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**Original article**

# Class III glands in the abdomen of Meliponini

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**Abstract** – Class III tegumentar glands were studied in workers, as well as in queens and males when available, of 56 Meliponini species. The presence and development of these glands varies widely among and within species. However, the queen typically has more glands than do workers, and males rarely have any. Gland development in workers was evaluated by counting and determining the size of cells in histological sections. Laying queens were found to have more active gland cells than did virgins. Cell numbers and cell ultrastructure differed among glands similarly located in workers, queens and males. Cell size and ultrastructure also varied from tergite to tergite. In conclusion, since it is likely that most of them produce pheromones, the wide variability in these glands suggests that they are important to social interaction.

**stingless bee / tergal gland / histology / ultrastructure / worker / queen / male**

## 1. INTRODUCTION

The tegument of insects is rich in glands, and bees follow this characteristic pattern. Noirot and Quennedey (1974, 1991) identified three classes of gland cells present in the insect tegument. In bees, the abdominal tegumental glands are composed of Noirot and Quennedey class I and class III cells.

The glands composed of class I cells consist of zones of hypertrophied epidermis and are known as epithelial glands. Dreyling (1903) and Rösch (1927, 1930) found glands of this type in the abdomens of *Apis mellifera* L. workers. The glands are located from sternite 3 to sternite 6, where they have the function of producing wax. Epithelial glands with the same function are located dorsally (from tergite 3 to tergite 6) on the abdomen of Meliponini workers (Cruz-Landim, 1963, 1967). In *A. mellifera*, only the workers have glands of this type. However, in Meliponini, they are also found in the queens and males of a few species, although the degree of development varies.

Class III cells are also epidermal cells, but they are modified. These glandular cells appear as free secretory units located below the tegument, but connected to it by their excretory canal. Glands consisting of groups of this type of cell were described on tergite 8 and on the quadrate plate (of the sting) in *A. mellifera* by Koschewnikow (1899) and now bear his name. Although the Meliponini sting is atrophied, the queens and workers of most species present glands at the same location (Mota, 1988; Cruz-Landim, 1996). Another gland consisting of these cell types was described on tergite 7 of *A. mellifera* by McIndoo (1914) and by Jacob (1924). McIndoo designated it the scent gland and attributed to it the function of identifying nest mates. It is now known as the Nasanov gland (Snodgrass, 1956). Glands in the same location were reported by Cruz-Landim (1963) in

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some Meliponini species. Following these pioneering studies, which mainly involved *A. mellifera*, interest in bee gland studies rose due to the potential role of such glands in the production of chemicals involved in social integration and communication.

In Apini and Meliponini, the glands composed of class III cells are found only on the dorsal abdomen, more commonly in queens than in workers, and are rarely seen in males (Renner, 1960; Renner and Baumann, 1964; Cruz-Landim et al., 1980a, b; Mota, 1988; Cruz-Landim, 1996). The presence of these glands differs among species, as well as for the sexes and castes of the same species, and the degree of their development also varies over the lifetime of a bee.

In the present study, the presence and morphology of these glands in several species of Meliponini were evaluated using light and electron microscopy. In addition, the size of certain glands was measured in an attempt to correlate gland development with caste and sex.

## 2. ORIGIN, CELL MORPHOLOGY AND PRESENCE OF GLANDS

The class III gland unit consists of two or more modified epidermal cells: the glandular cell proper; and one or more canal cells. The glandular cell tends to be spherical and features an inner canal which collects the secretion (Noirot and Quennedey, 1974; Cruz-Landim, 2002). The canal cells form the excretory duct that connects the gland cell to the tegument, through which the secretion is delivered.

Gland cells of this type have been classified as dermal due to their subepidermal location. Such cells are commonly found in sparse distribution beneath the epidermis and are thought to be responsible for the secretion of cement from the insect tegument (Chapman, 1998). However, Howard and Riddiford (1991) found no cement in the *A. mellifera* tegument. Therefore, the presence of these isolated gland cells in bees has no functional explanation.

Herein we focus on the glands composed of groups of class III cells in the abdomen of stingless bees. Although these glands vary from species to species and among individuals within the colonies of a given species, their location and general morphology are consistent (Tabs. I–III).

