

DUFOUR'S GLAND OF *POLYERGUS RUFESCENS* GYNES: AGE-DEPENDENT STRUCTURAL AND FUNCTIONAL CHANGES

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ABSTRACT

Young gynes of the amazon ant *Polyergus rufescens* have to penetrate into a colony of a slave species during colony foundation. From her large Dufour gland, the gyne at this critical moment discharges decyl butyrate as an appeasement substance. This function of the Dufour gland is reflected in its structural appearance according to age. Eclosing females have a gland lined with a thick active epithelium and empty central lumen. Secretion quickly accumulates in the lumen during the first week of adult life, and results at the age of 3 weeks in a turgid gland with full lumen surrounded by a thin inactive epithelium. The gynes are thus equipped with a gland full of appeasement substance at the time they penetrate into a slave colony.

KEY WORDS: ants, gynes, slavery, usurpation, Dufour gland, morphology, *Polyergus rufescens*

INTRODUCTION

Polyergus rufescens is a spectacular example of a slave-making ant, that depends on the work force of workers of a slave species that belongs to the subgenus *Serviformica*. During summer, impressive raids towards colonies of the slave species are organized in order to pillage the *Serviformica* pupae and so to maintain the work force in their heterospecific society (LE MOLI and MORI, 1987). Equally spectacular and probably even more risky is the process of colony foundation. The young, newly-mated *Polyergus* gyne at this stage has to find and penetrate a colony of the slave species, eliminate the resident queen, and take over power (TOPOFF et al., 1988; MORI et al., 1995). The initial stages of this usurpation process are characterized by a strong hostility directed by the resident *Serviformica* workers towards the penetrating female. The *Polyergus* female at this stage makes use of her very large Dufour gland that secretes an appeasement allomone (MORI et al., 2000a), that has been identified as decyl butyrate (VISICCHIO et al., 2000; MORI et al., 2000b). The present paper aims for a structural study of the Dufour gland in *P. rufescens* gynes of various age and at different stages in the usurpation process to see whether the behavioural evolution is reflected by structural changes in the gland's appearance and development.

MATERIALS AND METHODS

Winged and dealate gynes of *Polyergus rufescens*, at various stages in the usurpation process of *Formica cunicularia* colonies, as well as pupae of gynes were collected in the field in Casola, Northern Italy. The pupae served as a stock to obtain alate gynes of known age. The Dufour glands of the various gynes were fixed in glutaraldehyde, postfixed in osmium tetroxide, and embedded in Araldite resin. Semithin sections were stained with methylene blue and thionin, and examined under a Zeiss Axioskop microscope.

RESULTS AND DISCUSSION

The large Dufour gland in *P. rufescens* gynes has a characteristic bilobed shape (Fig. 1A). The central lumen is lined with a monolayered epithelium. Histological examination reveals clear differences in the appearance and development of the gland in relation to the age and functional stage of the gynes (Fig. 1B, C; Fig. 2). These are reflected both in the thickness of the epithelium and the diameter of the lumen: at the moment of eclosion, the epithelium consists of columnar cells with a height of approx. 35 μm , while the lumen is empty. Ultrastructural observations indicate that the cells at this stage are secretory very active with a well developed smooth endoplasmic reticulum and numerous lipid droplets in the basal region of the cells (BILLEN et al., 2001), which is in agreement with the production of decyl butyrate.

