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# ULTRASTRUCTURE OF THE TEGUMENT OF THE ANOPLOCEPHALID CESTODE *MOSGOVOYIA CTENOIDES* (RAILLIET, 1890) BEVERIDGE, 1978.

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**ABSTRACT.** The tegument of the mature proglottids of *M. ctenoides* was examined by means of TEM. The tegument of this species consists of two layers: (1) the external cytoplasm, and (2) the tegumental perikarya situated in the cortical parenchyma. The tegument surface is covered by typical microtriches. The anucleated external layer of cytoplasm is rich in vesicles of different shape and electron-density, but it lacks mitochondria. Large pore canals penetrate the external cytoplasmic layer. This layer is separated from the perikarya by a basal lamina, being connected with the tegument cell bodies by cytoplasmic bridges. The granular cytoplasm of perikarya contains typical cell organelles such as mitochondria, GER, Golgi complexes, free rybosomes, numerous vesicles and lipid droplets inclusions. The large nuclei of the perikarya with prominent nucleoli frequently contain large intranuclear, highly osmiophilic lipid droplets.

**Key words:** Anoplocephalidae, Cestoda, Cyclophyllidea, *Mosgovoyia ctenoides*, parasite, rabbit, tegument, ultrastructure

## INTRODUCTION

The functional ultrastructure and formation of cestode tegument have attracted for a long period of time a particular interest of pioneer researchers applying the electron microscopy technique for examination of body coverings of parasitic flatworms (for review see: Threadgold 1962, 1966, 1984; Béguin 1966; Lee 1966; Morseth 1966; Świderski 1966; Lumsden 1975; Smyth and McManus 1989). Considering that cestodes have no gut, the absorption of nutritive material as well as the gaseous exchange and elimination of metabolism waste products, must take place through the body surface. Therefore, the cestode tegument plays an important role in the physiology of these organisms (Read 1955, Lumsden et al. 1968, Arme and Read 1970, Lumsden 1975).

The purpose of the present paper is to describe for the first time the ultrastructure of the tegument of the anoplocephalid cestode, *Mosgovoyia ctenoides*, a parasite of domestic and wild rabbits, and sometimes hares.

## MATERIAL AND METHODS

Adult specimens of the anoplocephalid cestode, *Mosgovoyia ctenoides* (Railliet, 1890) Beveridge, 1978, were obtained from the small intestine of a naturally infected wild rabbits, *Oryctolagus cuniculus*, collected in Quiaios, Portugal. Tissue samples from mature proglottids were fixed for 3 h in 2% glutaraldehyde solution in 0.1 M cacodylate buffer (pH 7.2), washed overnight in the same buffer and postfixed for 2 h in 1% $OsO_4$. Material was then dehydrated in a graded alcohol series and propylene oxide and embedded in Spurr's resin. Ultrathin sections, double-stained with uranyl acetate and lead citrate, were examined under JEM 100B electron microscope operated at an accelerating voltage of 80 kV.

## RESULTS

The tegument of *M. ctenoides* is composed of two parts: (1) an external layer of anucleated cytoplasm with numerous, densly packed microtriches, and (2) a deeper internal part representing the tegumental perikarya, situated in the cortical parenchyma. Both parts are separated by a thick basal lamina and two layers of subtegumental muscles. The two above mentioned components of the tegument are interconnected by the long cytoplasmic processes or bridges (Fig. 1).

The surface of the external cytoplasmic layer is covered by an apical plasma membrane (about 0.04 μm thick) and bears characteristic digitiform microtriches with hard, electron-dense endings. Microtriches have the average length of about 0.68 μm and measure about 14 μm in diameter (Fig. 2 and inset). Each microtriches, is a bipartite structure, composed of a large, electron-dense spine-like apical part or blade and a less electron-dense basal part or shaft, surrounded by a moderately electron-dense core (Fig. 2).

