

MORPHOLOGY OF THE CLOACAL GLAND IN THE ANT *Cataglyphis savignyi*

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Summary

A cloacal gland has been found in *Cataglyphis savignyi*, and is the second report of the occurrence of this gland since it was first described in *Camponotus* (Hölldobler, 1982). The gland consists of two abdominal clusters of secretory cells, that correspond with the secretory unit type, in which specialized duct cells collect the secretion from the gland cells and bring it to the outside. No data are available on the function of the cloacal gland in *Cataglyphis*, though the individual foraging behaviour of these ants make a role as a source of recruitment pheromones, as in *Camponotus*, less probable.

Key-words : cloacal gland, *Cataglyphis savignyi*, morphology, ultrastructure, Formicidae.

Résumé : Morphologie de la glande cloacale chez la fourmi *Cataglyphis savignyi*

La glande cloacale est formée par deux amas de cellules sécrétrices dans la partie postérieure et ventrale de l'abdomen, où elles débouchent par des conduits individuels à travers la cuticule membraneuse latéralement des deux côtés au dessous de l'ouverture de la glande de Dufour. Cette glande cloacale jusqu'à présent n'avait été rapportée que chez des espèces de *Camponotus*, où elle produit des phéromones de recrutement (Hölldobler, 1982). Nous l'avons également trouvée chez *Cataglyphis savignyi*, et en décrivons ici la morphologie et l'ultrastructure. Les cellules sécrétrices, à noyau arrondi, contiennent un appareil terminal intracellulaire qui se continue dans la cellule par un conduit associé qui à son tour amène la sécrétion vers la région cloacale, d'où elle est finalement émise vers l'extérieur. Nous ignorons pour le moment la fonction de cette glande chez *Cataglyphis*. Une production de phéromones de recrutement, comme démontrée chez *Camponotus*, nous semble peu probable vu le fourrageage plutôt individuel des *Cataglyphis*. A cet égard des expériences comportementales pourraient éventuellement éclaircir la fonction exacte de cette glande chez cette espèce.

Mots-clés : glande cloacale, *Cataglyphis savignyi*, morphologie, ultrastructure, Formicidae.

Introduction

Among the abdominal exocrine glands in ants (and social Hymenoptera in general), the venom gland and Dufour's gland as derivatives of the female reproductive system always occur in workers and queens. Together with the pygidial gland, the development of which is less constant, they in addition form the most conspicuous glandular structures in the abdomen. In several ant genera, however, additional abdominal glands can be found, the location, fine structure and function of which is variable. One of these "new glands" is the cloacal gland, which so far has only been described in several, but not all species of the genus *Camponotus*. In these ants, the gland produces group recruitment pheromones (Hölldobler, 1982). We here report on the occurrence of this cloacal gland in another formicine ant, *Cataglyphis savignyi*, and describe its morphological organization.

Material and methods

Foraging workers of *Cataglyphis savignyi* (Dufour) were collected near their nest entrance at the base of the fence walls surrounding the Faculty of Science buildings of El Minya University, Egypt, in September 1986. The posterior part of their abdomen was fixed in 2% cold glutaraldehyde in Na-cacodylate buffer, postfixed in 2% osmium tetroxide, and embedded in Araldite. Semithin sections (1 μm) for light microscopy were stained with methylene blue and thionin; thin sections (60 nm) were routinely double-stained (uranyl acetate and lead citrate) and viewed in a Philips EM 400 electron microscope.

Results

The cloacal gland in *C. savignyi* workers comprises two lateral clusters of approximately 30 secretory cells each, located ventrally between the last abdominal sternite (S7) and the infolded intersegmental membrane that forms the ventral lining of the cloacal chamber (Figs. 1 and 2). From each secretory cell, a narrow duct cell runs

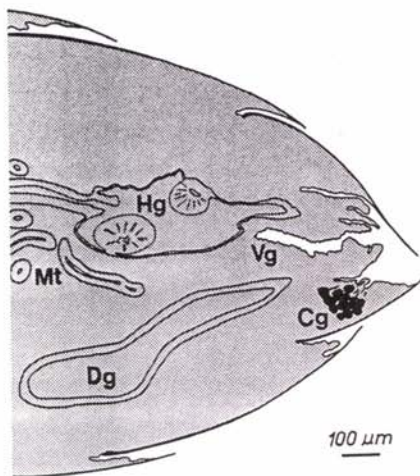


Fig. 1. Longitudinal section drawing of the posterior abdominal region illustrating the location of the cloacal gland (Cg). Dg = Dufour's gland, Hg = hindgut, Mt = Malpighian tubules, Vg = venom gland.