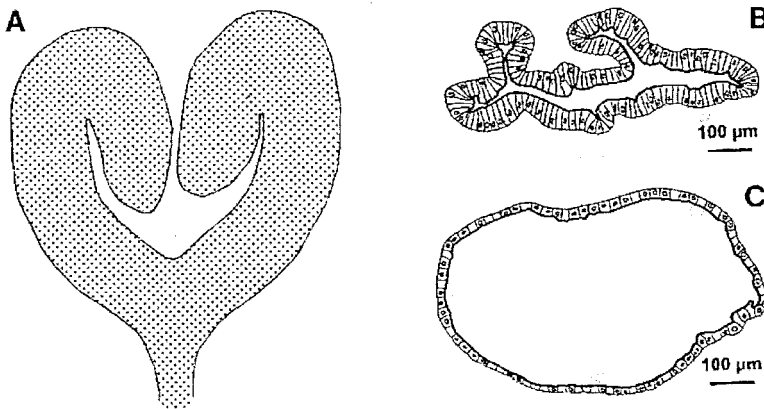


Fig. 1. General shape of Dufour gland in *P. rufescens* gynes (A), and appearance of epithelium in 1 day old gyne (B) and in dealate gyne (C).

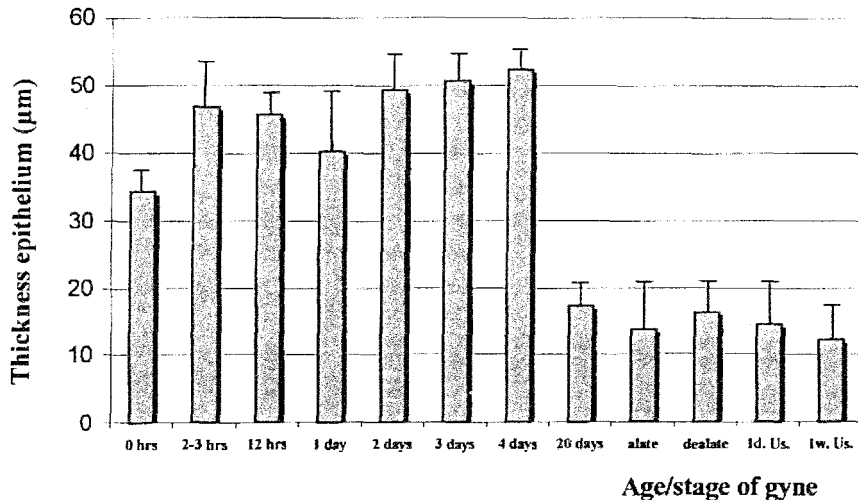


Fig. 2. Thickness of Dufour gland epithelium in gynes of various age and functional stage during usurpation process (1d. Us. and 1w. Us. indicate gynes 1 day and 1 week after onset of usurpation, resp.).

During the first week of adult life, the epithelial cells increase in thickness to reach a maximum of 50 µm, while the lumen starts to accumulate secretion. Between the age of 1 and 3 weeks, a considerable decrease of the epithelial thickness to approx. 15 µm occurs, while the lumen is turgid. This age corresponds with the period of mating and subsequent onset of usurpation of the slave colony by the inseminated *Polyergus* gyne. A decrease of the size of the Dufour gland soon after mating was also described for the American *P. breviceps* (TOPOFF et al., 1988).

The present morphological investigation is in agreement with previous studies on the adaptive function of the Dufour gland of *P. rufescens* queens (MORI et al., 2000a, b; VISICCHIO et al., 2000). The gland serves as a chemical weapon during a crucial phase of host colony usurpation, which is the invasion and take over of a *Serviformica* colony. During this moment, the invading gyne has to cope with the violent attacks and reactions of resident workers. Once the invader has come out undamaged from this critical phase, she has good chances to be successful in the continuation of the usurpation process. To this aim, *P. rufescens* gynes have evolved several morphological and functional adaptations, among which there is the production of an appeasement allomone by the Dufour gland, that lowers the aggressive reactions of resident ants. Our histological data illustrate that the

Dufour gland has accumulated a maximum load of secretion at the moment the young inseminated gyne enters a host nest, i.e. the chemical weapon is fully loaded. Successful usurpation results in the adoption of the *Polyergus* queen by the resident *Serviformica* workers. As soon as this has been achieved, the *Polyergus* queen no longer needs an active Dufour gland, which is reflected by the size reduction the gland then undergoes. The large space previously occupied by the Dufour gland can now be used for the growing ovaries that are needed for the production of offspring.

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