The external, anucleated, cytoplasmic layer contains numerous discoidal and/or spherical vesicles, enclosing material of different electron-density (Fig. 2). The larger discoidal secretory bodies, measuring approximately 0.13-0.16 μm in diameter (Figs. 2, 3), are present in higher quantities in the peripheral sublayer of the external cytoplasm; the smaller, spherical ones, about 0.08 μm in diameter, are localized predominately in the basal sublayer of the external cytoplasm (Figs. 2, 4). The most remarkable feature of the *M. ctenoides* tegument is a complete absence of mitochondria in this layer (Fig. 2). The external cytoplasmic layer is partially pierced by straight or partially convoluted pore canals (Figs. 1, 2). The fibrillar, electron lucent, basal lamina (about 0.03 μm in thickness), situated under the exter-

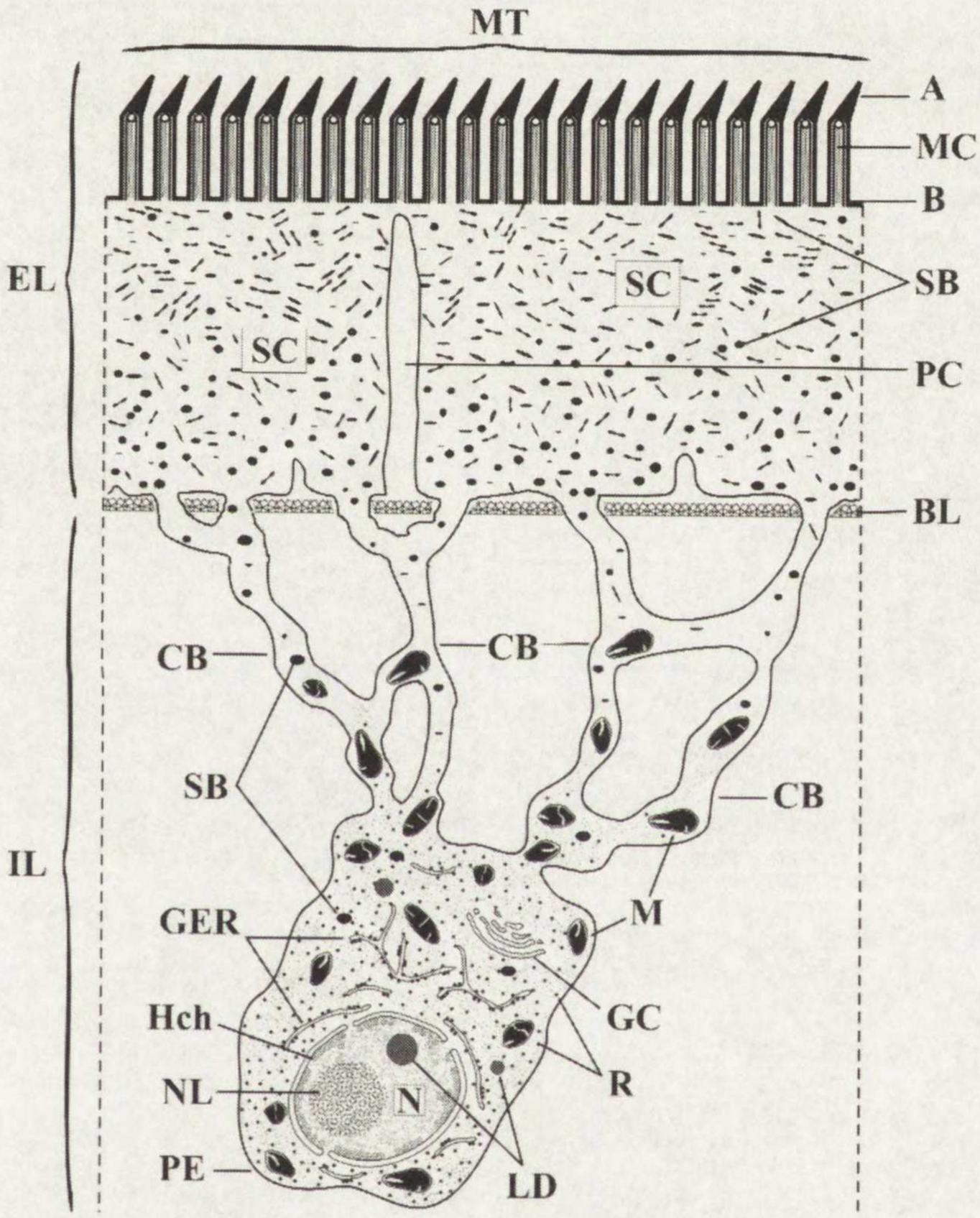
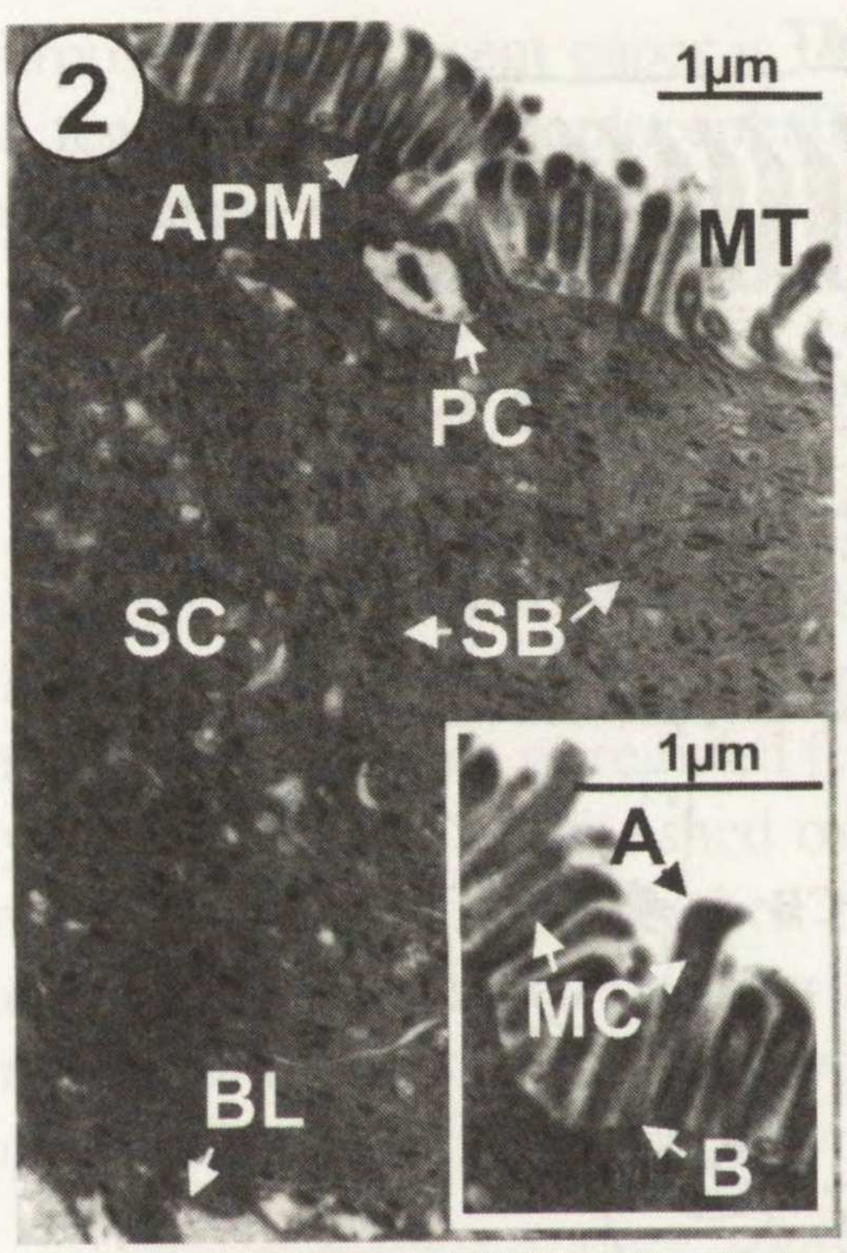


