

Morphology of Richards' Gland in the Wasp *Metapolybia docilis*

by

Johan Billen¹ & Fernando B. Noll²

ABSTRACT

Richards' gland in the epiponine wasp *Metapolybia docilis* occurs at the anterior side of the 5th abdominal sternite, and is formed by approx. 360 secretory cells. The cells discharge their secretory products through accompanying duct cells into a reservoir that is formed by the invaginated intersegmental membrane between the 4th and 5th sternites. The ultrastructural characteristics of the secretory cells are indicative for the production of a non-proteinaceous secretion, which is in line with the trail substance that is used by these wasps during their swarm-founding.

Key words : Epiponini, exocrine glands, histology, ultrastructure.

INTRODUCTION

Polistine wasps of the tribe Epiponini are known for their colony foundation through swarm founding, in which swarms with large numbers of workers and a smaller number of queens move from the old nest to the new nest site (West-Eberhard 1982; Jeanne 1991). During this process of nest moving, scout workers mark the trajectory between the old and new nest by dragging their abdomen over patches of vegetation along the route. This peculiar behaviour goes along with the deposition of a trail pheromone that originates in Richards' gland, which occurs at the anterior side of the 5th abdominal sternite (Jeanne & Post 1982). Richards' gland is known for the majority of the epiponine wasp species, although its development and structural organization may vary along species (Jeanne & Post 1982; Jeanne *et al.* 1983).

Even though this gland is very important in the sociobiology of neotropical swarm-founding wasps, there is almost no specific information on this gland in *Metapolybia docilis*, although it occurs among the 62 species surveyed by

¹Zoological Institute, University of Leuven, Naamsestraat 59, box 2466, B-3000 Leuven (Belgium)

²Departamento de Zoologia e Botânica, IBILCE-UNESP, Rua Cristóvão Colombo 2265, 15054-000 São José do Rio Preto-SP (Brazil)

* Corresponding author. E-mail address : Johan.Billen@bio.kuleuven.be

Jeanne *et al.* (1983), where it is listed to have cuticular scales and is classified as a “small gland” (according to the criterion of < 25 cells visible on a section – Jeanne & Post, 1982). We present here the first detailed characterization of this gland for this species.

MATERIAL AND METHODS

Metapolybia docilis workers were collected from their nest in Indiraporá, SP, Brazil. The posterior part of their gaster was fixed in cold 2% glutaraldehyde, buffered at pH 7.3 with 50 mM Na-cacodylate and 150 mM saccharose, and postfixed in 2% osmium tetroxide in the same buffer. Tissues were dehydrated in a graded acetone series, embedded in Araldite, and sectioned with a Reichert Ultracut E microtome. Semithin sections with a thickness of 2 μ m were stained with methylene blue and thionin and observed in a Zeiss Axioskop microscope. Double stained 70 nm thin sections were examined in a Zeiss EM900 electron microscope. Material for scanning microscopy was coated with gold and examined in a JEOL JSM-6360 scanning microscope.

RESULTS

Metapolybia docilis workers are characterized by a conspicuous Richards' gland underneath the anterior margin of the 5th gastral sternite (Fig. 1). The gland comprises a reservoir and a large cluster of secretory cells (Fig. 2). The

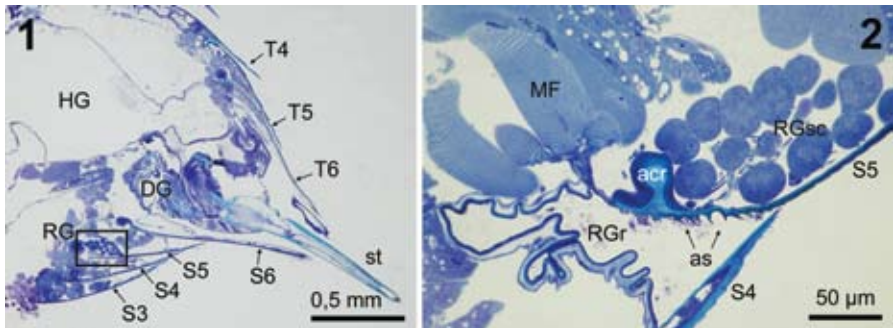


Fig. 1. Semithin longitudinal section through the abdomen along the body midline, illustrating the position of Richards' gland (framed).

Fig. 2. Detail of Richards' gland with secretory cells cluster (RGsc) and reservoir (RGr) formed by invaginated intersegmental membrane between 4th and 5th sternites. Note area with cuticular scales (as) at anterior side of 5th sternite, which is where duct cells of Richards' gland open. acr: antecostal ridge 5th sternite; DG: Dufour's gland; HG: hindgut; MF: muscle fibers; S3,4,5,6: numbered sternites, st: sting, T4,5,6: numbered tergites.

reservoir is formed by the irregularly invaginated intersegmental membrane between the 4th and 5th sternites. The secretory cells correspond to class-3 following the classification of Noirod and Quennedey (1974), with duct cells carrying the secretion to the outside. The cluster of secretory cells occurs at the posterior side along the transverse antecostal rim of the 5th sternite. The spherical cells have an average diameter of $32 \pm 1.9 \mu\text{m}$ ($n = 20$), and occur with reasonable intercellular distances between them rather than being closely packed. The total number of cells was calculated by an accumulative count

