ANATOMY AND HISTOLOGY OF THE DUFOUR AND VENOM GLANDS OF *AUGOCHLOROPSIS GRAMINEA* FABRICIUS, 1804 (HYMENOPTERA, HALICTIDAE)

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ABSTRACT

The Dufour and the venom glands of the solitary bee *Augochloropsis graminea* were studied through routine light and scanning electron microscopy. The Dufour gland is an accessory gland of the female reproductive apparatus of the bees, where plays functions related to reproduction. The venom gland produces the venom, which is injected during the sting. The results showed that Dufour gland in *A. graminea* is a long, tubular structure enveloped by a very organized web of tracheoles. The epithelium is folded, resulting an irregular lumen. The venom gland presents all the principal constituents of the venom gland observed in other bees (secretory filaments, common duct and reservoir), besides some globular enlargements placed along the secretory filaments. This is the first time these structures are described in bee venom glands and may represent some specialized region of the secretory filament.

Key words: Dufour gland, venom gland, *Augochloropis graminea*, solitary bees, anatomy, histology.

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INTRODUCTION

Associated to the sting apparatus of all aculeated female hymenopterans there are two glands: the Dufour and the venom gland [9,11].

Although in bees the Dufour gland is considered a sting associated gland due to its localization very close to the sting, in fact, it is an accessory gland of the female reproductive apparatus, opening in the vagina and playing functions related to reproduction [1,8,12]. The gland anatomy may vary among the hymenopterans, but it is often tubular or sack shaped epithelial structure, involved by an incomplete muscular envelope, tracheoles and nerves [2,3,5-7]. According to Lello [13], the solitary bees have larger Dufour glands than the social ones. Among the solitary bees, the families Colletidae, Halictidae and Andrenidae present the largest bee Dufour glands.

In bees, the size of the Dufour gland is related to the gland function. In solitary species the main function of the gland is to produce hydrophobic lining or cementing substances to protect and to build the nest, respectively [12]. In eusocial bees, the Dufour gland is more related to pheromone production [1,15].

The venom gland is responsible for the production of the poison, which is injected in the moment of the sting. In *Apis mellifera*, it consists of two secretory filaments, which join in a common duct that ends in a reservoir, from which leaves a single excretory duct that opens in the sting [17].

Besides the importance of these exocrine glands for the solitary bees, there are few studies about their morphology. Therefore, the present investigation presents a preliminary anatomical and histological study of the Dufour and venom glands in *Augochloropsis graminea*, a solitary bee species belonging to the family Halictidae [14].

MATERIAL AND METHODS

Material

Females of *Augochlorospis graminea* (Hymenoptera, Halictidae) were collected around the campus of UNESP (Rio Claro, Brazil) during January till March.

Methods

Light Microscopy

The glands were dissected and directly fixed in 4% paraformaldehyde, for at least 2h. After fixation, the glands were dehydrated in an alcoholic series (70%-90%) and then included in resin JB - 4 (Polysciences). The sections, obtained in microtome BIO-RAD JB-4, were stained with hematoxilyn and eosin, examined and photographed in a photomicroscope Zeiss.

Scanning Electron Microscopy

The glands were dissected and fixed in Karnowsky, dehydrated in acetone series (70% -100%), followed by two rinses of acetone PA, for 15 min each. After drying in critical point Balzers CPD/030, the glands were covered with gold in a sputtering Balzers and, later, examined and photographed in a scanning electron microscope Jeol JSM-P15.

RESULTS AND DISCUSSION

The *Augochloropsis graminea* Dufour gland is a tubular shaped structure, surrounded externally by a very thin and fenestrated layer of visceral muscles and a well organized network of tracheoles (Fig. 1A). Internally, it is lined by a folded cubic epithelium, resulting an irregular lumen, covered by a thin cuticle (Fig. 1A,B,C). The gland cells belong to class I of Noirot & Quennedey [16], which is characterized as epithelial glandular cells lined by cuticle, in the secretory pole.

The poison gland is formed by two filaments distally finish blind (Figs. 2A,B), joining proximally to form a long common duct, which presents the same diameter of the glandular tubules, and opens in a sack shaped reservoir (Fig. 2C). The distal filaments in *Apis mellifera* are considered the gland secretory portions, being, therefore, denominated secretory filaments [10]. The reservoir is constituted of an enlargement of the common duct and opens into the sting through a wide, short duct (Fig. 2C). This gland presents secretory cells individually provided of an intracellular canal, which take the intercellular secretion to the lumen, perforating the intima (Fig. 2D). The intima is constituted by a second layer of flat cells that lines the glandular epithelium and produces the cuticle that involves the lumen. The cells of the venom gland belong to type III of the Noirot & Quennedey [16] insect glandular cell classification, showing two cell types: the secretory cells and the excretory canal forming cells.