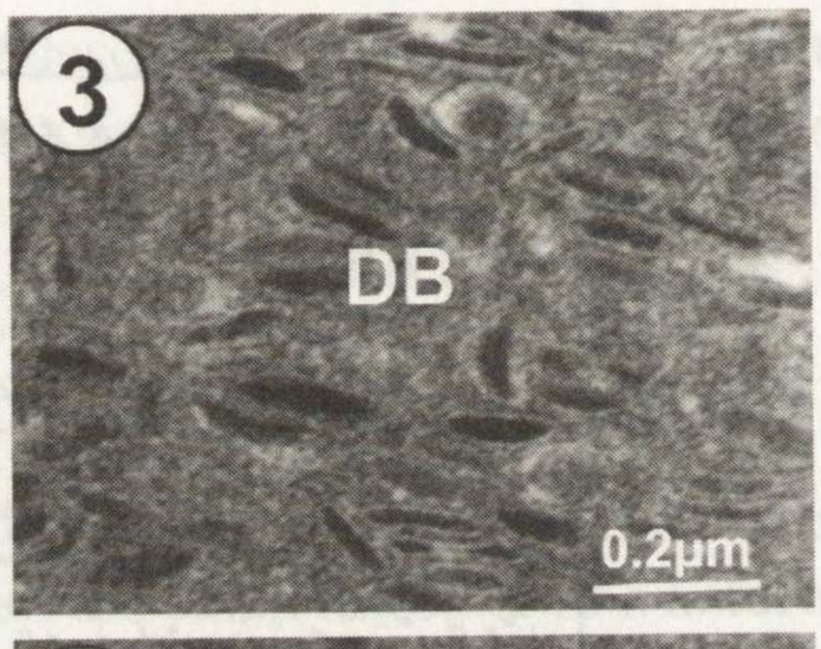

Fig. 1. Schematic diagram of the ultrastructure of *Mosgovoyia ctenoides* tegument. A – apical part of microtriches; B – basal part of microtriches; BL – basal lamina; CB – cytoplasmic bridge; EL – external layer; GC – Golgi complex; GER -granular endoplasmic reticulum; Hch – heterochromatin; IL – internal layer; LD – lipid droplet; M – mitochondria; MC – medullar center of microtriches; MT – microtriches; N – nucleus; NL – nucleolus; PC – pore canal; PE – perikarya; R – ribosomes; SB -secretory body; SC – superficial cytoplasm.

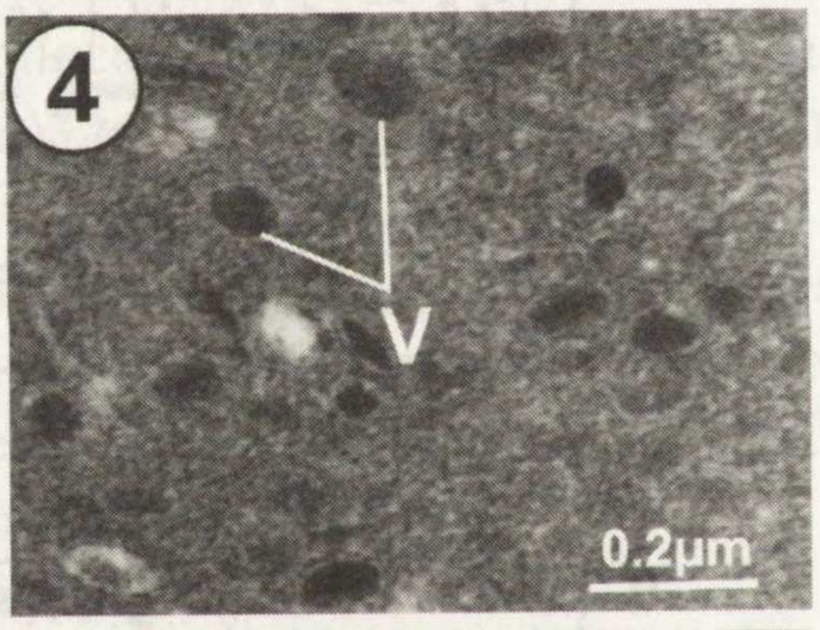
nal cytoplasmic layer, separates the outer body covering from the underlying cortical parenchyma (Figs. 2, 5).

