

Metathoracic scent glands in female adults of *Arocatus melanocephalus*

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Abstract

The elm seed bug *Arocatus melanocephalus* (F.) (Heteroptera Lygaeidae) has recently elicited attention for the repeated massive intrusions inside urban buildings occurred during summertime in Northern Italy. Although these bugs pose no threat to human health and do not cause any damage, for the nuisance and the unpleasant smell, they are considered aesthetic pests. Biology and behaviour of these insects have been poorly investigated and this study is part of a research undertaken to obtain basic knowledge on the gland system of *A. melanocephalus* in the view to find a sustainable control strategy based on the use of its semiochemicals. In particular, the present investigation was performed to characterize the anatomy of the adult female metathoracic scent gland system (MTGs), by means of optical and scanning electron microscopy techniques. Results showed that the MTGs, whose external opening is between the second and third pair of legs, consist of three secretory units (anterior, medial, and posterior glands) and an unpaired sack-like reservoir, located on both sides of the metathoracic segment. The detailed structure of the opening, of each secretory unit and of the reservoir is described. Further studies are being performed to understand the biological function of these glands.

Key words: Hemiptera, urban nuisance, morphological study, SEM, MTGs.

Introduction

Arocatus melanocephalus (F.) is a small lygaeid which develops its life cycle on elm trees (*Ulmus* spp.). This heteropteran never aroused particular attention until summer 2001, when it suddenly started to become a problem for the inhabitants of many locations in Northern Italy, due to the repeated massive intrusions of these insects inside urban buildings during summer. Winged adults (6.5-7 mm length) are mainly red and black. Knowledge about *A. melanocephalus* biology, anatomy and physiology is poorly reviewed (Péricart, 1998; Reggiani *et al.*, 2005; Maistrello *et al.*, 2006).

This lygaeid overwinters as adult, mating occurs during spring, eggs are laid on elms' fruits and nymphs go through five instars before appearance of adults in late May-June. The post-embryonic development is very short (4-6 weeks) and there is a pronounced overlap of different stages, especially in May (Santi *et al.*, 2002).

As a part of a research aimed to characterize the morphology and content of the gland system of *A. melanocephalus*, this study shows the detailed anatomy of adult female metathoracic scent gland system (MTGs), performed by means of optical and scanning electron microscopy investigations.

Materials and methods

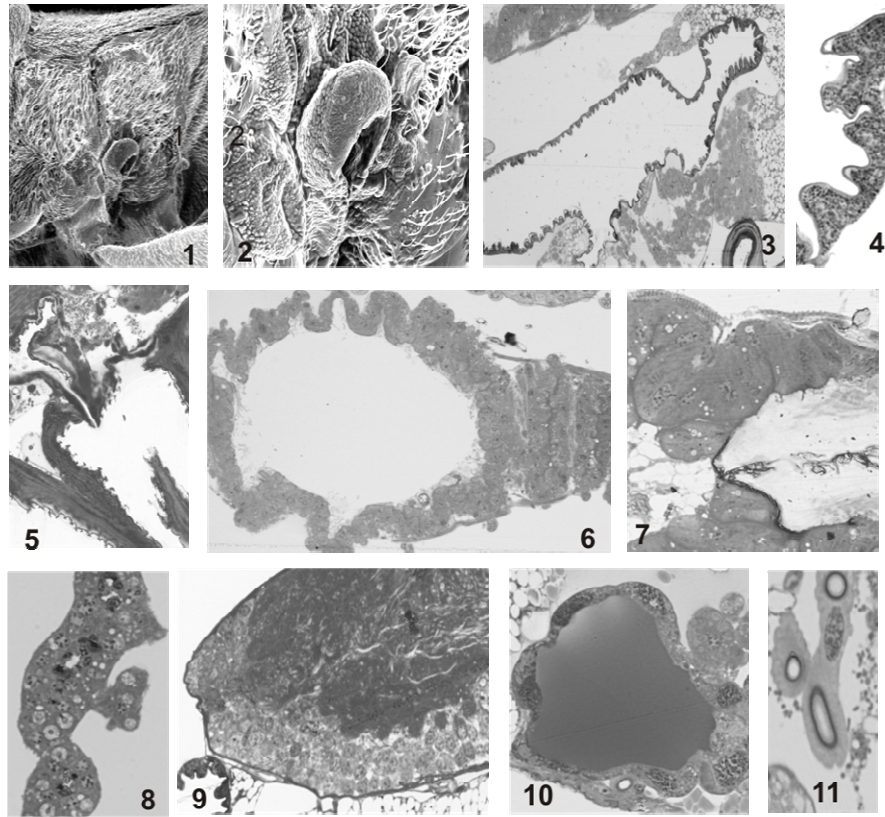
Reproductive females of *A. melanocephalus* were collected from elm trees in the city of Modena during spring 2006. They were fixed for 3 hours at 4 °C in 2% glutaraldehyde in 0.05 M sodium cacodylate buffer, pH 7.0. They were postfixed for 2 hours at 4 °C in 2% osmium tetroxide solution in the same buffer. After dehydration in ethanol, some samples were prepared for scanning electron microscopy (SEM) observations at the Center