The individual gland cells are free, i.e. there is no adherence among them. Therefore, these cells tend to be spherical (Fig. 1). Each secretory unit in the group is itself a gland, consisting of a secretory unit (cell) and an excretory canal that delivers the secretion through the tegument. Glands composed of these types of units have been classified as unicellular glands. However, the number of secretory units composing the glandular organ can vary greatly, from just a few to hundreds of cells (Fig. 2; Tabs. I–III).

Most of these glands are located bilaterally on the tergites and deliver the secretion outside the body. In the sclerites this occurs through openings in the tegument, which can appear scattered across the sclerite surface or grouped into the form of a sieve (Fig. 3). The secretion is frequently seen draining from the opening in the form of solid cords. However, some glands deliver the secretion through the intersegmental membrane, as is the case for the Nasanov and Koschewnikow glands of *A. mellifera*. In this case, and when the glandular cells are numerous, a fold in the membrane may form a kind of reservoir, causing the cells to acquire a polyhedral shape, or to take on an epithelial arrangement around the intersegmental membrane fold, as is seen in the Koschewnikow gland of the *A. mellifera* queen. In Meliponini, the gland located at the same site consists of only a few cells, and this folding phenomenon does not occur.

## 3. VARIABILITY

Table I shows the variability of the gland presentation among the species examined and among classes of individuals within the same species The considerable variability is also evidenced by the number and size of the cells composing the gland (Tab. IV). Cell size may vary according to the different phases in the

**Table I.** Occurrence of abdominal unicellular glands in workers of some Meliponini species.

| Subtribe | Species | Tergite 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| TRIGONINA | *Aparatrigona impuntacta* (Ducke), *Paratrigona subnuda* (Moure), *Partamona cupira helleri* (Smith), *Plebeia droryana* (Friese), *Plebeia minima* (Gribodo), *Plebeia remota* (Holmberg), *Tetragonisca angustula* (Latreille), *Trigona dallatorreana* (Friese) | – | – | – | – | – | – | – |
| | *Celetrigona longicornis* (Ducke), *Friesella schrottkyi* (Friese), *Frieseomellita silvestri faceta* (Moure), *Frieseomellita varia varia* (Lepeletier), *Leurotrigona muelleri* (Friese), *Nannotrigona testaceicornis* (Lepeletier), *Nannotrigona minuta* (Lepeletier), *Nannotrigona melanocera* (Schwarz), *Parapartamona tunguhuana* (Schwarz), *Parapartamona zonata* (Smith), *Parapartamona pseudomusarum* (Camargo), *Partamona testacea* (Klug), *Tetragona clavipes* (Fabricius), *Schwarziana quadripuntacta* (Lepeletier), *Schwarzula flavornata* (Moure), *Tetragona dorsalis* (Smith), *Tetragona goettei* (Friese), *Trigona hypogea* (Silvestri), *Trigona recursa* (Smith), *Trigona palens* (Fabricius), *Trigona truculenta* Almeida, *Trigona dallatorreana* (Friese), *Trigona branneri* (Cockerell), *Trigona spinipes* (Fabricius), *Mourella coerulea* (Friese) | – | – | – | – | – | – | + |
| | *Duckeola ghiliani* (Spinola), *Lestrimelitta limao* (Smith), *Oxytrigona tataira* (Smith), *Tetragonisca essequiboensis* (Schwarz), *Trigona crassipes* (Fabricius), *Trigona fulviventris gutanae* (Guérin), *Trigona williana* (Friese), *Camargoia nordestina* (Moure) | + | – | – | – | – | – | + |
| | *Geotrigona mombuca* (Smith), *Scaura latitarsis* (Friese), *Scaura tennis* (Ducke) | + | – | – | – | – | – | – |
| | *Scaptotrigona bipuntacta* (Lepeletier), *Scaptotrigona postica* (Lepeletier), *Scaptotrigona nigrohirta* (Moure), *Scaptotrigona tubiba* (Smith), *Scaptotrigona xanthotricha* (Moure) | – | + | – | – | – | – | + |
| | *Ptilotrigona lurida moesaryi* (Friese) | + | + | + | + | + | – | + |
| MELIPONINA | *Melipona marginata marginata* (Lepeletier), *Melipona quadrifasciata anthidioides* (Lepeletier), *Melipona quadrifasciata quadrifasciata* (Lepeletier) | + | – | – | – | – | – | – |
| | *Melipona bicolor bicolor* (Lepeletier), *Melipona compressipes fasciculata* (Smith), *Melipona quinquefasciata* (Lepeletier), *Melipona seminigra seminigra* (Friese) | + | – | – | – | – | – | + |

– = absence; + = presence.