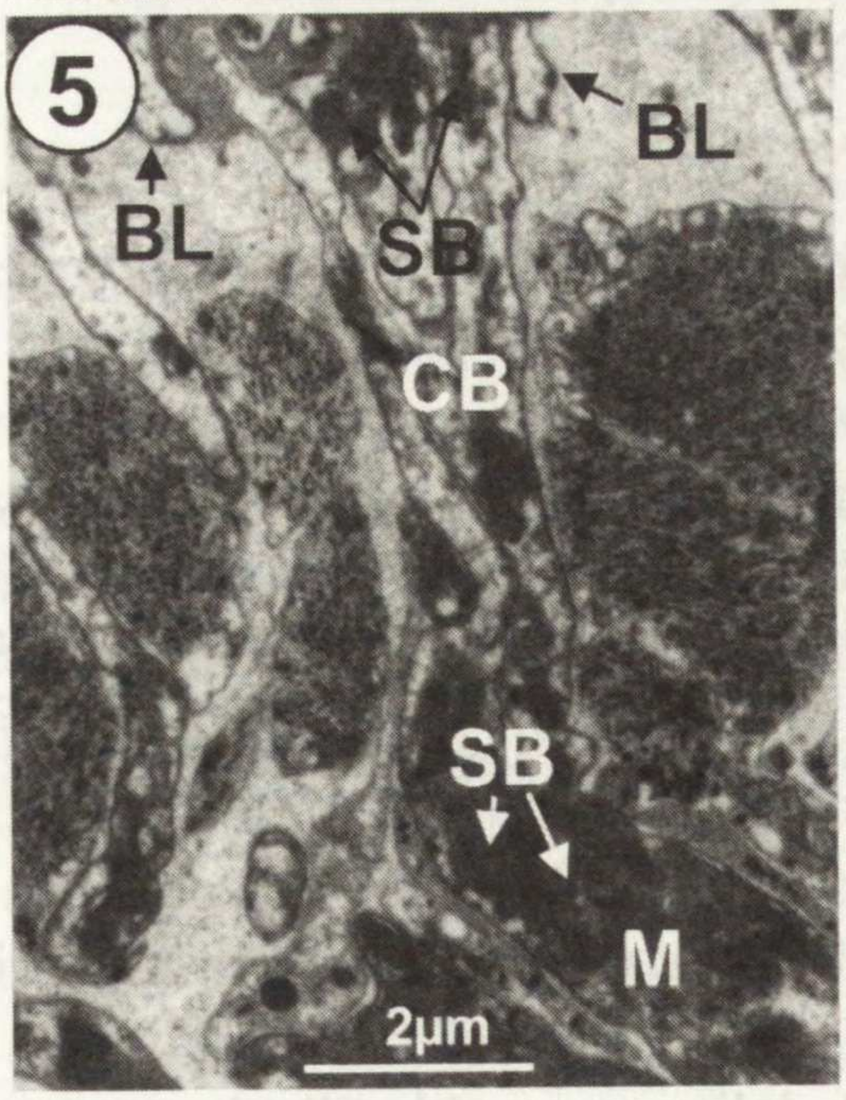
The long cytoplasmic processes provided direct comunication between the external cytoplasmic layer and the subjacent tegumental perikarya. They contain several mitochondria, secretory granules and vesicles (Figs. 5-7).

Tegumental cell bodies, measuring about 3.64 μm x 5.18 μm, are situated among the cortical parenchyma cells (Figs. 6, 7). They are elongated, irregular in shape, and their large, spindle-shaped nuclei (about 2.47 μm in diameter), occupy more than the half of the cell. Each nucleus contains prominent, spherical nucleolus and several heterochromatine islands (Figs. 6, 7). The granular cytoplasm of each perikaryon shows the presence of numerous free ribosomes, mitochondria, granular endoplasmic reticulum (GER), Golgi complexes and Golgi originated secretory vesicles (Figs. 6, 7). Lipid droplets of different size were observed both in the cyto-