for Electron Microscopy of the University of Ferrara. Samples for optical microscopy (OM) were further processed by soaking in propylene oxide and embedding in Epon-Araldite resin. Sections 1-µm thick were obtained by a Reichert Om2 ultramicrotome and were stained with Azure II-Methylene Blue.

Results and discussion

The *A. melanocephalus* MTGs consists of three secretory units (anterior, medial and posterior glands) and an unpaired sack-like reservoir, located on both sides of the metathoracic segment. The external opening of the MTGs is between the second and third pair of legs (figure 1), where there is an ostiole (figure 2) consisting of an ovoid cuticular slit, connecting at his inner end with the reservoir. Around each ostioles there is a peculiar area of pleural cuticle considered as an evaporative surface, functioning as an external reservoir which probably causes the retarded evaporation of the secretions stored in the internal reservoir (Staddon, 1979). The SEM of the pleural scent area shows cuticular microsculptures (figure 2).

The reservoir, situated in the ventral part of the metathorax below the digestive tract, shows signs of storing secretion (figure 3) and consists of a single layer of unicellular secretory units (figure 4), underlying the cuticular intima and separated from the haemocoel by a thin basal lamina. Similar structures have been observed in *Nezara viridula* (L.) in the glandular epithelium (type-1 Unicellular Secretory Units) of the metasternal reservoir (Lucchi, 1996). The reservoir leads to the ostiole by means of a thin duct (figure 5). The anterior gland has a lens-shaped structure and consists of a single layer of columnar epithelial secretory cells (figure 6), whose structure is similar to the cells of the "ductless" secretory units of the accessory gland of *Oncopeltus fasciatus* (Dallas)



Figures 1-11. **1)** External opening, situated between the second and third pair of legs, of the metathoracic scent gland system (MTGs) of an *A. melanocephalus* female adult. Picture obtained at S.E.M. (12 X). **2)** Cuticular microsculptures in the pleural scent area of the MTGs. Picture obtained at S.E.M. (15 X). **3)** Reservoir in the MTGs, located in the ventral part of the metathorax below the digestive tract, showing signs of storing secretion (10 X). **4)** Single layer of unicellular secretory units in the reservoir of the MTGs (450 X). **5)** Thin duct which leads from the reservoir of the MTGs to the ostiole (30 X). **6)** Anterior gland of the MTGs, consisting of a single layer of columnar epithelial secretory cells (20 X). **7)** Convergence of the anterior gland of the MTGs in a scent canal (70 X). **8)** Secretory cells arranged radially around the central collecting duct of the anterior gland of the MTGs (160 X). **9)** Structure of the medial gland of the MTGs (50 X). **10)** Structure of the posterior accessory gland of the MTGs (80 X). **11)** Duct connecting the posterior accessory gland of the MTGs to the reservoir (200 X).

