SHORT NOTE

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Size and protein content of male accessory glands in the variegated grasshopper, *Zonocerus variegatus* (Orthoptera: Pyrgomorphidae)

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Abstract. Male accessory glands of *Zonocerus variegatus* L. undergo no significant changes in size after emergence. However, their protein content, nearly doubles during the second week, and again during the fifth week, after emergence. Copulation has little effect on the protein content.

Introduction

Male accessory glands of insects secrete proteins and hormones whose functions include stimulation of oviposition, inhibition of female receptivity, activation and nourishment of sperm, and formation of spermatophores (Baker & Davey, 1982; Loher, 1984; Chen, 1984; Happ, 1984). The reproductive system of male *Zonocerus variegatus*, a cassava pest in West and Central Africa, contains eleven pairs of mesodermally derived accessory gland tubules (Muse & Balogun, 1992). The present study describes changes in the size and protein content of these glands after imaginal emergence.

Material and Methods

Adults of the variegated grasshopper, *Zonocerus variegatus*, were maintained on cassava shoots (*Manihot esculenta*) in illuminated cages at 28 ± 2°C, 60–70% r.h., and 10 : 14 LD photoperiod. Their age was measured in days after emergence. To establish the size of accessory glands, eight unmated males of chosen age were dissected in 30% ethanol (Grimes & Happ, 1980), and the length and maximal width of the glands were measured with ocular micrometer fitted in a dissecting microscope. For the protein analysis, glands were dissected from individual males that had been frozen at –25°C for 30 min. Unmated males and those allowed to copulate 21 days after emergence were used, always in replicates of three. Gland homogenates in saline (one gland per 0.5 ml) were centrifuged (2,000 g for 10 min), and the supernatants taken for protein estimation according to Lowry et al. (1951).

Results and Discussion

Accessory gland size

The mean length of male accessory glands increased slightly during the first 3 weeks after emergence and fluctuated afterwards (Table 1). The width of glands appeared constant. Statistical analysis revealed that the size changes of accessory glands were insignificant, but apparent attainment of their maximal length on day 21 is consistent with the report that the males of variegated grasshopper commence mating between 14 and 21 days of imaginal life (Youdeowei, 1974). Increase in the size of accessory glands during male maturation has been described in various insects, including the locust *Schistocerca gregaria* (Dhadialla et al., 1986).

The protein content of accessory glands

Accessory glands of newly emerged males contained 106.8 ± 3.6 μg protein, whereas in the 49 days-old unmated males we detected an amount five times higher (Fig. 1). Thus the development of accessory glands can proceed in the absence of mating. Protein content remained low during the first week after emergence, when the grasshoppers consume little food. A maximal protein increase by 119% was found

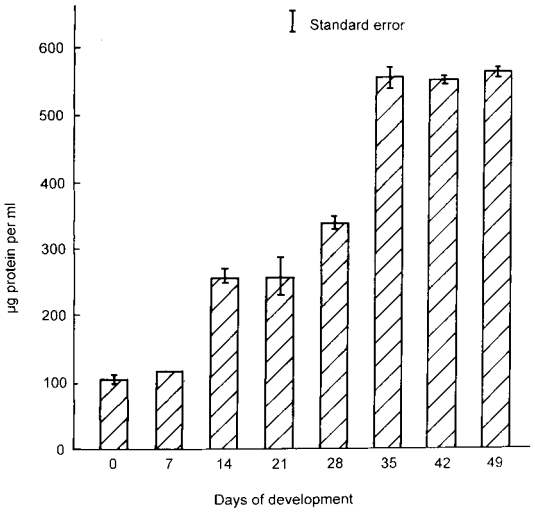

Fig. 1. Changes in soluble protein concentration in the accessory glands of unmated males.

between days 7 and 14, indicating that this is a period of intensive feeding. Protein rises between days 21 and 28, and even more between days 28 and 35 (Fig. 1) are also highly significant ($P < 0.01$).

TABLE 1. Length and width of the accessory glands in unmated males.

Day after emergence	Length (mm) $\bar{x} \pm$ S.E.	Width (mm) $\bar{x} \pm$ S.E.
0	2.68 ± 0.225	0.12 ± 0.002
7	2.69 ± 0.322	0.12 ± 0.003
14	3.03 ± 0.277	0.15 ± 0.004
21	3.08 ± 0.334	0.14 ± 0.007
28	2.88 ± 0.295	0.16 ± 0.008
35	2.68 ± 0.343	0.16 ± 0.006
42	2.81 ± 0.388	0.15 ± 0.005
49	2.77 ± 0.225	0.15 ± 0.008
56	2.92 ± 0.262	0.14 ± 0.006

Since mating commences between days 14 and 21 (Youdeowei, 1974), the protein content at this time must be sufficient for the proper function of accessory glands. It is possible that the further increase of the protein content to high levels found in old males (35 days and more) represents a storage available for periods when food is wanting. Preliminary data (not shown) indicated that protein content of accessory glands drops by 17.6% during copulation, suggesting that old males may be capable of repeated mating without replenishing the storage of accessory gland secretion. However, it is normal that the protein content of accessory glands returns rapidly to the value before copulation. In the grasshopper *Melanoplus sanguinipes* it occurs in 6 hr (Friedel & Gillot, 1976), and in *Z. variegatus* within 48 hr or less (Muse, unpublished).

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