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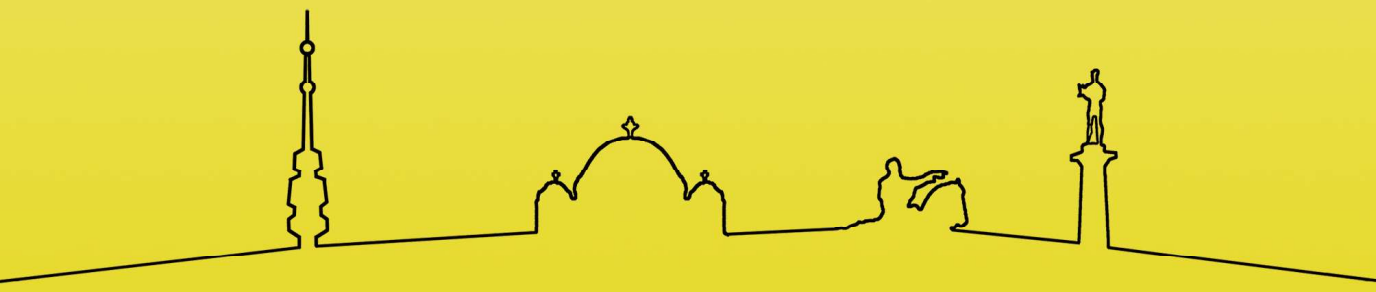

EFFECTS OF SEASONALITY AND LANDSCAPE COMPOSITION ON POLLEN COLLECTED BY HONEYBEES

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The honeybee is the most important and widespread managed pollinator. Its diet is based on nectar and pollen, and since the quality of pollen varies among plant species, bees must have access to diverse pollen sources to assure colony health. Only landscapes with high floristic diversity, e.g., related to the presence of semi-natural areas, can therefore guarantee adequate resources for honeybees. Besides the availability of heterogeneous pollen, also the amount of agricultural area can have a strong effect bee health, due to pesticide contamination in pollen.

This work aimed to explore how the composition of pollen and pesticide residues in pollen collected by honeybees were modulated by seasonality and landscape heterogeneity in Northern Italy. We selected 13 locations, where we placed two honeybee colonies from which we collected pollen samples every month during the whole flowering season over two years. For each pollen sample, we determined pollen type composition and diversity and the Pollen Hazard Quotient (PHQ), which provides a measure of potential pollen toxicity. Finally, we determined the cover of the main habitat types in 3-km radius buffers around the sampling locations.

Honeybees, despite being extremely generalist, focused their foraging activity on a few plant species, which changed throughout the season. Landscape composition did not affect pollen diversity from April to August, however, in September the diversity increased with increasing semi-natural areas. While honeybees were able to collect heterogeneous pollen independently of landscape composition up to mid-summer, the scarcity of floral resources in late summer turned semi-natural areas into key habitats. Only 6 pollen samples out of 136 were pesticide-free. We detected more than 100 compounds, mainly fungicides.

PHQ increased with increasing proportion of certain categories of agricultural areas, in particular apple orchards, and decreased with increasing semi-natural areas.

Our research highlighted the scarcity of floral resources in late summer and the resulting importance of semi-natural habitats for honeybees. Since pollen quality can affect the response of bees to pesticides, beekeepers should evaluate landscape composition before placing beehives, to maximise floral resources and the diversity of pollen collected by bees, while minimising the likelihood of pollen contamination by pesticides.

Keywords: foraging behavior, pesticides, pollen composition

ATRAZINE EXPOSURE PERTURBS THE GUT MICROBIOTA, REDUCES POLLEN CONSUMPTION AND ALTERS FUNCTIONAL GENE EXPRESSION IN HONEYBEES

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Atrazine is a widely used pesticide and the effect of this xenobiotic on the microbiota metabolism has been reported in many insects. However, it is not clear whether atrazine negatively affects the gut microbiota in honeybees. To address this research gap, we evaluated the effects of atrazine exposure on size and composition of honeybee gut communities, and showed that treatment with sublethal atrazine severely increased beta diversity of composition and reduced

the size of gut microbiome. Moreover, we assessed other indicators associated with gut microbes: pollen consumption and global genes expression in gut. Importantly, exposure to higher concentrations of atrazine (37.3 mg/L) significantly decreased pollen consumption compared to exposures to lower concentrations of pesticide (3.73 mg/L) and in control groups. When compared with control honey bees, several functional genes associated with cytochrome P450, peroxisome and lysosome were up-regulated in both low and high exposed groups. Additionally, we observed a reduction in expression of 93 genes, in bees exposed to lower atrazine concentrations. This expression downregulation extended to 384 genes in bees exposed to higher concentrations of the pesticide. The overlapping down-regulated gene list was enriched in insect genes involved in hormone biosynthesis, protein processing in endoplasmic reticulum, glutathione, and pyruvate, propanoate, cysteine and methionine into the KEGG signaling pathways. Thus, exposure of bees to atrazine perturbs the honeybee microbiota, reducing pollen consumption and leading to alterations in functional genes expression, which may influence the honeybee effectiveness as pollinators, and possibly weak colony health.

Keywords: atrazine, honeybee, microbiota