisted of free nerve endings derived from thick myelinated nerve fibres and the other type consisted of non-encapsulated glomerular bodies, similar to the glomerular endings described by Munger (1973) in the primate tongue.

MATERIALS AND METHODS

The material consisted of biopsy specimens taken from five patients with the erosive type of lichen planus with an age range between 50 and 60 yr. The specimens were fixed in Karnovsky's (1965) fixative for 2 h at 4°C, post-fixed in 1 per cent osmium tetroxide in phosphate buffer at pH 7.2 and embedded in epoxy resin. Sections were cut with an L.B.K. ultramicrotome, stained with uranyl acetate and lead citrate and examined with a Philips 201 electron microscope.

FINDINGS

Meissner's corpuscles

Meissner's corpuscles were observed in the lamina propria of the buccal mucosa in 2 of the 5 specimens. In one case only was the corpuscle sufficiently intact to enable observations on its fine structure (Fig. 1). The dimensions of the corpuscle were approximately 30 × 25 μm; it consisted of lamellar cells and profiles of terminal neurites.

The cytoplasm of the lamellar cells showed only a few profiles of the rough surfaced endoplasmic reticulum and an extensive Golgi complex (Figs. 1 and 2). The cell bodies of the lamellar cells contained numerous mitochondria with moderately electron-dense matrices, transverse and longitudinally orientated cristae and a few electron-dense granules with diameters of approximately 50 nm (Figs. 1 and 2). The processes of the lamellar cells formed concentric rings around the terminal neurites and occasionally the terminal neurite was exposed to the extracellular substance (Fig. 3). The cytoplasm of the lamellar cells also contained intracytoplasmic filaments about 6 nm in diameter (Fig. 2) and microtubules about 20 nm in diameter (Fig. 3). The plasma membrane of the lamellar cell was associated with a delicate basal lamina and exhibited marked pinocytosis (Fig. 3). Terminal neurites contained numerous mitochondria with regular transverse cristae and a moderately electron-dense matrix (Fig. 3). Occasionally electron-dense granules, 40 to 50 nm in diameter, were seen in the mitochondrial matrices (Fig. 3). Where exposed to the extracellular substance, the terminal neurites contained synaptic-like vesicles with diameters between 40 and 60 nm (Fig. 3). As the terminal neurites decreased in size the number of mitochondria decreased and neurotubules were observed in the cytoplasm (Fig. 2). In appropriate sections, both the lamellar cell processes and the plasma membranes of the axons showed delicate basal laminae (Fig. 3). The plasma membranes of these elements were about 20 nm apart (Fig. 3).

Discrete mechanoreceptors

Loosely encapsulated nerve endings with dimensions of approximately 10 × 5 μm were seen (Fig. 4). The capsular cell processes were slender elements with an inconstant basal lamina. The nerve endings were usually closely invested by Schwann cells and, when sectioned transversely, the plasma membranes of the axons and the Schwann cells were about 10 nm apart (Fig. 6). The nerve endings contained small mitochondria and synaptic-like vesicles. The synaptic-like vesicles had diameters of about 40 nm and some had electron-dense cores (Fig. 6). The endoneurium consisted of fine filamentous material (Figs. 4 and 6).

Free nerve endings

Free nerve endings were also seen. They consisted principally of minute axons containing synaptic-like vesicles with diameter between 40 and 60 nm (Fig. 5). Neurotubules, about 20 nm in diameter, were observed in the cytoplasm of some of the axons. The extracellular substance consisted of collagen fibrils and a microfibrillar reticulum.

DISCUSSION

Meissner's corpuscles of the buccal mucosa closely resemble those described in primate digital skin (Cauna, 1968; Cauna and Ross, 1960) and human palmar skin (Hashimoto, 1973). They correspond to Meissner's corpuscles described by Munger (1973) in the primate tongue and hard palate. The discrete mechanoreceptors, on the other hand, correspond to similar structures described in human periodontal membrane (Griffin, 1972). The free nerve endings are also similar to those previously described in the human periodontium (Griffin and Harris, 1968).

