Morphology of the Tibial Gland in the Ant *Crematogaster scutellaris*

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Trail-laying behaviour has been reported for a large number of ants. The anatomical source of the trail substances involved are the abdominal glands that open at the posterior tip of the ant’s body. According to the subfamily considered, this glandular activity has been attributed to the Pavon’s gland in Dolichoderinae [1], the sternal gland in Aneuretinae [2], the hindgut in Formicinae and Ectoninae [3, 4] and the poison or Dufour’s gland in Myrmicinae [5, 6].

In the myrmicine genus *Crematogaster*, however, the source of the trail pheromone cannot be found in the abdomen. Behavioural observations of foraging workers of *C. ashmeadi* [7] and *C. peringueyi* [8] led to the discovery of the metathoracic legs as the origin of the pheromone. The glandular tissue was reported in the hindleg tibia [7], while the fore- and midlegs in *C. clara* and *C. minutissima* were found to contain a similar, but less developed, glandular region to the hindlegs [9].

The morphological organization of the tibial glands, however, is very limited, and so far only deals with its general anatomical position along with a description of the gland’s secretion opening at the pretarsus tip [9].

We therefore investigated the morphology and ultrastructure of the gland in the three pairs of legs in *Crematogaster scutellaris* (Olivier) 1791. The workers used for this study were collected from their natural foraging paths, near Calvi (Corsica), in March 1983.

The gland consists of a spindle-shaped and cuticle-lined reservoir surrounded by a monolayered epithelium. In cross section, the gland, positioned half-way near to the tracheolar side, reveals a more thickened epithelium, which constitutes the real glandular tissue. From this tibial region a hollow tendon extends which guides the secretion to the pretarsal opening of the gland. Due to their very small reservoir size, the fore- and midleg glands do not exceed 35 µm in diameter. The hindleg gland, on the other hand, exhibits a very elaborate reservoir containing an increased number of glandular cells which contributes to an overall diameter of approximately 70 µm (Fig. 1).

Fig. 1. Cross section drawing of the hindleg tibia (A) showing the well developed tibial gland (TG). MF muscle fibres, nf nerve fibres, tr tracheoles. B and C represent the tibial gland in fore- (B) and midlegs (C) at the same magnification and relative orientation.

Figs. 2. Central (a) and apical (b) region of the hindleg tibial gland epithelium, b) shows the subcuticular space (*) and three cuticular pore canals. ct cuticle, ga Golgi apparatus. M mitochondria, mc microvillar projections, N nucleus, sj septate junctions, V vacuole. Scale 1 µm
The investigation of the ultrastructure of the three pairs of legs reveals highly vacuolar glandular cells containing a rounded nucleus with distinct nucleolus in their basal region. The cytoplasm is characterized by a well-developed Golgi complex, fairly numerous mitochondria and randomly scattered free ribosomes (Fig. 2a). The lateral cell contacts show extensive septate junctions in their upper part. Basal invaginations are well pronounced while the apical cell membrane forms numerous, rather irregular, microvillar processes. A subcuticular, although extracellular region, is found which penetrates into the cuticle through distinct cuticular pores with a diameter of 0.1 μm (Fig. 2b).

The ultrastructure of the tibial gland clearly suggests a metabolically active tissue. The basal invaginations may indicate an absorbing function for the metabolic constituents. The well-developed Golgi complex and the numerous mitochondria, along with the apical microvillar processes and cuticular pore canals, may point to an intense synthesis and subsequent secretion of the trail substances. Among the numerous ectodermal and hence cuticle-lined glands in ants, this tibial gland in *Crematogaster*, together with the sternal gland in dolichoderine species, is the only hitherto known example where cuticular pore canals are found (Bilien, unpublished).

The most remarkable result of our investigations is probably the completely similar fine structure of the tibial gland cells in the three pairs of legs. The much enlarged reservoir and the more numerous glandular cells of the hindleg gland in fact are in agreement with the trail-following experiments [7–8]. The existence, however, of a smaller, but ultrastructurally identical glandular tissue in the fore- and midleg tibia remains a surprising characteristic. Further ethological and perhaps chemical investigations will be required in order to explain the presence of this possible, but so far neglected pheromone source.

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