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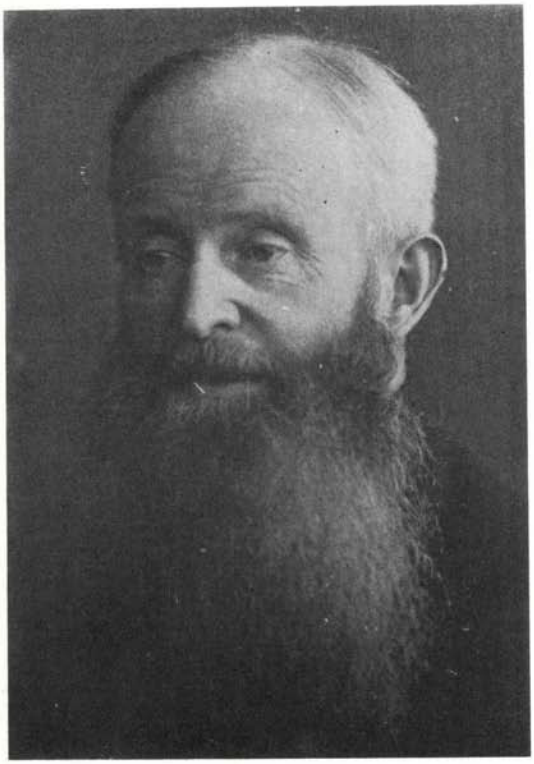

Erich WASMANN

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THE POSTPHARYNGEAL GLAND OF WORKERS OF SOLENOPSIS GEMINATA (Hymenoptera : Formicidae)

par

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Summary: The postpharyngeal gland of *Solenopsis geminata* workers consists of four hypertrophied lobes which completely fill the upper part of the head cavity. The gland is lined with a monolayered epithelium, showing numerous basal invaginations and a distinct microvillar border at its apical side.

It contains a hydrocarbon oil of complex composition but heneicosane, tricosane and tricosene (linear C_{21} and C_{23} hydrocarbons) are the major constituents. These same substances are found in different proportions, in the Dufour gland.

No explanation for the enlarged gland in this species has been discovered.

Key-words: *postpharyngeal gland*, Solenopsis geminata *morphology*, *hydrocarbons*.

Résumé: La glande postpharyngienne des ouvrières de *Solenopsis geminata* (Hymenoptera: Formicidae).

La glande postpharyngienne de *Solenopsis geminata* contient quatre lobes hypertrophiées qui occupent presque toute la partie frontale de la tête. Sa paroi est formée par un épithélium simple, pourvu de nombreuses invaginations basales ainsi que de microvillosités apicales.

La glande contient une huile d'hydrocarbures de composition complexe, avec le heneicosane, le tricosane et le tricosène (chaînes linéaires C_{21} et C_{23}) étant les éléments principaux. Ces mêmes substances sont également présentes dans la glande de Dufour, mais dans des proportions différentes.

Jusqu'à présent, il nous manque l'explication de l'agrandissement de la glande dans cette expèce.

Mots-clés: *glande postpharyngienne*, Solenopsis geminata, *morphologie*, *hydrocarbures*.

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INTRODUCTION

The postpharyngeal gland in ants has always been described as glove-shaped structures consisting of 20 to 25 finger-like projections (BAUSENWEIN, 1960; FORBES & McFARLANE, 1961; EMMERT, 1968; KÜRSCHNER, 1971; FEBVAY & KERMARREC, 1981). The gland, which occurs in both workers, females and males, is a unique structure that is only found in the family Formicidae. Its function most probably is related to digestive processes since it is known to show a specific absorption of the lipid compounds from the ingested food. This digestive function is most probably related to social life, as follows from the inter-individual transfer of radio-labelled compounds (NAARMANN, 1963; DELAGE-DARCHEN, 1976). Other suggestions have included involvement in larval feeding, digestion of lipids, a cephalic caecum, colony organization, caste determination, queen and brood tending and age polyethism. Some knowledge of the morphology and chemical contents of the gland might help to choose between these alternatives. The material is usually described as a yellow oil. The few chemical analyses that have been made are reviewed by ATTYGALLE and MORGAN (1984).