The relationship of terminal neurites to the plasma membranes of Schwann or lamellar cells is close, but gaps in these investments expose the axons, except for a basal lamina, to the extracellular substance (Figs. 3 and 4). When this occurs, the synaptic-like vesicles within the axons appear to increase in number. It is usually conceded that nerve endings may be identified by the presence of these vesicles, small mitochondria and neurofilaments (Biscoe and Stephens, 1966). The presence of a dense core in certain of these vesicles (Fig. 6) suggests that they may contain a transmitter substance or its precursor (Grafstein, 1975). Lever, Mumtazuddin and Irvine (1965) noted that synaptic-like vesicles were disposed towards the free surface of axons in coronary arteries. They suggested that humoral agents might be released from these sites to act upon coronary smooth muscle and cardiac muscle. It is also possible that the vesicles in the nerve terminals described here could contain a transmitter substance which, on the appropriate stimulus, might be released into the intercellular spaces and provide a mechanism for depolarization of the axonal plasma membrane.

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Plates 1–3 overleaf

Plate 1.

Fig. 1. Meissner's corpuscle from lamina propria of buccal mucosa. Profiles of terminal neurites (A) are surrounded by processes of lamellar cells (L). The nuclei of lamellar cells (NL) with cell bodies are seen. Uranyl actetate, lead citrate. × 6000

Fig. 2. Detail of nerve endings and cell body of lamellar cell which has an extensive Golgi complex (G) and some scattered profiles of the rough-surfaced endoplasmic reticulum (R). Mitochondria (m) show transverse and longitudinally orientated cristae with an occasional dense granule (dg) in the matrix. The plasma membrane of the lamellar cell shows pinocytotic activity (p) and is associated with a basal lamina (B). Microtubules (t) are evident in the cytoplasm of lamellar cells and neurotubules (nt) in the cytoplasm of nerve endings. Probable pleomorphic lysosomes (L) are present in one nerve ending. Uranyl acetate, lead citrate. × 45,000

Plate 2.

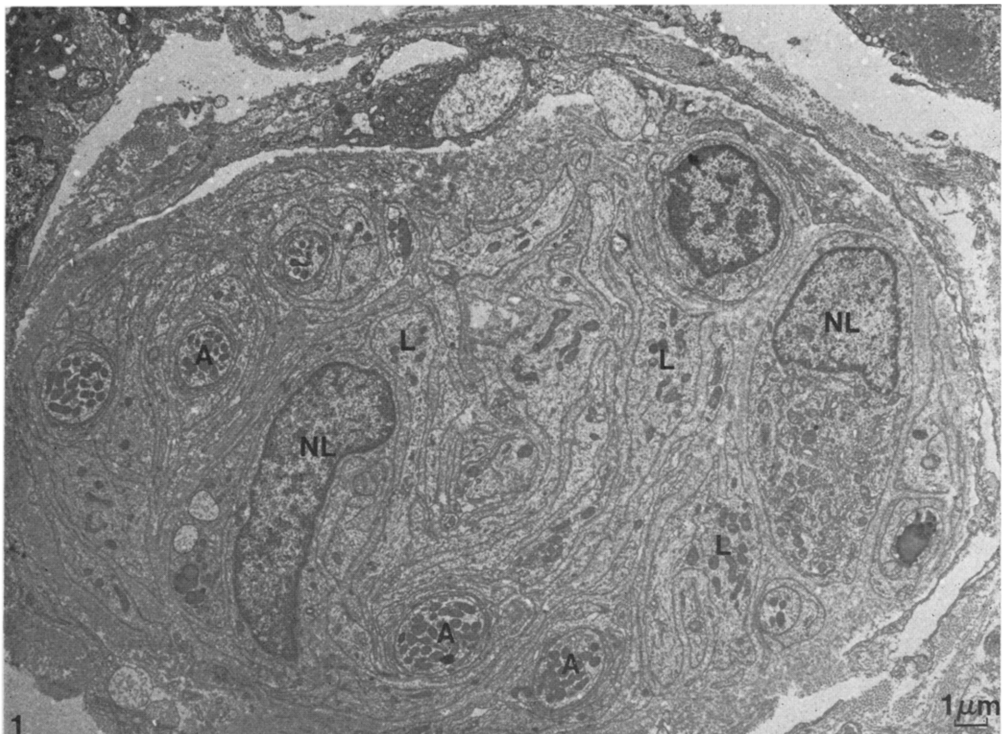
Fig. 3. Detail of terminal neurite. The terminal axon (A) contains numerous mitochondria (m), some with an electron-dense granule (dg). The exposed face of the terminal neurite shows synaptic-like vesicles (SV). A basal lamina (B) is associated with the terminal neurite and the processes of lamellar cells. The processes of lamellar cells (1) show intense pinocytotic activity (p). Uranyl acetate, lead citrate. × 45,000

