

Chemical Expression of a Sexual Dimorphism in the Tubular Scent Glands of the Milkweed Bug *Oncopeltus fasciatus* (Dallas) (Heteroptera; Lygaeidae)

The belief that scent glands provide many land bugs with a chemical means of defense against predators has been amply confirmed^{1,2}. In at least one species the scent has been shown to contain alarm substances as well as poisons and repellents³. Whether the glands have other functions is not at present certain but those of several species from different families are sexually dimorphic⁴⁻⁶. The scents from these possibly combine a sexual and a defensive function.

The scent gland complex of the adult milkweed bug, *Oncopeltus fasciatus* (Dallas), is situated ventrally in the hind part of the thorax. In common with that of many land bugs it consists of a pair of tubular glands, a reservoir and a pair of organs of uncertain function, the 'accessory glands', which lie in the wall of the reservoir⁶ (Figure). It differs from most, however, in that at maturity the male tubular glands are much larger than the female. The central collecting duct is distended with a liquid having different properties from that stored in the median reservoir⁶.

Methods. The median reservoir of *O. fasciatus* opens out on each side between the second and third coxae. The opening is hidden in a furrow which leads to a raised drop-shaped area, the ostiolar peritreme^{6,7}. After release, the secretion accumulates on the peritreme as a discrete droplet. With the object of collecting secretion after release, an insect was seized by the thorax and the tip of its abdomen then pinched with forceps. As the secretion emerged onto the peritreme it was taken up into a capillary pipette. The secretions separately stored in the male tubular gland and median reservoirs were similarly collected after dissection. No attempt was made to collect secretion from the reduced female tubular glands.

The secretions were accumulated separately in acetone and stored until required in sealed glass tubes at -40°C . The solutions were first analysed by gas chromatography (GC)⁸ and the components subsequently identified by combined gas chromatography-mass spectrometry (GC-MS)⁹. Confirmation of identity was sought by comparing the spectra and retention times (RT) of the scent components with those of reference compounds under identical conditions of analysis¹⁰.

Results. The scents were found to consist almost entirely of a series of 4 alkenyl and alkadienyl acetates and a corresponding series of 4 alkenyl and alkadienyl aldehydes in similar proportions to the acetates. Little individual variation was found in the percentage composition of either fraction. Several quite minor components were not identified.

The composition of the acetate fraction is given in Table I. In the male, this fraction, consisting of octenyl, octadienyl, hexenyl, and hexadienyl acetate, accounted for about 98% of the scent stored in the tubular gland reservoir, for between about 10 and 30% of the scent collected after release onto the peritreme, but for about only 1% of the scent stored in the median reservoir. In the female, the acetate fraction accounted for less than 1% of the scent released onto the peritreme.

The composition of the aldehyde fraction, consisting of octenal, octadienal, hexenal, and hexadienal, is given in Table II. The female scent was made up almost entirely of the aldehydes in proportions similar to their counterparts in the male scent.

It was concluded that the tubular glands secrete the acetates and that the only difference between the scents released by mature male and female insects is one of acetate content, the acetates being virtually, if not quite strictly, male specific. It was noted that whereas boxes

Table I. Composition of the acetate fraction in the male scents

Peak No.	Identity	RT ^a (min)	Composition (%)	
			Tubular gland	Released onto peritreme
2	hex-2-enyl acetate ^b	4.4	9	8
4	hexa-2,4-dienyl acetate ^b	8.4	10	6
7	oct-2-enyl acetate ^b	14.0	24	28
8	octa-2,4-dienyl acetate	16.2	55	58

^a 3% OV 225, temp. 90°C ; carrier gas flowrate $22\text{ cm}^3/\text{min}$ ^b Authentic compounds were available for comparison. The alkenyl compounds were *trans*.

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⁴ J. CARAYON, C. R. hebdom. Séance Acad. Sci., Paris 227, 303 (1948).

⁵ J. CARAYON, Bull. Mus. Hist. nat., Paris 26, 602 (1954).

⁶ A. S. JOHANSSON, Norsk ent. Tidsskr. 10, 95 (1957).

⁷ A. S. JOHANSSON and T. BRATEN, Entomologia scand. 7, 158 (1970).

⁸ 3% OV 225 on Gas Chrom Q (100-120 mesh) and 10% Apiezon L on Universal B (60-80 mesh); temp. 90 to 100°C .

⁹ A Varian CH 5D mass spectrometer on line to a Varian 620i data system was used.

¹⁰ We thank Proprietary Perfumes Limited for supplying sample materials.

Table II. Composition of the aldehyde fraction

Peak No.	Identity	RT ^a (min)	Composition (%)		
			♂ median reservoir	♂ released onto peritreme	♀ released onto peritreme
1	hex-2-en-1-al ^b	3.0	23	15	27
3	hexa-2,4-dienal ^b	6.0	5	2	3
5	oct-2-en-1-al ^b	9.2	26	35	32
6	octa-2,4-dienal	11.0	46	48	38

^a and ^b see under Table I.

containing several-week old males emitted the pleasant odour associated with the acetates those containing females of a similar age did not.