As in *A. mellifera* [4], the folds of the Dufour gland epithelium are very organized and represent a mechanism for optimization of the abdominal space, permitting the increase of gland capacity during secretion storage, according to the gland activity.

While the Dufour gland of *A. graminea* presents the basic morphological pattern of the Dufour gland of most hymenopterans [17], the venom gland shows some variation when compared with *A. mellifera*, especially in relation to the secretory filaments, which presents some globular enlargements along their length (Fig. 2B). These regions of the secretory filaments may represent differentiated glandular regions and need more detailed future studies.

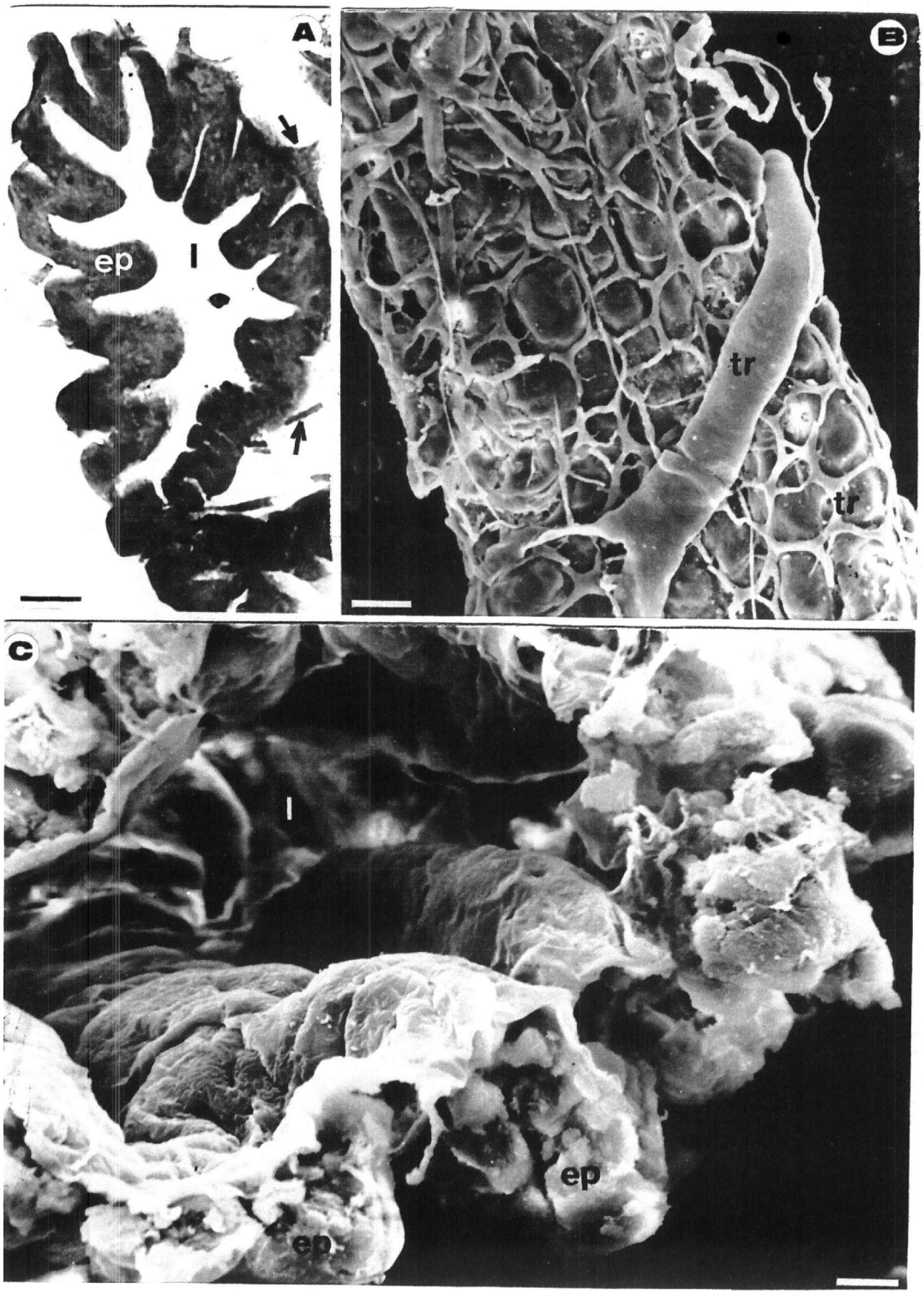

Figure 1. Dufour gland of *A. graminea*. A. Light micrograph of a cross section of the Dufour gland, showing the irregular lumen (l) due to the many epithelium (ep) folds. Notice muscle and tracheole fragments around the epithelium (arrows). Bar = 60 μm. B. Scanning electron microscopy (SEM) of a portion of the Dufour gland wall. Notice the tracheole network (tr), forming a very organized web

involving the gland. Bar = 50 μm. C. SEM of a sectioned Dufour gland, showing the irregular lumen (l) and folds of the epithelium (ep). Bar = 30 μm.