**Table II.** Occurrence of abdominal unicellular glands in queens of some Meliponini species.

| Subtribe | Species | Tergite | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TRIGONINA | *Frieseomelitta schrottkyi* (Friese), *Nannotrigona testaceicornis* (Lepeletier), *Plebeia droryana* (Friese), *Scaptotrigona postica* (Lepeletier) | – | + | + | + | + | + | + |
| | *Leurotrigona muelleri* (Friese), *Trigona crassipes* (Fabricius), *Trigona spinipes* (Fabricius) | + | + | + | + | + | + | + |
| | *Schwarziana quadripuntacta* (Lepeletier) | – | + | + | + | – | – | + |
| MELIPONINA | *Melipona bicolor bicolor* (Lepeletier), *Melipona compressipes fasciculata* (Smith), *Melipona marginata marginata* (Lepeletier), *Melipona quadrifasciata anthidioides* (Lepeletier) | + | + | + | + | + | + | + |

– = absence; + = presence.

**Table III.** Occurrence of abdominal unicellular glands in males of some Meliponini species.

| Subtribe | Species | Tergite | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TRIGONINA | *Frieseomelitta schrottkyi* (Friese), *Mourella coerulea* (Friese), *Plebeia droryana* (Friese), *Scaptotrigona postica* (Lepeletier) | – | – | – | – | – | – | – |
| | *Lestrimelitta limao* (Smith) | + | – | – | – | – | – | + |
| | *Trigona crassipes* (Fabricius) | – | – | – | – | – | – | + |
| MELIPONINA | *Melipona bicolor bicolor* (Lepeletier), *Melipona marginata marginata* (Lepeletier), *Melipona quadrifasciata anthidioides* (Lepeletier), *Melipona seminigra seminigra* (Friese) | – | + | – | – | – | – | – |

– = absence; + = presence.

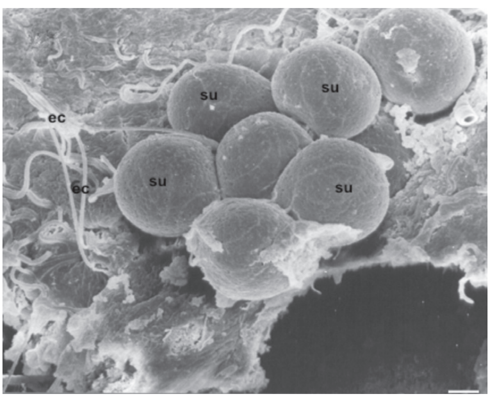


**Figure 1.** Scanning electron micrograph of secretory units (su) from a class III gland on tergite 4 of a *Scaptotrigona postica* queen. ec = excretory canal; Bar = 50 $\mu$m.

life cycle of bees, and such variation is frequently accompanied by variation in cell ultrastructure. Both characteristics are thought to reflect secretory activity, and the ultrastructure may also give clues about the chemical nature of the secretion. The importance of a given gland to the species can, therefore, be estimated by its degree of development, as determined by the number of constituent secretory units and by the changes in their size over time. In addition, the changes in cell ultrastructure can, albeit indirectly, provide information about possible changes in the cell function.

In *Scaptotrigona postica*, the glands on tergite 3 of workers present ultrastructural features that are distinct from those of the corresponding glands of queens. This suggests that these glands synthesize different compounds