In seeking to study the mandibular glands of *Solenopsis geminata* (Fabr.) 1804, we discovered that the postpharyngeal glands, filled with a hydrocarbon oil, almost fill the upper part of the head capsule of workers of this species. Our chemical and morphological studies of the gland are described here.

MATERIAL AND METHODS

A colony of *Solenopsis geminata* collected at Galle, Sri Lanka was maintained in the laboratory, in a nest of moist earth.

Preparation of sections

The heads of a few workers were cut off, keeping a reasonably large opening at the hind part to allow penetration of the fixative and other preparation solutions. The heads were fixed in a cold 2% solution of glutaraldehyde in 0.05 M sodium cacodylate and 0.15 M saccharose. After postfixation in 2% osmium tetroxide in the same buffer, dehydration in aceton and bloc-staining in 2% uranyl acetate occurred. Serial semi-thin sections stained with methylene blue were used for a microreconstruction according to GAUNT (1971), while thin sections were used for ultrastructural observation in a Philips EM 400 electron microscope.

Chemical sample preparation

Ants were killed by momentary immersion in liquid nitrogen. Individual heads were sealed in glass tubes (35 mm ×

1.8 mm), or the postpharyngeal glands were excised in water, by breaking the cuticle and withdrawing the yellow mass over the brain with tweezers.

Gas chromatography

Individual heads or dissected glands were injected by the solid sampling method (MORGAN and WADHAMS, 1972) onto a 1.5 m × 4 mm glass column filled with 5% SE-30 silicane on Chromosorb W-AW-HMDS. The oven temperature was programmed from 147 to 260°C at 3°C/min. Pieces of cuticle, mandibular gland, and other parts of the head and thorax were examined for comparison. Quantification was made by comparison with a solution of hexadecane in hexane (770 ng/µl) as an external standard.

Mass Spectrometry

The mass spectra of the three major hydrocarbons were obtained by a GC-MS system using the same GC column conditions. The mass spectra of authentic heneicosane, tricosane and (Z)-9-tricosene were taken under the same conditions for comparison.

Double bond position of tricosene

The tricosene peak from gas chromatography was trapped in a cooled metal U-tube, and converted into two isomeric methoxy-derivatives by the methoxy-mercuration-demercuration procedure (ABLEY *et al.*, 1970).

Configuration of 9-tricosene

The tricosene peak trapped from the gas chromatography of two heads of *S. geminata* workers was chromatographed on a 10% $AgNO_3$-silica gel TLC plate, developed in 1% diethyl ether in light petroleum, and compared with authentic (Z)-9-tricosene and a mixture of (Z)- and (E)-9-nonadecene after spraying with 10% H_2SO_4 and heating to 120°C for 10 min.

RESULTS AND DISCUSSION

The postpharyngeal gland in *Solenopsis geminata* is composed of 4 large lobes instead of the normal finger-like appearance in other ant species. Two of them overlie the brain in a more or less horizontal position (1 and 4 in Fig. 1), while the other two have a rather vertical position reaching from the dorsally occurring pharynx to the ventral ridge of the integument (2 and 3 in Fig. 1).