The results raise for consideration the possibility that the acetates supplied by the tubular glands are the precursors of the aldehydes stored in the median reservoir, the role of the accessory glands being to provide the necessary mechanism. It accords well with this suggestion that if the tubular glands are blocked or removed the median reservoir fails to fill up with secretion⁶. To explain the fact that the scent released by mature male insects contains an appreciable quantity of unmodified tubular gland scent it is necessary to suppose only that the tubular gland and median reservoirs are emptied simultaneously.

Working on a pentatomid bug, *Nezara viridula*, GILBY and WATERHOUSE¹¹ found that in the tubular gland extracts the concentration of decenyl acetate was much higher and decenal much lower than in the scent stored in the median reservoir. They suggested that the aldehydes are formed in the median reservoir. It has also been reported that the tubular scent glands of giant water bugs

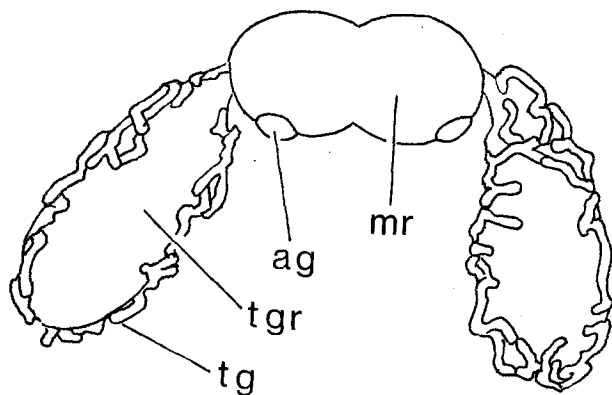
of the genus *Lethocerus* secrete largely hexenyl acetate¹²⁻¹⁴ and it is of considerable interest that as in *O. fasciatus* the glands are sexually dimorphic. In *Lethocerus* spp, however, the male glands are very much larger than the female and a separate reservoir with accessory glands is lacking.

It has been suggested that the sexual dimorphism in the tubular scent glands of Lygaeid bugs such as *O. fasciatus* is a physiological necessity somehow connected with the fact that the males are smaller than the females¹. It has also been suggested that because *O. fasciatus* is gregarious it has no need for specialized mechanisms for sound or scent production, or for courtship, for one sex to find the other¹⁵. We suggest that the male specific acetates have an as yet undiscovered role to play in the sexual activities of the adults¹⁶.

Zusammenfassung. Die Metathorakalduftdrüsen der Landwanze *Oncopeltus fasciatus* erzeugen als Hauptkomponenten ungesättigte aliphatische Acetate und Aldehyde. Die röhrenförmigen Duftdrüsen, die Acetate erzeugen, und das Vorkommen dieser Acetate im Duftsekret sind für die Männchen spezifisch.

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Scent gland complex of mature male *Oncopeltus fasciatus* (after JOHANSSON, 1957). ag, accessory gland; mr, median reservoir; tg, tubular gland; tgr, tubular gland reservoir.

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¹² A. BUTENANDT and N. TAM, *Hoppe-Seyler's Z. physiol. Chem.* **308**, 277 (1957).

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¹⁵ W. LOHER and H. T. GORDON, *Ann. ent. Soc. Am.* **61**, 1566 (1968).

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Intracellular Enzymes in Renal Lymph as a Measure of Anoxic Injury of the Kidney

Anoxic damage to the renal tissue is a major problem in traumatic shock and is one of the difficulties encountered in kidney transplantation. It seemed reasonable to look for the signs of cellular injury ensuing after interruption of blood flow to the kidney in the intercellular fluid, or at least in the part which is accessible for collection and study, i.e. in the lymph. The present report describes the biochemical changes which occurred in the lymph collected in the renal hylum of dogs after a transient occlusion of the renal artery.

Material and methods. In dogs under pentobarbitone general anaesthesia a lymph vessel in the hylum of the left kidney was cannulated. Urine was collected through plastic catheters introduced into both ureters. After preliminary lymph collection, the renal arteries were clamped for 30 min or 2 h. Lymph and urine were again collected after the release of the clamp for 1 h.

The concentrations of the following 8 intracellular enzymes were estimated according to the methods listed in the references: lactate dehydrogenase (LDH)¹ maleic

acid dehydrogenase (MDH)² GOT and GPT³ glutamic acid dehydrogenase⁴ acid-⁵ and alkaline phosphatase⁶ and leucinarylamidase (AA)⁷. All results are expressed in international units, corresponding to 1 μ Mol of transformed substrate per min at 25 °C.

It is assumed that LDH, MDH and GOT are exclusively or mostly present in the cytoplasm, alkaline phosphatase,

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⁵ A. L. BABSON and G. E. PHILLIPS, *Clin. chim. Acta* **13**, 264 (1962).

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