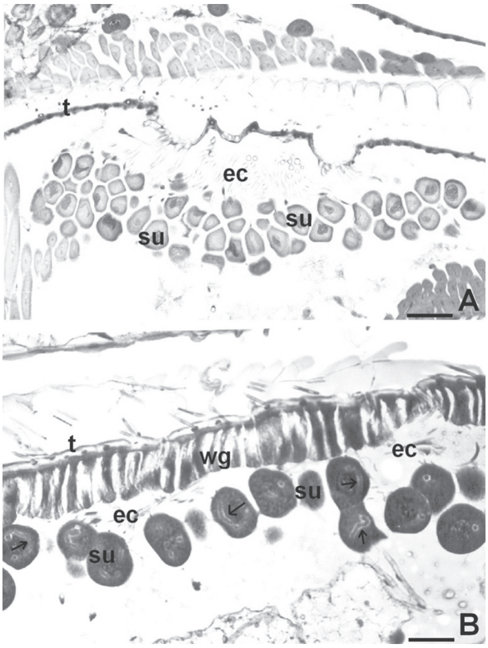


**Figure 2.** Light micrographs of class III glands of *Plebeia droryana* abdomen. **A.** Queen tergite 6. Bar = 50 $\mu$m. **B.** Worker tergite 5. Bar = 20 $\mu$m; t = tegument; ec = excretory canals; su = secretory unit; arrows = collector canals inside the cell; wg = wax gland.

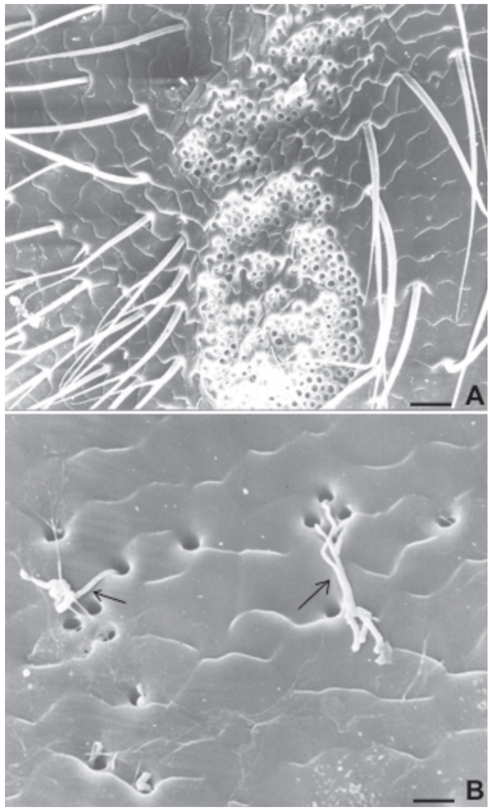


**Figure 3.** Scanning electron micrographs of the unicellular gland openings in the tegument of a *Scaptotrigona postica* queen. **A.** Sieve formed by grouped openings in the gland on tergite 7. Bar = 150 $\mu$m. **B.** Scattered openings showing cords of secretion (arrows). Bar = 50 $\mu$m.

in workers and queens. In the majority of *S. postica* specimens, the queen gland consists of a large number of cells, whereas the worker gland is composed of only very few cells. Accordingly, the cell ultrastructure of the queen gland is more complex, presenting both smooth and rough endoplasmic reticulum, together with several Golgi complexes and many secretion granules of medium electron-density (Fig. 4A). In the worker gland, the smooth endoplasmic reticulum predominates, and no secretion is seen stored in the cytoplasm (Fig. 4B). Similarly, Guerino and Cruz-Landim (2003) and Guerino (2004) found ultrastructural differences among the glands found on tergite 3 of workers, queens and males of *Melipona bicolor*. In this and in other species, the gland cells also differ between virgin and egg-laying queens (Fig. 5).

Glands on different tergites also display different ultrastructural features. The ultrastructural differences indicate that glands located at the same site in different species, or in different adult individuals of a colony, might synthesize distinct compounds specific to the uses of each class of bees (sex, caste, or age class). The ultrastructure also shows that the function of a gland can change depending on the stage of the life cycle. Therefore, the degree of development of the gland and the secretion it produces may maintain a close relationship with the specific activity of an individual bee within the colony.