Fig. 4. Discrete mechanoreceptor from lamina propria of buccal mucosa. Nerve endings (ne) are surrounded by Schwann cell cytoplasm (BS) The Schwann cell shows a constant basal lamina (B) and is separated from capsular cell processes (C) by the endoneurium (E). Uranyl acetate, lead citrate. × 13,500

Plate 3.

Fig. 5. Free nerve ending from lamina propria of baccal mucosa. The nerve endings (ne) are surrounded by Schwann cell cytoplasm (S) and on occasions a mesaxon (ma) is seen. The Schwann cell is covered by a constant basal lamina (B) and surrounded by collagen fibrils (cf). A nearby connective tissue cell, probably a macrophage, shows an extensive Golgi complex (G) and many lysosomes (L). Uranyl acetate, lead citrate. × 30,000

Fig. 6. Detail of nerve endings in discrete mechanoreceptor. Certain of the synaptic-like vesicles within the nerve endings contain electron-dense cores (gsv) and their mesaxons (ma) may on occasion be seen. They are surrounded by Schwann cell cytoplasm (S). Uranyl acetate, lead citrate. × 90,000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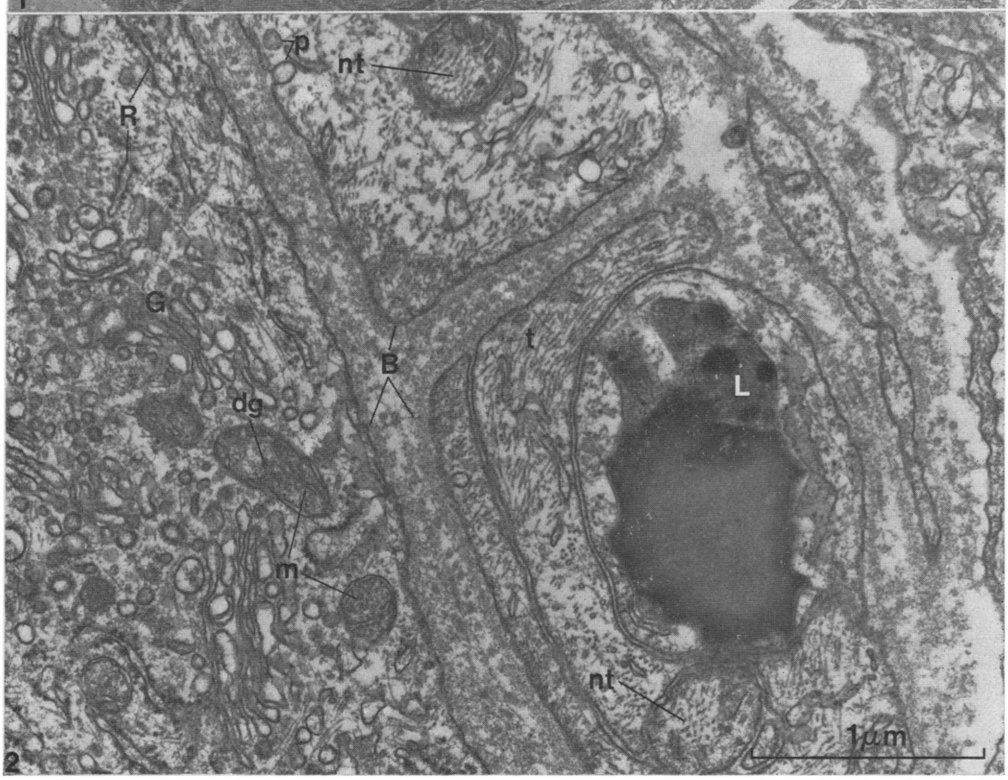
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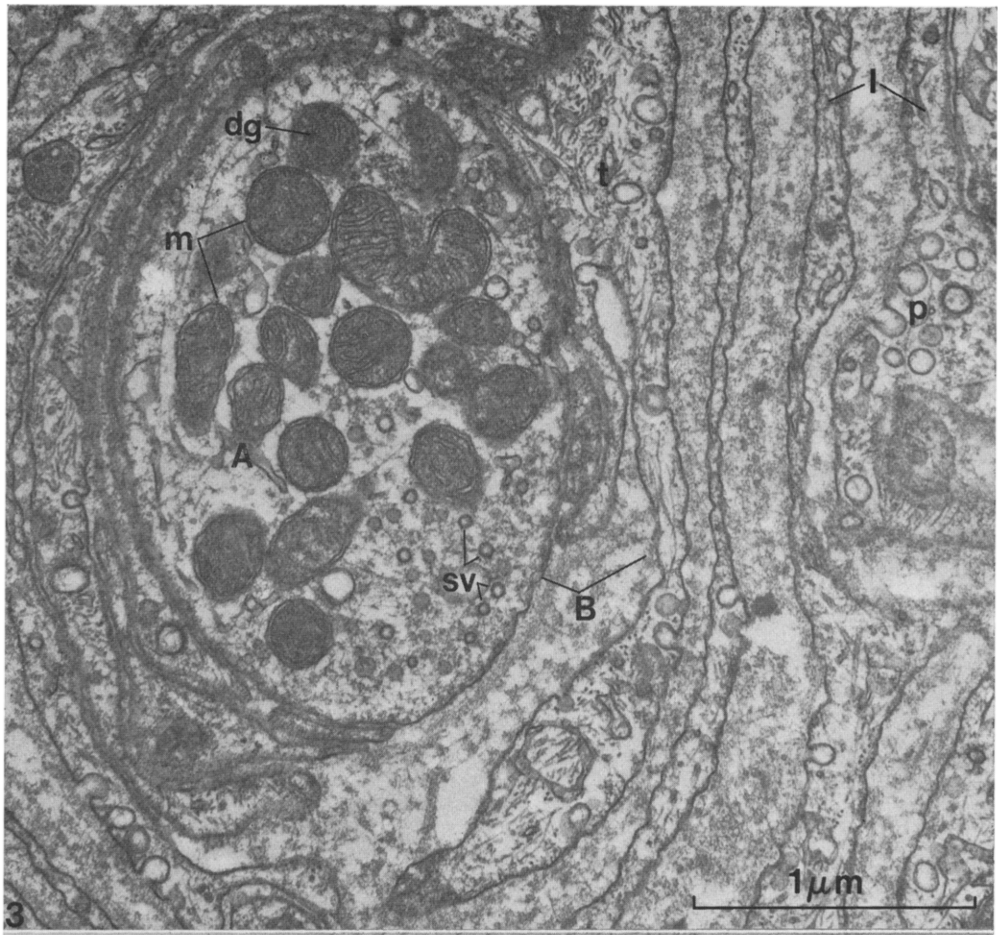
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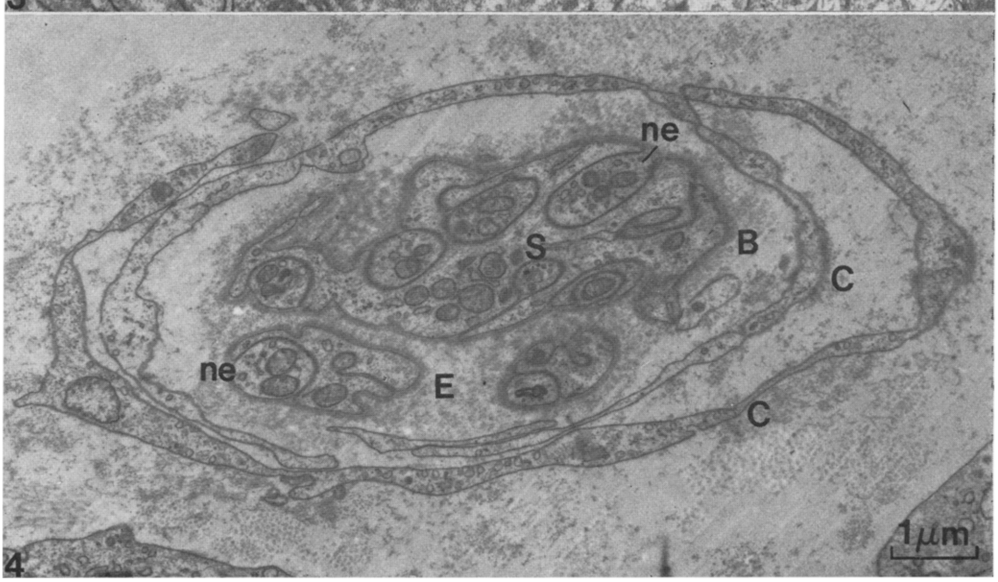
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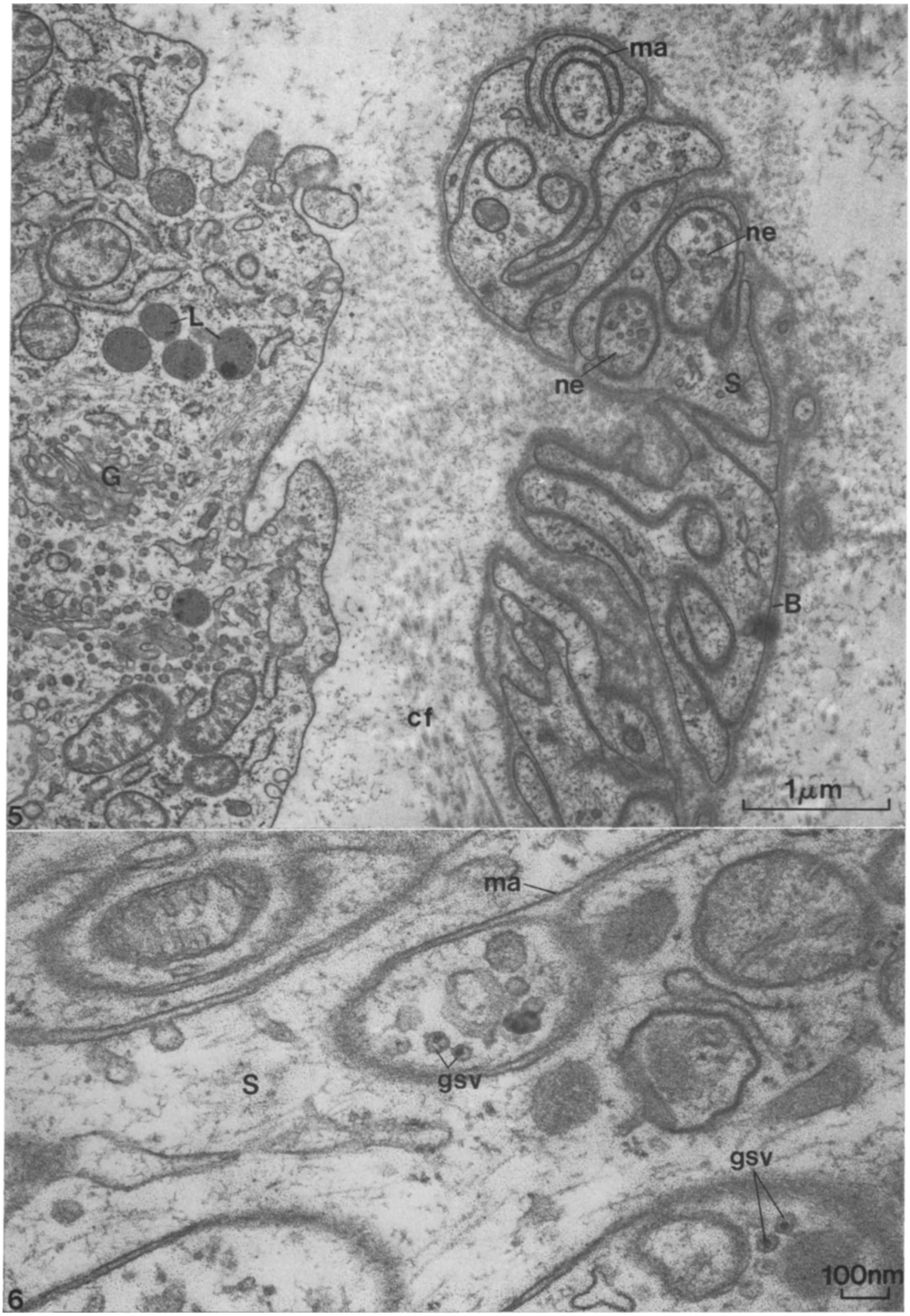
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