(Everton and Staddon, 1979). The gland opening is provided with muscle-controlled fibers. The anterior gland structure converges in a scent canal (figure 7), whose cuticular ductule has a peculiar shape which changes its structure along its course. Transverse sections of the anterior gland show the presence of a number of secretory cells arranged radially around the central collecting duct (figure 8). Similar structures have been described for *N. viridula* paired lateral glands (Filshie and Waterhouse, 1968). The medial gland (figure 9), ovoidal shaped, seems made up of a thick layer of overlapping cells and its lumen is filled with a secretion whose appearance is non homogeneous and seems condensed in fibrils assembled in fascicles. This gland is connected to the reservoir by a canal inside which it can be observed a secretion of fibrillar nature.

The last structure of this complex MTGs is the posterior accessory gland (figure 10). Its appearance is peculiar: a single layer of differently shaped cells surrounds a lumen filled with a material which assumes a very intense and homogeneous blue colour. This gland is connected to the reservoir by a duct with an evident cuticular wall (figure 11).

Comparing the MTGs for the studied Lygaeid species, it can be noted that although there are remarkable differences in the gross morphology, similarities can be detected in the structure of the unicellular secretory units (Staddon, 1979), as shown in the case of *A. melanocephalus* and *O. fasciatus*. Moreover, in the latter species a conspicuous sexual dimorphism has been shown regarding the size of the MTGs (Staddon *et al.*, 1985). Further studies are being performed to analyze also the structure of adult male MTGs of *A. melanocephalus*, together with a chemical characterization of the scent substances in order to understand the biological function of these glands.

References

- EVERTON I. J., STADDON B. W., 1979.- The accessory gland and metathoracic scent gland function in *Oncopeltus fasciatus*.- *Journal of Insect Physiology*, 25: 133-141.
- FILSHIE B. K., WATERHOUSE D. F., 1968.- The fine structure of the lateral scent glands of the green vegetable bug, *Nezara viridula* (Heteroptera, Pentatomidae).- *Journal de Microscopie*, 7: 231-244.

- LUCCHI A., 1996.- The scent gland system of *Nezara viridula* (L.) (Heteroptera: Pentatomidae). IV The metathoracic scent-apparatus.- *Frustula Entomologica*, 32: 1-10.
- MAISTRELLO L., LOMBROSO L., PEDRONI E., REGGIANI A., VANIN S., 2006.- Summer raids of *Arocatus melanocephalus* (Heteroptera: Lygaeidae) in urban buildings in Northern Italy: Is climate change to blame? - *Journal of Thermal Biology*, 31: 594-598.
- PÉRICART J., 1998.- *Hémiptères Lygaeidae Euro-Méditerranéens*.- Fédération Française des Sociétés de Sciences Naturelles, Paris, France.
- REGGIANI A., PEDRONI E., MAISTRELLO L., 2005.- Infestazioni da *Arocatus melanocephalus* (Fabricius) (Heteroptera: Lygaeidae) nella città di Modena.- *Atti Società Naturalisti Matematici di Modena*, 136: 119-125.
- SANTI F., REGGIANI A., BARONIO P., 2002.- Ricerche su *Arocatus melanocephalus* (F.) e notizie su altri rincoti ligeidi incontrati nell'ambiente urbano.- *Disinfestazione e Igiene ambientale*, 19: 3-7.
- STADDON B. W., 1979.- The scent glands of Heteroptera.- *Advances in Insect Physiology*, 14: 351-418.
- STADDON B. W., GOUGH A. J. E., OLAGBEMIRO T. O., GAMES D. E., 1985.- Sex dimorphism for ester production in the metathoracic scent gland of lygaeid bug *Spilostethus rivularis* (Germar) (Heteroptera).- *Comparative Biochemistry and Physiology*, 80B: 235-239.

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