In order to create a quantitative profile of these glands, measurements were taken for queens of three different species (*M. compressipes fasciculata*; *M. quadrifasciata*

**Table IV.** Estimate of gland development by cell numbers present in the histological sections and apparent cell size. The number in parenthesis corresponds to the cell numbers in the section.

| Species | Tergite | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| *Celetrigona ghiliani* | | | | | | | +(3) |
| *Friesella schrottkyi* | +++(40) | | | | | | +++(10) |
| *Frieseomelitta silvestrii* | | | | | | | +++(8) |
| *Frieseomelitta varia* | | | | | | | ++(12) |
| *Geotrigona mombuca* | ++(10) | | | | | | |
| *Lestrimelitta limao* | ++(5) | | | | | | +++(20) |
| *Leurotrigona muelleri* | | | | | | | +(3) |
| *Mourella coerulea* | | | | | | | +(2) |
| *Nannotrigona melanocera* and *minuta* | | | | | | | +++(10) |
| *Nannotrigona testaceicornis* | | | | | | | +++(15) |
| *Oxytrigona tataira* | ++(4) | | | | | | ++(4) |
| *Parapartamona tungurahuana* and *zonata* | | | | | | | ++(4) |
| *Partamona pseudomusarum* and *testacea* | | | | | | | +(2) |
| *Ptilotrigona lurida* | +(4) | +(8) | +(6) | +(6) | | +(6) | ++++(80) |
| *Scaptotrigona postica, nigrohirta, bipuntacta* and *tubiba* | | +(4) | | | | | ++(8) |
| *Scaptotrigona xanthotricha* | | ++(10) | | | | | |
| *Scaura latitarsalis* and *tenuis* | +(4) | | | | | | +(4) |
| *Schwarziana quadripuntacta* | | | | | | | +(4) |
| *Schwarzula flavocornata* | | | | | | | +(3) |
| *Tetragona dorsallis, goettei* and *clavipes* | | | | | | | +++(20) |
| *Tetragona essequibensis* | +(5) | | | | | | ++(10) |
| *Trigona branneri, dallatorreana, hypogea, spinipes,* and *truculenta* | | | | | | | +++(15) |
| *Trigona crassipes* | ++(5) | | | | | | +++(10) |
| *Trigona palens* | | | | | | | +++(45) |
| *Trigona recursa* | | | | | | | ++(4) |
| *Trigona fulviventris* | +(2) | | | | | | ++(10) |
| *Trigona williana* | ++(5) | | | | | | +++(25) |
| *Melipona bicolor* | +++(20) | | | | | | +(2) |
| *Melipona compressipes* and *quinquefasciata* | +++(30) | | | | | | +(3) |
| *Melipona rufiventris* and *seminigra* | + + +(30) | | | | | | +(2) |
| *Melipona marginata* | +++(30) | | | | | | |

cell size: + = small; ++ = medium; +++ = large; ++++ = very large.

*anthidioides* and *Scaptotrigona postica*). The glands measured were those found on tergites 3, 7 and 8. These particular glands were chosen due to the fact that they consistently presented more than ten cells per histological section. The number of sequential sections in which the gland appeared was determined. The cell diameters, as well as the diameters of their nuclei were measured from 10 cells each from virgin and laying queens (Tab. V). Owing to the small sample size and differences in the queen life stage (related to the difficulty of obtaining individuals of this class at exactly the same stage), no statistical tests were applied to the results. In addition, the size of the nucleus in relation to cell size (percentage of the cell occupied by the nucleus) was calculated (Tab. V). It was assumed that nucleus size is indicative of the state of the cells secretory activity, and that cell growth in adults is related to the storage of secretion in the cytoplasm. In all three species, the glands measured were found to be more developed in fertilized, egg-laying queens than in virgin queens, i.e. the