Fig. 1. Section longitudinale à travers la partie abdominale postérieure montrant la localisation de la glande cloacale (Cg). Dg = glande de Dufour, Hg = intestin postérieur, Mt = tubes de Malpighi, Vg = glande à venin.

towards this cloacal wall and opens through it (Fig. 3). According to the position of their corresponding secretory cell, the length of these duct cells varies from 30 to 150 μm , while their internal diameter is more or less constant around 0.6 μm . Each efferent duct continues within its associated secretory cell as a slightly sinuous intracellular cuticular ductule, which is mainly formed by a granular procuticle, whereas the electron-dense epicuticle is much reduced and discontinuous. The ductule is surrounded by a layer of microvilli, which have a length around 1 μm and a diameter of 0.1 μm . The microvillar arrangement is variable, even among cells of the same individual, and can be more or less densely packed (Fig. 4), or can occur in a much disorganized pattern by the presence of large spaces in between the microvilli (Fig. 5). These spaces, although situated within the general outline of the secretory cell, are to be considered as extracellular, since the microvilli themselves are a differentiation of the invaginated secretory cell cytoplasm. The occurrence of such expandable extracellular spaces can be regarded as a kind of storage area for secretion before transport through the duct cells (Bazire-Bénazet and Zylberberg, 1979). Small electron-lucid vesicles can be found at the base of the microvilli (Fig. 4), and also occur dispersed in the cytoplasm. Other elements in the cytoplasm include a moderate number of small mitochondria, few scattered free ribosomes, and a rounded nucleus, mostly in an eccentric position. Granular endoplasmic reticulum is not observed, smooth endoplasmic reticulum of the tubular type is weakly developed.

Discussion

Cataglyphis savignyi is a desert ant which is only active during the heat of the day. Workers of this genus are extremely fast running (Bernard, 1984) and forage individually. They are the second genus in which a cloacal gland is reported since the first description by Hölldobler (1982) in several *Camponotus* species. In the latter genus, the cloacal gland was found to produce a group recruitment pheromone in *C. ephippium*, while in *C. sericeus* it may produce the tandem running pheromone (Hölldobler, 1982). Although the cloacal gland of *Cataglyphis* is morphologically identical to the one in *Camponotus*, we are reluctant to attribute a similar function to it because of the individual foraging behaviour displayed by *Cataglyphis*. It remains unknown whether individual foragers leave the nest after stimulation by recruiting scouts, and whether the cloacal gland is involved in this eventual behaviour, but even then the supposed pheromone does not elicit group recruitment.

Fig. 2. Semithin section through the cloacal gland and the adjacent intersegmental cuticle (*ic*). Arrows indicate efferent ducts, *EA* = intracellular end apparatus.

