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Research Article

Defensive Glands of the Darkling Beetle *Mesomorphus villiger* Blanchard (Coleoptera: Tenebrionidae)

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Massive home invasion by the darkling beetle *Mesomorphus villiger* Blanchard 1853 (Coleoptera: Tenebrionidae) during monsoon season make it a nuisance pest in many regions of south India. Morphology of defensive glands and mode of release and dispersal of the defensive secretion were analysed. Defensive glands were separated from the abdominal sternites by cutting along the posterior margin of the seventh sternite. Glands are evaginations of intersegmental membrane between the seventh and eighth sternites consisting of two long sac-like reservoirs, and glandular secretion is released by exudation and spread through epipleural gutter of elytra. Gradual release of the secretion is a strategy to repel the predators for a longer duration.

1. Introduction

Darkling beetle, *Mesomorphus villiger* Blanchard 1853 (Coleoptera: Tenebrionidae: Opatrini), is of cosmopolitan distribution with occurrence in Indian subcontinent, Afghanistan, Siberia, Australia, and Africa (Madagascar) [1–3]. Nibbling and gnawing at the base of the stem of newly transplanted tobacco seedlings lead to the death of the plants. Hence, they are referred as tobacco ground beetle in tobacco growing belts in India [1, 4]. However, in the Kerala state in south India, they are present in the litter of rubber (*Hevea brasiliensis* ((Willd. ex Adr. De Jus) Müll. Arg. 1865)), mango (*Mangifera indica*, Linnaeus 1753), cashew (*Anacardium occidentale,* Linnaeus 1753), and rain tree (*Samanea saman* (Jacquin) Merrill 1916) and have strong feeding preference towards fallen tender leaves (personal observation). Home invasion of huge aggregation of *M. villiger* into residential buildings with the onset of monsoon season, their nocturnal movements and release of an irritating, odoriferous quinonic secretion that causes mild skin burns, makes it a nuisance pest in many regions of the South Western Ghats.

Similarities in morphology and the aggregation pattern by *M. villiger* often lead to its misidentification as rubber litter beetle *Luprops tristis* (Fabricius, 1801). No data exists on the structure of defensive glands of the genus, and the present study analyses the structure of defensive glands and mode of release and dispersal of the defensive gland secretion in *M. villiger*.

2. Materials and Methods

Aggregated beetles were collected from a residential building at Calicut (11°15′N, 75°50′E), in south India, during the monsoon season. Adults of both sexes were killed using diethyl ether and pinned to a wax tray. Elytra and abdominal tergites were removed to expose the internal structures and observed under a stereo zoom microscope (Labomed, ASZ-99TR).

Reproductive and digestive structures and fat reserves were removed to expose defensive glands. After washing in water followed by 70% alcohol treatment, the sternites with the attached glands were separated. The defensive glands were separated from the sternites by cutting along the posterior margin of the seventh sternite. Glands were dehydrated in graded series of ethyl alcohol, brought to xylene through alcohol, and mounted on a glass slide in Canada balsam.

Live beetles were held between the left thumb and index finger and placed on the stage of a stereo zoom microscope with the ventral surface of the insect facing up and keeping

Figure 1: Defensive gland of *Mesomorphus villiger* cut from the remainder of the sternites.

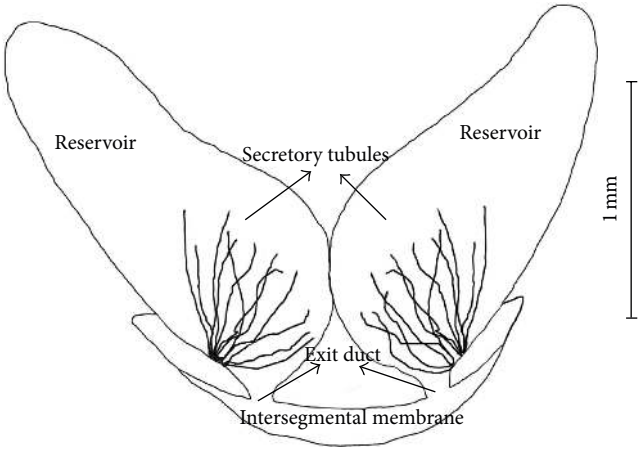

Figure 2: Line diagram of defensive gland of *Mesomorphus villiger.*

the posterior end away from the observer. Beetles were subjected to a graded series of stimuli, namely, by (1) pressing the abdomen; (2) tapping the body, especially the elytra, with a steel rod; and (3) pinching the legs with forceps, to observe the pattern and mode of release of gland secretion. Time taken for production of gland secretion is estimated by making the beetle to discharge the entire gland secretion and noticing the time taken to initiate the discharge again following repeated stimulation by application of successive stimuli.