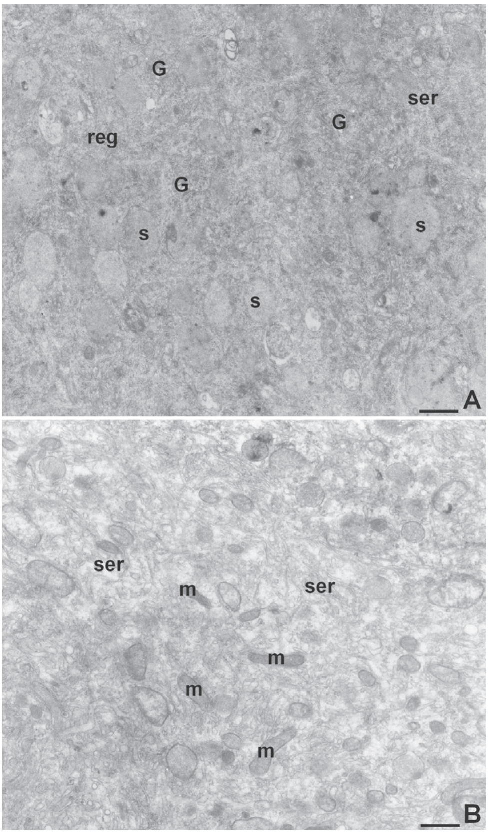


**Figure 4.** Transmission electron micrographs of *Scaptotrigona postica* unicellular gland cells. **A.** Cytoplasm of a cell from a gland on tergite 3 of a queen showing smooth endoplasmic reticulum (ser) and rough endoplasmic reticulum (reg), Golgi (G) and secretion (s). Bar = 0.5 $\mu$m. **B.** Cytoplasm of a cell from a gland on tergite 3 of a worker showing smooth endoplasmic reticulum (ser) and mitochondria (m). Bar = 0.5 $\mu$m.

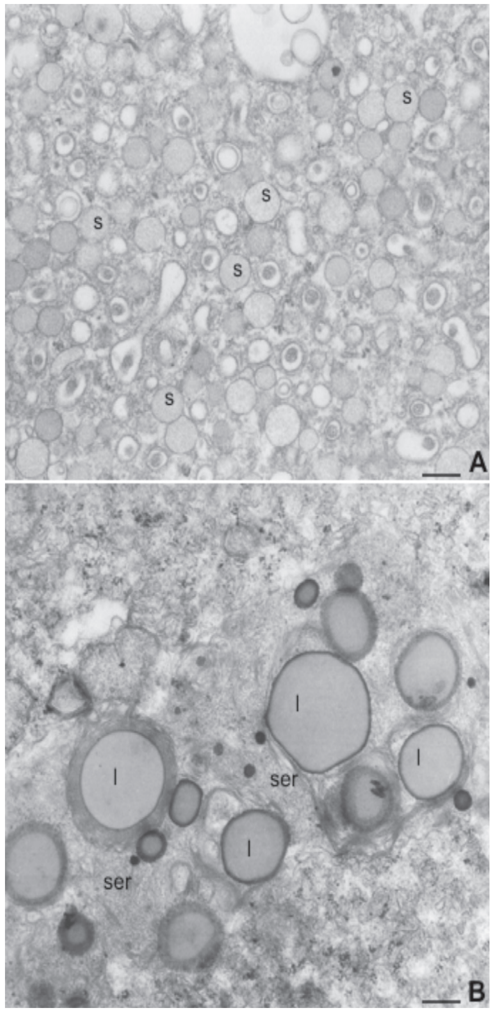


**Figure 5.** Transmission electron micrographs of tergite 6 gland cells from virgin and mated *Melipona bicolor* queens. **A.** Virgin queen gland cell presenting cytoplasm filled with secretion (s) of mucous aspect. Bar = 0.5 $\mu$m. **B.** Mated queen gland cell presenting cytoplasm rich in smooth endoplasmic reticulum (ser) and lipids (l). Bar = 0.5 $\mu$m.

percentage of the cell occupied by the nucleus was consistently lower in the laying queens.

## 4. DISCUSSION

It is a general assertion that individual bees that engage more often in behavioral interactions have more, or more developed exocrine glands since, with few exceptions, their secretions have pheromonal functions. Therefore, the variations seen in gland presence and morphology are likely to be related to the function of those glands in the individual. The exocrine glands of bees present great functional plasticity. Glands of the same morphological type and in the same location produce different compounds in different classes of individuals of the same species and during different life phases of the same individual (Francke et al., 1983; Smith and Breed, 1995; Abdalla et al.,

**Table V.** Size of the nucleus in relation to cell size (percentage of the cell occupied by the nucleus) in the abdominal unicellular gland cells of queens of some Meliponini species.