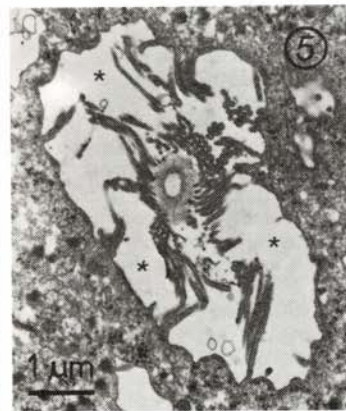
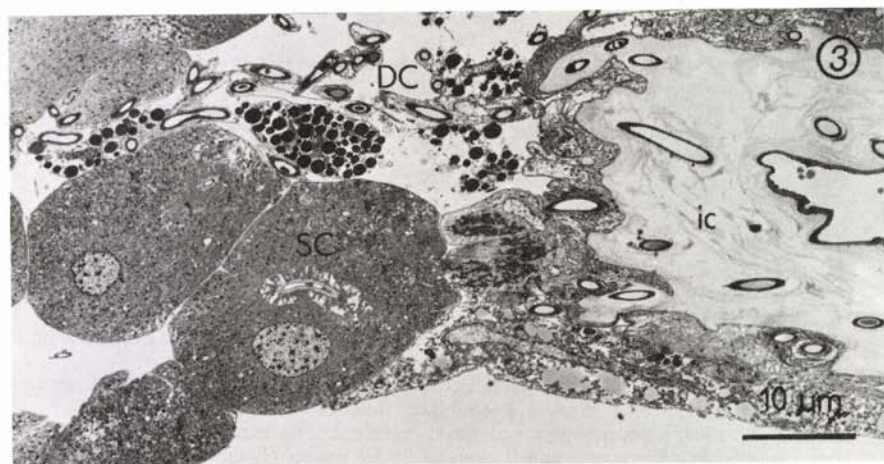
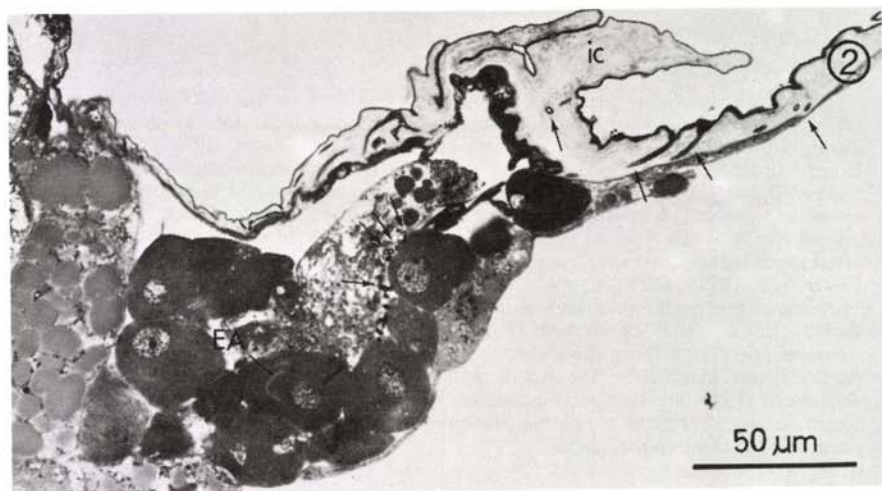
Fig. 3. Electron micrograph showing the opening of the efferent duct cells (*DC*) through the intersegmental cuticle (*ic*). *SC* = secretory cells.

Figs. 4 and 5. Detail pictures of the end apparatus in different secretory cells, in which the microvillar layer can be either more or less densely packed (Fig. 4) or loosely arranged with extensive spaces (*) among them (Fig. 5). Arrows = electron-lucid vesicles.

Fig. 2. Section semi-fine montrant la glande cloacale et la cuticule intersegmentaire (*ic*). Les flèches indiquent des conduits efférents, *EA* = appareil terminal intracellulaire.

Fig. 3. Ouverture des cellules à conduit efférent (*DC*) à travers la cuticule intersegmentaire (*ic*). *SC* = cellules sécrétrices.

Figs. 4 et 5. Détail de l'appareil terminal des cellules sécrétrices. En 4, on voit la couche microvilloseuse plus ou moins dense. En 5, elle apparaît sous un aspect irrégulier, de grands espaces (*) s'intercalant entre les villosités. Flèches = vésicules claires.



In spite of its sternal position, the cloacal gland in *Camponotus* and *Cataglyphis* is by no means homologous with any of the other sternal glands in other ants. Epithelial sternal glands are found in several subfamilies (Hölldobler and Engel, 1978 ; Pavan and Ronchetti, 1955 ; Billen, 1985), but have a basically different morphological organization to the cloacal gland. The composition of the latter with several secretory cells and associated duct cells is consistent with the secretory unit type glands (Billen, 1987). Other sternal glands of this type are mainly known among the Ponerinae, where they are most often found between sternites 5 and 6, and sternites 6 and 7 (Hölldobler and Engel, 1978 ; Jessen *et al.*, 1979 ; Hölldobler *et al.*, 1982 ; Jessen and Maschwitz, 1983). Sternal glands in Formicinae are so far only known from *Oecophylla*, where the secretory units open directly through the 7th sternite (Hölldobler and Wilson, 1978). All these glands, however, open ventrally on the abdominal wall, and never inside the cloacal chamber, as do the cloacal gland cells. The ventral wall of the cloacal chamber moreover is to be considered as the intersegmental membrane between the external 7th and the remaining internalized and reduced abdominal sternites, and therefore forms the most posterior location of all these sternal glands.

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