3. Results and Discussion

3.1. Morphology of Defensive Glands. Defensive glands of *M. villiger* consist of a pair of non eversible reservoirs located in the abdomen between the fourth to seventh sternites irrespective of the sex. They belong to the platynotine type gland [5] with swollen base and conical tips and without prothoracic glands. Each gland opens independently on the seventh sternite beside the anus. Gland reservoirs are long and strongly annulated conical pouches (length 1.5–1.7 mm; width 0.5–0.7 mm), occur parallel to the long axis of the body, and are separated (Figure 1).

Reservoirs consist of the intersegmental membrane evaginations between the seventh and eighth sternites, occur on either side of hind gut, and are immersed in a thick matrix

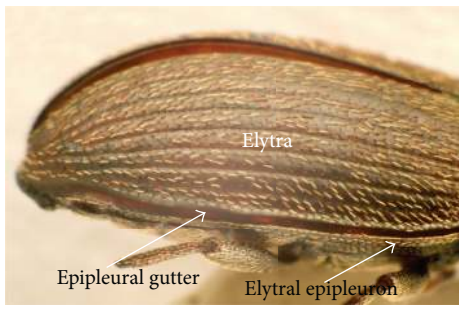

Figure 3: Epipleural gutter on the elytra of *Mesomorphus villiger.*

of fat reserves. No muscles were found associated with the reservoirs. Reservoirs have narrow exit ducts and backwardly directed constricted openings. Gland secretion is produced by the 10–15 secretory tubules present on the proximal dorsolateral field of the reservoirs (Figure 2).

3.2. Delivery of Secretion. On disturbance, *M. villiger* released the odoriferous secretion by exudation to the seventh abdominal sternite, the most common method of delivery among tenebrionids [5]. Exudation of defensive secretion is considered as an advanced feature compared to eversion [5, 6], a primitive character seen in *Luprops tristis* [7], where it causes rupture of the reservoirs. Entire gland secretion was not released at once, and upon maintaining the disturbance, beetles released the secretion at intervals from five to six times within a period of 10 minutes. Following the complete discharge of the secretion, beetles were defenceless for four to five days without gland secretion. Slow release of the gland secretion might be enabling the beetle to repel predators for a prolonged period of time. Beetle responded towards all the three stimuli applied, and the quickest response was towards pinching of legs. Exudation of gland secretion was side specific, as when the stimulus was applied on one side of the beetle, exudation of reservoir of that particular side alone occurred.

3.3. Dispersal of Secretion. Margins of the epipleura are formed into a gutter or channel in *M.villiger* along the lateral edge of the elytra with the posterior end opening in to the seventh abdominal sternite and the anterior end merging with the elytral humeri (Figure 3). Epipleural gutter is present in all other species of *Mesomorphus* (*M. gridelli* Kaszab 1963, *M. kulzeri* Kaszab 1963, and *M. Striolatus* Fairmaire 1896) recorded from the region. Portion of the exuded secretion was expelled as a narrow streak through the gutter as far as the elytral humeri and spread over the anterior margin of elytra as in many other tenebrionids [5]. Dispersal through the epipleural gutter has the effect of increasing the area exposed to the secretion, and the remaining secretion spreads over the posterior end of abdomen and elytra. Dispersal of secretion was very rapid, with the entire length of the elytra and posterior part of pronotum being covered within

a fraction of a second. Released secretion dried off within 10–20 seconds, and the repelling odour persisted for three to five minutes.

4. Conclusion

Defensive glands of *M. villiger* consist of a pair of abdominal glands and without prothoracic glands. Glands are evaginations of the intersegmental membrane between seventh and eighth sternites with the secretory tubules distributed at the proximal dorsolateral portion of the reservoirs. Secretion is released by exudation which constitutes a comparatively advanced mode of dispersal, and the exuded secretion spreads quickly along the epipleural gutters to reach the anterior portion.

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