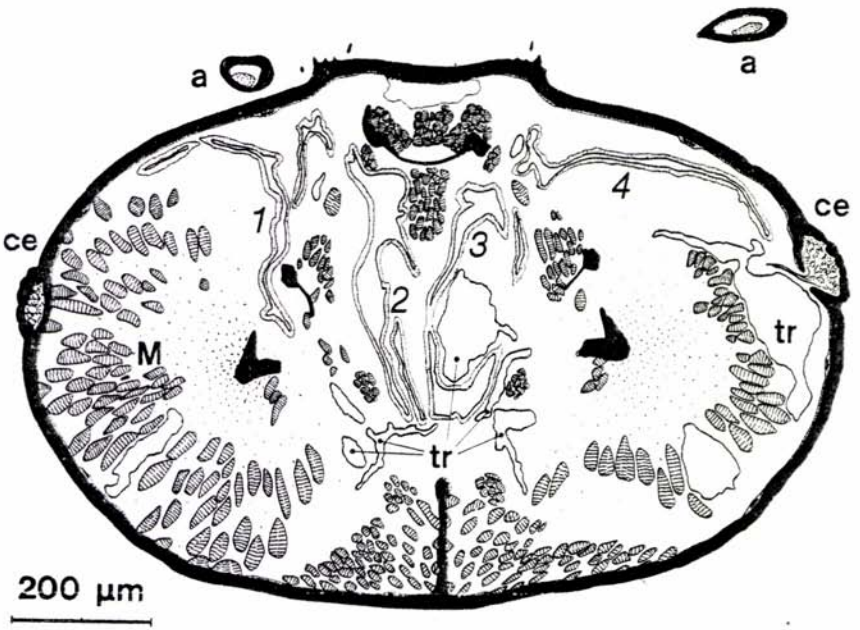

Fig. 1. Cross section through the head of a S. geminata *worker, showing the large postpharyngeal gland lobes (1 to 4).* a = *antenna ;* ce = *compound eye ;* M = *muscle fibres ;* tr = *tracheolar sac.*

The gland wall is formed by a monolayered epithelium consisting of type-1 cells according to the classification of NOIROT and QUENNEDEY (1974). The rounded nuclei are found in the centre of the cells, while the cytoplasm is characterized by numerous mitochondria (Fig. 2). Multivesicular and multilamellar inclusions also are fairly obvious, and probably form part of the cellular lysosome system. An apical microvillar border is observed, while the basal cell membrane forms very distinct invaginations that penetrate into the basal quarter of the cell. The epithelium is lined with a cuticular layer, that is composed of an electron-dense outer epicuticle and a fibrillar endocuticle. According to ZYLBERBERG *et al.* (1979), this cuticular structure of the postpharyngeal gland epithelium constitutes a lipophilic layer thus enabling transport of metabolics through is. This transport

function moreover is suggested by the occurrence of the well developed basal invaginations along with the apical microvillar layer. The direction of this transport, however, remains an unsolved question (DELAGE-DARCHEN, 1976).

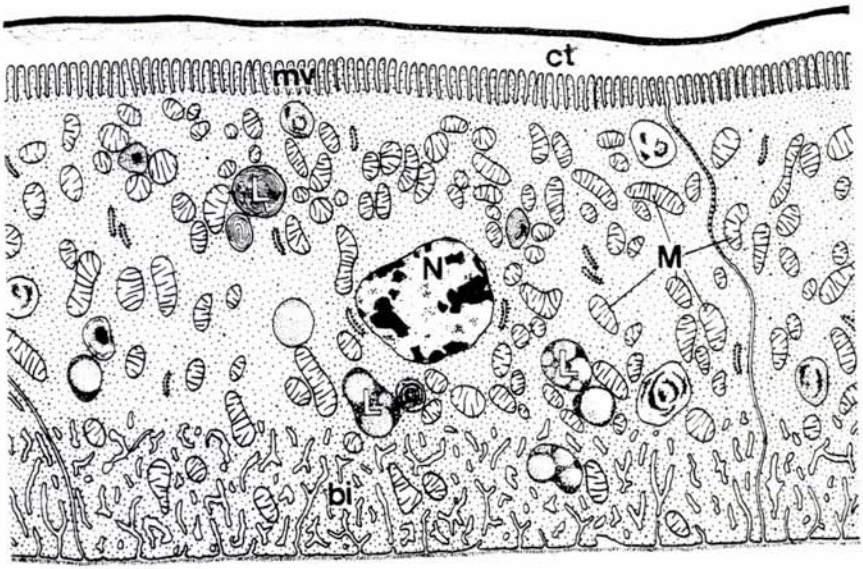

Fig. 2. Half-schematical drawing of the postpharyngeal gland wall bi = *basal invaginations* ; ct = *cuticle* ; L = *lysosomal elements* ; M = *mitochondria* ; mv = *microvilli* ; N = *nucleus*.

Examination of the postpharyngeal glands by gas chromatography revealed that the major contents were hydrocarbons. A typical gas chromatogram from the gland of a single individual is given in Fig. 3. Three components represent 85% of the total volatile material. These were identified by mass spectrometry as heneicosane (M^+ 296, $C_{21}H_{44}$), tricosene (M^+ 322, $C_{23}H_{46}$) and tricosane (M^+ 324, $C_{23}H_{48}$). Insufficient material was available for complete mass spectra of the other components. The amounts of material and percentage composition are summarized in Table I.

