

# A novel granular cell type of locust Malpighian tubules: ultrastructural and immunocytochemical study

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**Summary.** A novel secretory cell type in the initial segment of the Malpighian tubules of the locusts *Schistocerca gregaria* and *Locusta migratoria* is described ultrastructurally and studied by means of immunocytochemical techniques. The cells show abundant rough endoplasmic reticulum with interspersed Golgi zones. The richness of the cell secretory machinery and the presence of apical dense pleomorphic granules suggest a role in secretion of proteinaceous material to the tubule lumen. The surprising finding of ACTH (1–24)-,  $\alpha$ -MSH-, and 7B2-like immunoreactivity for this cell is discussed.

**Key words:** Excretory system – Exocrine cells – ACTH-like immunoreactivity –  $\alpha$ -MSH-like immunoreactivity – 7B2-like immunoreactivity – *Locusta migratoria*, *Schistocerca gregaria* (Insecta)

The Malpighian tubules are the main excretory organs of insects. They consist of blind-ended, single-layered epithelial tubules that empty waste products into the gut. The urine is initially formed in the tubules, by a process of filtration from the hemolymph. The useful molecules are subsequently reabsorbed from the primary excreta at the hindgut and rectal ampullae. Reabsorption of useful substances may also be initiated by the action of cells in the Malpighian tubules (for review of the insect excretory process, see Maddrell 1980; Phillips 1981; Bradley 1985; Phillips et al. 1988). Malpighian tubules are well known models for the study of basic mechanisms and functional-morphological relationships of ion- and metabolite-transporting epithelia, hence the necessity of a detailed knowledge of the morphological traits of the cells in these tubules. A close relationship between tubule cell morphology and function has been shown in several insect species (Maddrell and Phillips

1975; Green 1979; Szibbo and Scudder 1979; Meredith et al. 1984; Cooper et al. 1989). The morphological characterization of Malpighian tubule cells is particularly important for insect species that are common experimental models in physiological studies. The desert and migratory locusts (*Schistocerca gregaria* and *Locusta migratoria*, respectively) are traditionally used for physiological studies of the tubules (Phillips 1981; Phillips et al. 1988) and for research on hormonal regulation of diuresis (Phillips 1983). In previous reports (Alba et al. 1983; Montuenga et al. 1985), we have briefly described the general morphology of the Malpighian tubules of the desert locust *S. gregaria*. We showed that the tubules of this species have three main segments: distal, medial, and proximal (to the gut). The tubules drain into the midgut-hindgut junction through several ampullae. Several cell types comprising the different regions were described in the cited papers: principal cells, stellate cells, mucocytes, and granular cells in the tubules, as well as secretory cells and endocrine cells in the ampullar system. Our ensuing observations showed no relevant morphological differences between the Malpighian tubules of *S. gregaria* and *L. migratoria*. In a later study, Garrett et al. (1988) also studied the ultrastructure of the principal and stellate cells in *S. gregaria*. In order to gain a better understanding of the excretory phenomena and the processes involved, a complete picture of the histological features of the tubules is required. This is especially important for the interpretation of physiological experiments that use the whole length of the tubule, semi-isolated tubules, or whole gut-tubules for in vitro measurements (see review by Wheeler and Coast 1990).

The object of the present study was a further characterization of the granular cell of the Malpighian tubules of two locust species. Apart from ultrastructural and classical histological techniques, we have performed immunocytochemical tests with antibodies directed against regulatory peptides. To the best of our knowledge, apart from our preliminary reports, there is no other mention or description of this granular cell type in insects.