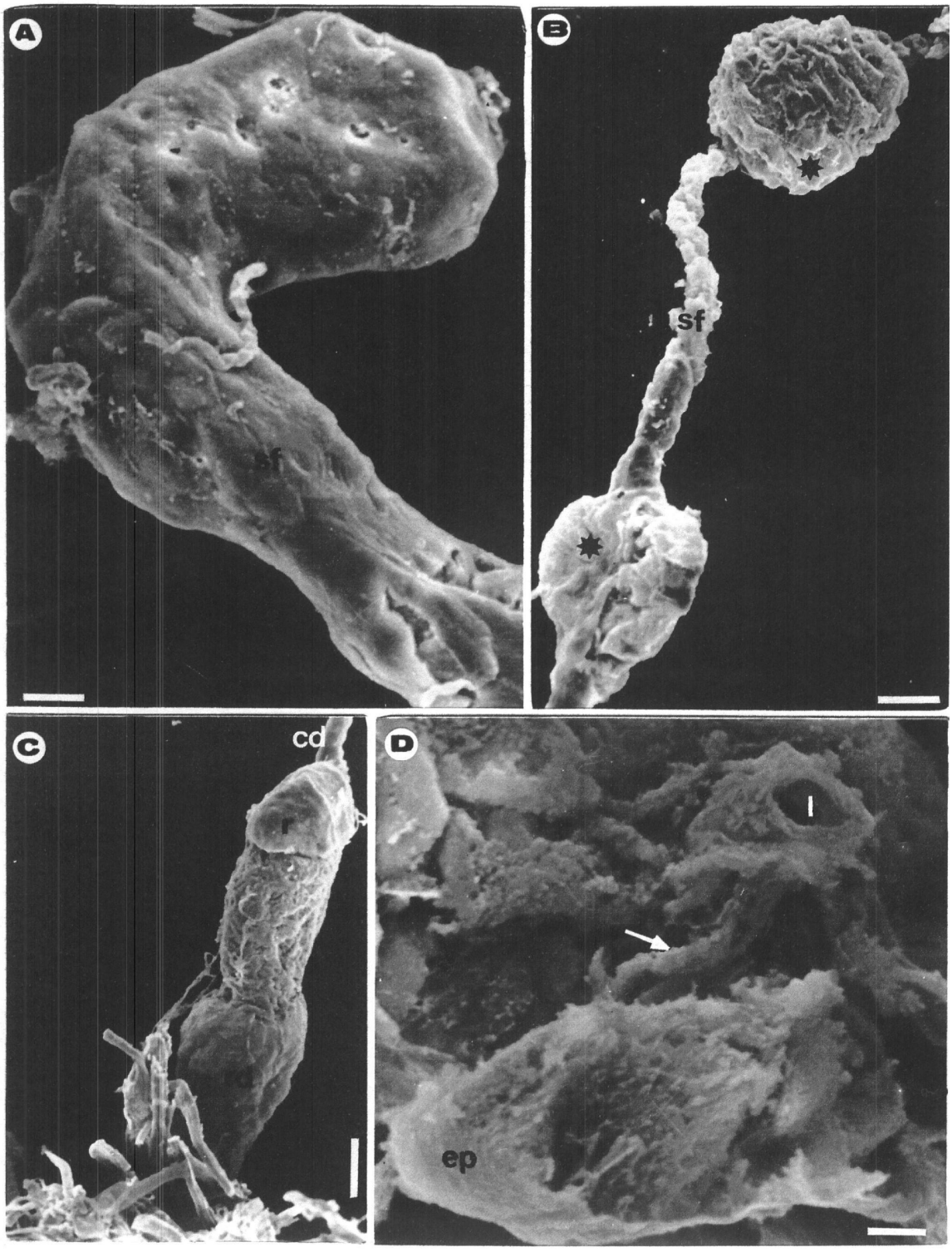

Figure 2. **Venom gland of *A. graminea.* A. SEM of a secretory filament (sf) distal portion, finishing blind. Bar = 10 μm. B. SEM of a secretory filament (sf) median portion, in which globular structures (asterisks) are observed. Bar = 30 μm. C. SEM showing the common duct**

(cd) linked to the reservoir (r); from this later a reservoir duct (rd) conducts the venom to the sting. Bar = 50 μm. D. Detail of a fracture of the venom gland epithelium, showing the intracellular canal (arrow) connected to the intima, which lines the gland lumen. Bar = 5 μm.

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Recebido em 27/9/2003
Aceito em 5/1/2004