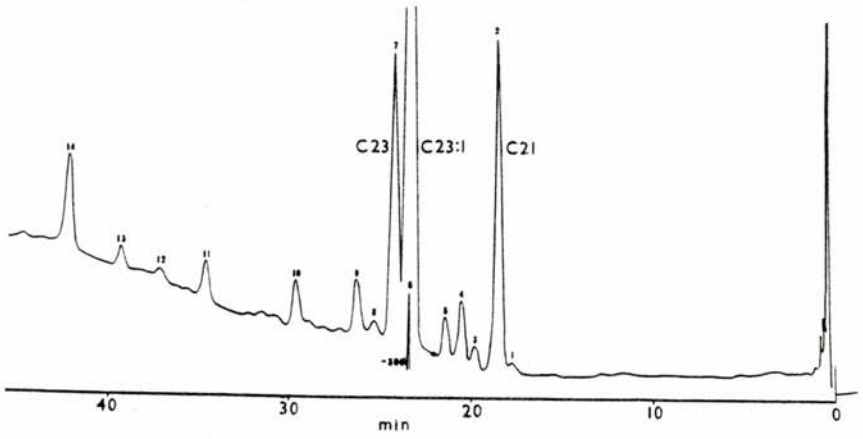

Fig. 3. A gas chromatogram of the postpharyngeal gland of a single worker of Solenopsis geminata. *The chromatographic conditions were a 1.5 x 4 mm column of 5% SE-30 on Chromosorb W, temperature programmed from 147° to 260°C at 3°C/min. The attenuation was changed at 22 min from 500 to 1000. The peak numbers refer to table I.*

Mass spectrometry of the mixture of methoxy-derivatives obtained by methoxy-mercuration-demercuration showed the tricosene to be 9-tricosene and argentation-TLC showed this to be the (Z) isomer. The major component of the gland therefore, representing 50% of the total, is (Z)-9-tricosene.

The only previous chemical examination of postpharyngeal glands was that of queens of *Solenopsis invicta* (THOMPSON *et al.*; 1981). Hydrocarbons were reported as the major component (63%), together with triglycerids (32%) and some free fatty acids. The hydrocarbons were all methyl-branched, namely 13-methylheptacosane, 3-methylheptacosane, 13,15-dimethylheptacosane and 3,9-dimethylheptacosane. There were no peaks evident in the C_{22} to C_{23} region. THOMPSON *et al.* (1981) reported that workers of *S. invicta* clustered around a sample of the hydrocarbons from the queen postpharyngeal gland, however, in a similar test with *S. geminata* worker glands, we observed no response from congener workers.

This study has shed more light on the structure and contents of postpharyngeal glands and has drawn attention to the large size of this gland in *S. geminata* which should help in deciding the function of the gland, though for the present, this function remains uncertain.

Table I : Composition of the volatile chemicals in the postpharyngeal gland of *Solenopsis geminata*.

No[a]	Compound	Mean Composition[b] by weight (ng/ant ± S.D.)	Mean % by weight ± S.D.
1	(Heneicosene ?)	62 ± 29	0.7 ± 0.3
2	Heneicosane	2215 ± 356	23.2 ± 2.2
3	-	81 ± 56	0.8 ± 0.4
4	(Docosene ?)	162 ± 111	1.7 ± 0.9
5	Docosane	94 ± 24	1.1 ± 0.5
6	(Z)-9-tricosene	4672 ± 604	49.9 ± 4.1
7	Tricosane	1057 ± 89	11.4 ± 0.6
8	-	64 ± 24	0.7 ± 0.2
9	-	155 ± 45	1.6 ± 0.4
10	-	202 ± 48	2.2 ± 0.5
11	-	132 ± 22	1.5 ± 0.3
12	-	79 ± 35	1.0 ± 0.3
13	-	70 ± 17	0.8 ± 0.2
14	-	315 ± 57	3.4 ± 0.8
	Total	9356 ± 980	100

[a] numbers refer to the peaks of Figure 3.

[b] numbers of replicates = 10

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