| Species | Stage – Age | Percentage of nucleus in glands | | |
|---|---|---|---|---|
| | | tergite 3 | tergite 7 | tergite 8 |
| *Melipona compressipes fasciculata* | Virgin – 4 h (1) | 23.7 | – | 27.0 |
| | Virgin – 24 h (1) | 14.2 | 21.0 | 19.7 |
| | Virgin – 48 h (1) | 15.5 | 22.0 | 19.0 |
| | Laying – approx. 6 mos (2) | 14.9 | 18.9 | 18.1 |
| *Melipona quadrifasciata anthidioides* | Virgin – 6 h (2) | 34.1 | 34.0 | 34.6 |
| | Laying – 1 mo (1) | 25.0 | 27.6 | 26.9 |
| | Laying – approx. 1 yr (1) | 27.2 | 29.4 | 30.6 |
| *Scaptotrigona postica* | Virgin – 2 h (2) | 34.6 | 30.0 | 33.3 |
| | Virgin – 5 days (2) | 31.0 | 30.0 | – |
| | Laying – age ignored (1) | 29.1 | 27.8 | 25.3 |

Note: the number in parenthesis indicates the number of queens in the given condition.

1999). Therefore, the size and morphological variation found in the same gland of different individuals, should reflect changes in its functional status.

Unfortunately, there are very few data regarding the composition of secretions for glands that are encountered at the same location in Meliponini and *A. mellifera*. Therefore, it would be difficult to draw comparisons between the two taxa. Apini and Meliponini present many behavioral differences in terms of the use of pheromones in communication and social interaction between the castes. The Meliponini queens, for instance, do not control the ovarian development of the workers and the raising of new queens. To date, no clearly recognizable pattern of gland presence has been identified in the studied species of Meliponini. However, it seems obvious that the differences found in the presence of these glands, as well as in their morphology and development, reflect the function they have in the life cycle of the individual or of the colony. In males that engage in less social interaction, these glands are typically poorly developed or absent (Tab. III). Of the species of Trigonina studied, only *Lestrimelitta limao* and *Trigona crassipes* males presented these glands, whereas they are found in the males of all *Melipona* species, suggesting that the interactions between sexes differ between these two types of bees. Although males play a vital reproductive role in the colony, little is known about their behavior. According to Velthuis et al. (2005), there is a broad spectrum of patterns of male production, sex ratios, and parentage in Meliponini.

Among the females, the queen caste is the richest in glands (Tab. II), indicating that these are important for their interactions with workers and males. It is possible that the secretion from these glands identifies them as queens to the other colony members. In *A. mellifera capensis* and *A. mellifera scutellata*, the composition of that secretion differs between queens and pseudoqueens (Smith and Breed, 1995). In addition, the virgin and mated queens secrete different compositions from their glands. The secretion produced by the glands of these bees varies depending on the functional state, age of the individual or both (Smith and Breed, 1995). In mated honey bee queens, the principal component produced by the tergite gland is decyl decanoate (Espelie et al., 1990). It is possible that most of the compounds of the class III abdominal glands are spread over the epicuticle of the integument to create the "finger print" that permits recognition among colony members. Abdalla et al. (2003) found that the cuticular hydrocarbon composition in *Melipona bicolor* changes qualitatively and quantitatively between and within castes and sexes, and also during the worker life cycle. These authors found that there was great variability in the hydrocarbon compounds found on the queen cuticle, which corresponds to the greater number and diversity of glands present in this caste.

Bees use complex chemical communication systems in their social life. Yet even though the biosynthetic pathways for the production of these compounds probably are conserved, the usage of these pathways may change depending on environmental or physiological circumstances. This is of particular interest when considering the caste systems, resulting from caste-specific gene expression within a basic female genome. This caste polyphenism is a common pattern in highly eusocial insects, and the exocrine glands are excellent example of this condition, resulting in great plasticity in the function of bee glands. The great variability in gland presence and potential function presents an obstacle to comprehending the roles that their products play in stimulating the behaviors necessary or colony homeostasis. Identifying the exact chemical nature of the secretions and performing bioassays of their principal components will be essential to understanding the language that controls and coordinates colony activities.