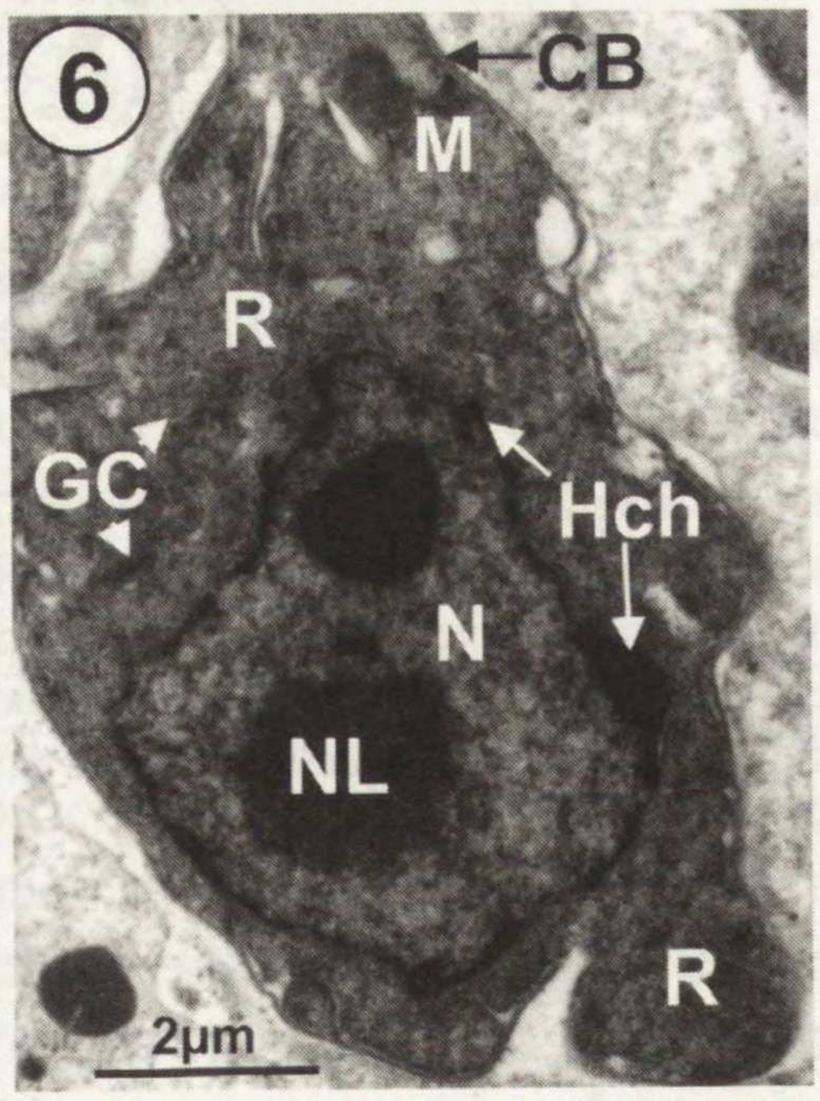
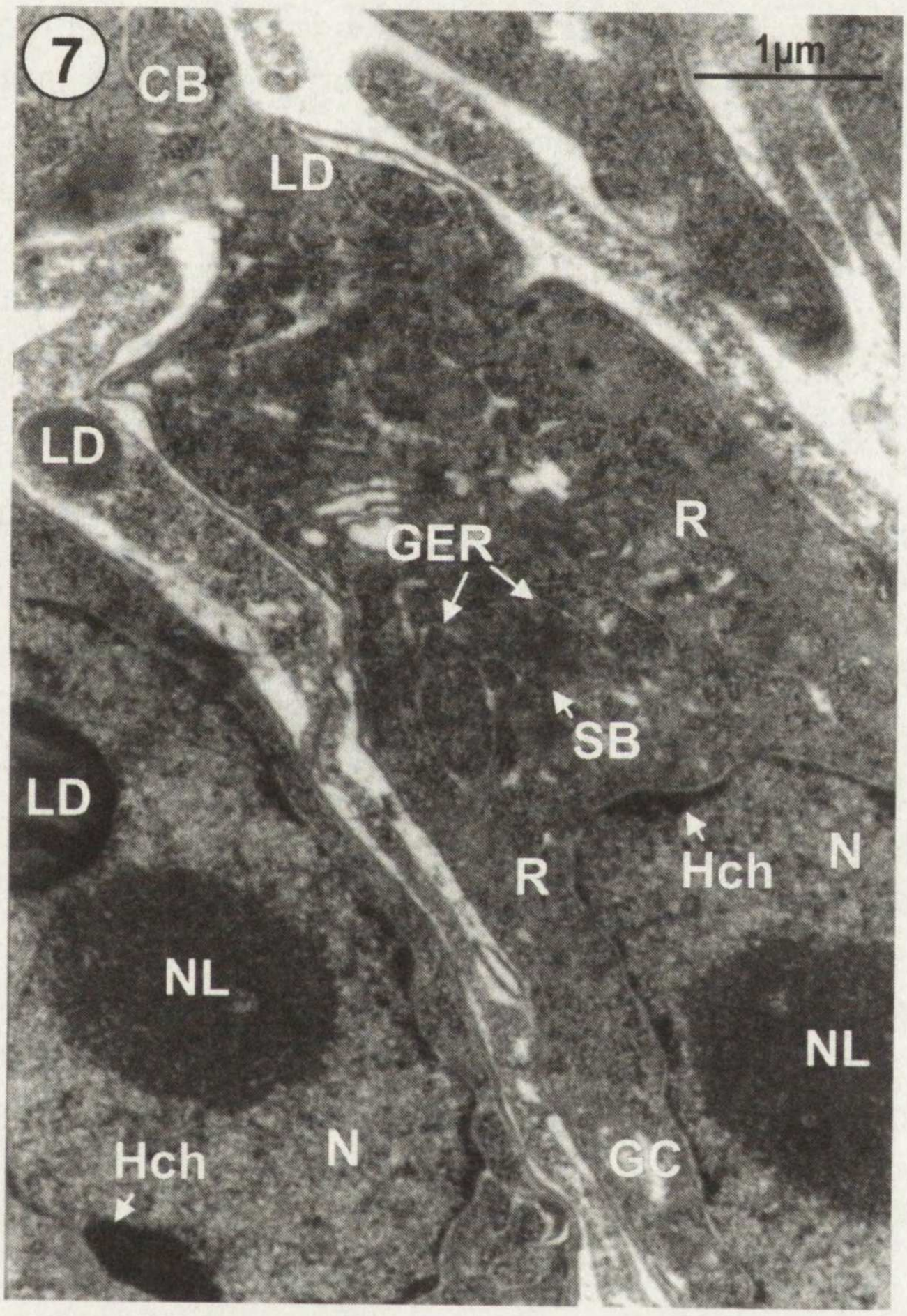