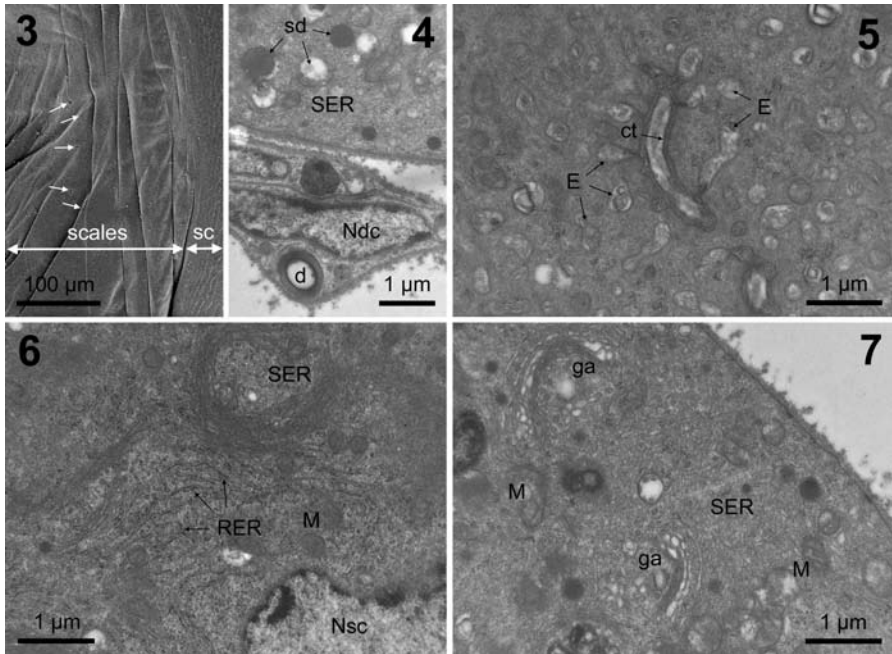


Fig. 3. Scanning micrograph of anterior region of 5th sternite (posterior tip to the right), showing scales region and beginning of smooth cuticle more posteriorly. Arrows indicate pores of Richards' gland duct cells.

Fig. 4. Electron micrograph of duct cell (below) and part of secretory cell (top).

Fig. 5. Detail of end apparatus with branched extracellular extensions.

Fig. 6. Cytoplasmic detail showing whorls of smooth endoplasmic reticulum as well as loose strands of granular endoplasmic reticulum.

Fig. 7. Detail of secretory cell cytoplasm with well developed Golgi apparatus and smooth endoplasmic reticulum. ct: cuticular lining of end apparatus; d: duct cell lumen; E: extracellular extensions of end apparatus; Ga: Golgi apparatus; M: mitochondria; Ndc: nucleus duct cell; Nsc: nucleus secretory cell; RER: granular endoplasmic reticulum; sc: smooth cuticle; sd: secretory droplets; SER: smooth endoplasmic reticulum

of the number of cells along a longitudinal section series through the entire gaster at 32 μm intervals. This was done for 3 workers, and gave corresponding total cell numbers of 356, 364 and 378. The anterior region of the 5th sternite where the duct cells penetrate the cuticle is externally differentiated into posteriorly pointing tile-lake scales (Fig. 2).

The individual duct cells open through the cuticle in the scales region as small round pores (Fig. 3). The ducts have an internal diameter of approx. 0.5 μm and are lined with an electron-dense cuticular lining with a thickness of 0.15 μm (Fig. 4). The duct cells continue inside the secretory cells as the end apparatus, which is branched. It is formed by an inner cuticular lining, surrounded by the irregular surface of the secretory cells (Fig. 5). Ultrastructural observation shows cytoplasmic details such as an extensive smooth endoplasmic reticulum, some loose strands of granular endoplasmic reticulum (Fig. 6), a well developed Golgi apparatus and some scattered mitochondria (Fig. 7).

DISCUSSION

In their 1983 paper on gastral sternal glands, Jeanne *et al.* list 62 species of female polistine wasps, and report for *Metapolybia docilis* that only the 5th sternite contains a sternal gland that is classified as a 'small gland' following the criterion that less than 25 gland cells are visible on an average of at least 2 histological sections. Although our analysis of Richards' gland in this species confirms that an average of 15-20 gland cells occur on longitudinal sections, the total number of approx. 360 cells is fairly large as the gland extends almost along the entire anterior region of the 5th sternite, and therefore represents one of the major abdominal glands in *M. docilis*.

The invaginated intersegmental membrane between the 4th and 5th sternites forms a reservoir in which the gland's pheromonal secretion can be stored until it is discharged during the scent-marking of swarming wasps. The marking acts go along with an exposure of the anterior margin of the 5th sternite in order to deposit glandular secretion onto the substrate (Jeanne & Post 1982). Cuticular scales at the anterior side of the sternite may provide narrow spaces from which a small amount of stored secretion can be released during each marking act. During retraction of the sternite to its rest position after each marking event, the intersegmental reservoir moves anteriorly over the region with the cuticular modifications, and fills the narrow inter-scale

spaces with another small dosis of marking pheromone to be used during the next marking act (Jeanne *et al.* 1982).

The ultrastructural occurrence of a well developed Golgi apparatus and a smooth endoplasmic reticulum are typical features for pheromone glands, and are indicative for the elaboration of non-proteinaceous secretory products (Noirot & Quennedey 1974; Billen & Morgan 1998). Although the chemical composition of the epiponine marking substance is not yet known, it appears most likely that the trail substances will be volatile and therefore non-proteinaceous in order to be detectable from a distance by swarming nestmates.

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