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**Résumé – Les glandes de classe III dans l'abdomen des Meliponini.** Nous avons étudié chez les abeilles sans aiguillon les glandes composées de cellules glandulaires de classe III. Notre but était d'obtenir des informations qui puissent servir de base pour de futures études concernant la fonction de ces glandes. La répartition, la localisation, l'histologie et l'ultrastructure de ces glandes ont été étudiées chez les ouvrières, ainsi que chez les reines et les mâles quand c'était possible, de 56 espèces d'abeilles sans aiguillon du Brésil. Ces glandes ont été étudiées dans la mesure du possible aux divers stades du cycle évolutif et dans divers contextes physiologiques de façon à trouver des corrélations entre ces paramètres et le degré de développement des glandes. Ces glandes ne se trouvent que dans la partie dorsale de l'abdomen et leur présence ou absence est très variable chez les ouvrières des espèces étudiées (Tab. I). Elles sont en outre plus communes chez les reines, où on les trouve dans chaque tergite abdominal (Tab. II), et rares chez les mâles (Tab. III). Le degré de développement, déterminé d'après le nombre et la taille des cellules, varie aussi d'un tergite à l'autre chez le même individu ainsi qu'entre les diverses espèces et castes (Tabs. IV, V). On trouve une variabilité semblable lorsqu'on prend en compte les caractères histologiques et ultrastructuraux (Figs. 1–5). Les cellules des glandes situées aux mêmes endroits chez les ouvrières et les reines présentent une structure différente et les cellules de la même glande voient leurs caractéristiques structurales évoluer au cours de la vie. Ces différences pourraient correspondre à des modifications fonctionnelles. Il existe peu de données concernant la composition chimique des produits de ces glandes. Il est pourtant hautement probable qu'elles produisent des phéromones. La grande plasticité de ces glandes pourrait être liée aux caractéristiques comportementales propres à chaque espèce.

**abeille sans aiguillon / glande tergale / histologie / ultrastructure / reine / ouvrière / mâle / Apidae / Meliponini**

**Zusammenfassung – Drüsen der Klasse III im Abdomen von Meliponini.** In der vorliegenden Arbeit untersuchten wir an Stachellose Bienen Drüsen, die aus Drüsenzellen der Klasse III aufgebaut sind. Unser Ziel war es, Informationen zu gewinnen, die zur künftigen funktionellen Charakterisierung dieser Drüsen beitragen können. Die räumliche Verteilung und Lokalisierung, sowie ihre Histologie und Ultrastruktur wird für Arbeiterinnen und, soweit verfügbar, auch für Königinnen und Männchen von 56 Arten brasilianischer Stachelloser Bienen beschrieben. Soweit möglich wurden diese Drüsen bei Bienen in unterschiedlichen Stadien des Lebenszyklus und unterschiedlichem physiologischen Kontext untersucht, um Korrelationen zwischen diesen Parametern und dem Entwicklungsgrad der Drüsen zu finden. Diese Drüsen finden sich ausschliesslich im dorsalen Abdomen und ihre An-, bzw. Abwesenheit variiert weit innerhalb der Arbeiterinnen der untersuchten Arten (Tab. I). Bei Königinnen sind diese Drüsen weiter verbreitet und kommen in praktisch jedem der abdominalen Tergite vor (Tab. II). Bei Männchen hingegen sind sie selten (Tab. III). Der Entwicklungsgrad der Drüsen hängt von der Zahl und Grösse der Zellen ab, aus denen sie aufgebaut sind, und auch dies variiert von Tergit zu Tergit innerhalb einzelner Bienen, sowie zwischen Kasten und Arten (Tab. IV, V). Eine ähnliche Variabilität findet sich in der Histologie und Ultrastruktur (Abb. 1–5). Drüsenzellen, die sich an gleicher Position befinden, weisen beim Vergleich von Königinnen und Arbeiterinnen starke

Unterschiede in der Ultrastruktur auf, und Zellen der gleichen Drüse verändern ihre Strukturmerkmale über den Lebenszyklus einer Biene hinweg. Diese Unterschiede könnten in Zusammenhang stehen mit funktionellen Veränderungen. Obwohl es bis jetzt nur wenige Daten über die chemische Zusammensetzung der Produkte dieser Drüsen gibt, scheinen sie Pheromone zu produzieren. Die grosse Plastizität dieser Drüsen könnte sich auch in artspezifischen Verhaltensmerkmalen widerspiegeln.

**Stachellose Bienen / Tergitdrüsen / Histologie / Ultrastruktur / Arbeiterin / Königin / Männchen Apidae / Meliponini**

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