CALCIUM RESPONSES TO QUEEN PHEROMONES, SOCIAL PHEROMONES AND PLANT ODOURS IN THE ANTENNAL LOBE OF THE HONEY BEE DRONE *APIS MELLIFERA* L.

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INTRODUCTION

The functional role of honey bee males (drones) in the colony is to mate with queens, a behaviour relying heavily on the olfactory detection of queen pheromone. How the brain of drone honey bees processes olfactory stimuli, in particular pheromones, is still largely unknown. Olfactory receptor cells located in sensillae on the antennae project to the antennal lobes (AL), the first brain structures to process olfactory information, and contact projection neurons in delimited functional units, the glomeruli. Projection neurons connect the ALs with higher-order processing centres, the mushroom bodies. In drones, there are about 100 'ordinary' glomeruli and additionally, 4 large compartments which form the macroglomerular complex (MGC). Because in moths the MGC is responsible for sexual pheromone detection and processing, such a function was also proposed in drones. One of these compartments (MG1) is particularly prominent at the surface of the AL, together with about 30 usual-size glomeruli, which makes them accessible for optical imaging studies. Using calcium imaging, we measured odour-evoked responses in the glomeruli of the drone AL.

MATERIALS AND METHODS

Drones were placed in recording chambers. The head cuticle was opened, and membranes and glands covering the brain were removed revealing the antennal lobes. Then, the brain was bathed with Calcium-Green 2AM in saline for 1 h. Afterwards, the brain was thoroughly rinsed and the chamber placed under an epifluorescence microscope. For each measurement an antennal lobe was illuminated 100 times (5 times per second) with a monochromatic light beam and fluorescence emission was recorded by a camera coupled to a computer. Three seconds after the beginning of each measurement, an odour was presented for 1 sec. Seventeen different odours belonging to three main classes of stimuli were used: (i) queen pheromonal components, used by drones for the recognition of queens during nuptial flights, (ii) social pheromonal components used for social cohesion in the colony, and (iii) floral odours, which are present in the food stores of the hive and/or brought back by foragers. Odor-evoked activity was observed as relative changes in calcium concentration (fluorescence) in particular glomeruli of the antennal lobe.

RESULTS

All three classes of stimuli produced signals in a variety of glomeruli of the antennal lobe. The main components of the queen pheromone, 9ODA and 9HDA induced signals in the MGC, whilst the other components HOB and HVA each triggered activity in mostly one, but not the same, ordinary glomerulus. Social pheromones and floral odours generally evoked responses in a combinatorial manner in ordinary glomeruli. Comparisons of activity maps in different individuals allowed to show that the glomerular code for odours is conserved among drones and symmetrical between sides.

CONCLUSION

This study suggests that the most active queen pheromonal components are processed in the macroglomeruli of the drone AL, as are pheromonal compounds in moths, and that social pheromones and floral odours, as well as secondary queen pheromone components are processed in ordinary glomeruli. These results are discussed in relation to the differential coding of signals that are inherently relevant vs. that of signals whose relevance depends on individual experience as well as with respect to the behaviour and role of drones in the honey bee society.

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