Fig. 2. A section throught the external cytoplasmic layer of the tegument. Note the numerous discoidal and spherical secretory bodies and lack of mitochondria in this layer. Inset showing details of longitudinal sections of microtriches, with moderately electron-dense shafts and blade-like, dense osmiophilic endings. Notice the cross-sectioned pore canal containing electron-dense debris. A – apical part of microtriches; APM – apical plasma membrane; B – basal part of microtriches; BL – basal lamina; MC – medullar center of microtriches; MT – microtriches; PC – pore canal; SB -secretory body; SC – superficial cytoplasm.

Figs. 3 and 4. Two types of secretory bodies in the external cytoplasm: the electron-dense discoidal bodies (Fig. 3), and moderately electron-dense spherical vesicles (Fig. 4). DB – discoidal bodies; V – vesicles.

Fig. 5. Long cytoplasmic conections between two components of the tegumental syncytium. Notice the presence of the electron-dense mitochondria and several secretory bodies. BL – basal lamina; CB – cytoplasmic bridge; M – mitochondria; SB -secretory body.




Figs. 6 and 7. Longitudinal section through the tegumental perikarya showing large nuclei, with prominent nucleoli and heterochromatin islands. Their cytoplasm shows well-developed GER, Golgi complexes, several mitochondria, and numerous free rybosomes and secretory vesicles of different size and electron density. Notice large, electron-dense, lipid droplet in the nucleus of the perikaryon (Fig. 7). CB – cytoplasmic bridge; GC – Golgi complex; GER -granular endoplasmic reticulum; Hch – heterochromatin; LD – lipid droplet; M – mitochondria; N – nucleus; NL – nucleolus; R – ribosomes; SB -secretory body.

plasm and nuclei of these cells (Fig. 7). Usually, on the sections they appear very electron-dense or osmiophilic which is indicative that, from a cytochemical point of view, these lipids represent unsaturated fatty acids.

## DISCUSSION

The general topography and cellular organization of the tegument in *M. ctenoides* is essentially similar to those previously described in other cyclophyllidean cestodes (Béguin 1966, Lumsden 1975, Threadgold 1984). In what concerns to the interpretation of the functional ultrastructure of *M. ctenoides* tegument, our

results corroborate most of the previously drawn hypotheses on the three important functions of tegument: protection, absorption and transport of nutrients, gases and metabolic waste products. It refers also to the three main functions of the tegumental microtriches, namely their role in (1) increasing the absorptive surface area (Rothman 1963, Béguin 1966), (2) the additional role to that of scolex in the maintenance and the locomotion of the parasite in the intestinal lumen (Lee 1966, Mettrick 1971, Smyth and McManus 1989) and (3) the protective role thus preventing tapeworm destruction by the host digestive enzymes (Smyth and McManus 1989).

The main differences observed in the ultrastructure of the tegument of *M. ctenoides* appear to be the absence of mitochondria in the external cytoplasmic layer and the large intranuclear lipid droplets, frequently observed in the tegumental perikarya nuclei.

In spite of the fact that the tegument of different tapeworm species has remained for a long period of time as a fascinating subject for numerous TEM studies, our results show that evident differences in its ultrastructure still exists in different cestode taxa. Some functional aspects of the tegument still remain to be elucidated.

A better knowledge on the functional ultrastructure of the cestode body surface may have also some applied importance. In fact, the tapeworm tegument, due to its high metabolic rate, represents a very sensitive target for analysing the effects of antihelminthic drugs upon the parasite and, indirectly, upon parasite egg production considering the so-called „ovicidal effects" leading in some cases to the interruption of the parasite life cycle.

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