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EFFECTS OF SEASONALITY AND LANDSCAPE COMPOSITION ON POLLEN COLLECTED BY HONEY BEES

Effetto della stagione e della composizione del paesaggio sulle caratteristiche del polline raccolto dalle api mellifere

In recent years, pollinator abundance and diversity faced a strong decline due to multiple anthropogenic pressures (Potts *et al.*, 2010). Among the main causes of this decline are the use of pesticides in agricultural areas and the loss and fragmentation of semi-natural areas, which led to a decrease in plant diversity, potentially determining insufficient nutrition for pollinators (Goulson *et al.,* 2008). The honey bee, *Apis mellifera* Linnaeus, is the most widespread pollinator species and its presence is crucial not only for ensuring the reproduction of plant species in natural habitats but also for crop production (Hung *et al.,* 2018; Rollin & Garibaldi, 2019).

The honey bee diet is based on nectar and pollen. Since the quality of pollen in terms of nutrient content varies from one plant species to another (Roulston & Cane, 2000), honey bees must have access to diverse pollen sources in order to assure colony health. Only landscapes with a certain degree of floristic diversity, linked for example to the presence of semi-natural areas, can therefore guarantee adequate resources for honey bees (Di Pasquale *et al.,* 2016). On the other hand, landscape composition and in particular the amount of agricultural area can have a strong effect on the presence of pesticides, which can contaminate the pollen collected by bees, with important effects on bee health (McArt *et al.,* 2017).

This work aimed to explore how the composition of pollen and the

pesticide residues in pollen collected by honey bees were modulated by seasonality and landscape composition heterogeneity in a mountainous cultivated area of Northern Italy. We selected 13 locations, and at each location, we placed two honey bee colonies from which we collected pollen samples every month during the whole flowering season in 2019 and 2020. We analysed 136 pollen samples, for which we determined pollen type composition and diversity using the Shannon index. For pesticide residue analysis, we searched for more than 300 compounds in pollen samples, including fungicides, acaricides, herbicides, and insecticides. We then calculated for each pollen sample the Pollen Hazard Quotient (PHQ), an index that provides a measure of the potential toxicity of contaminated pollen (STONER & EITZER, 2013). Finally, to assess landscape heterogeneity, we determined the cover of the main habitat types in a 3 km radius buffer around the sampling locations and analysed landscape composition using PCA and Shannon's diversity index.

We observed almost 117000 pollen grains belonging to 122 taxa. Honey bees, despite being extremely generalist, usually focused their foraging activity on a few plant species. The composition of pollen collected by bees showed a strong turnover throughout the season, which partly reflects the availability of resources and partly the preferences of honey bees. Only 6 pollen samples (4%) were pesticide-free. In the remaining 130 pollen samples, we detected more than 100 compounds, mainly fungicides. PHQ values were high (PHQ>1000) in 11 samples (8%), medium-high (500<PHQ<1000) in 10 samples (7%), medium (50<PHQ<500) in 35 samples (26%), and low (PHQ<50) in 74 samples (55%).

Sampling season had a strong effect on both pollen diversity and pesticide residues. Pollen diversity was higher in May, July, and August, while pollen samples of April and particularly September were more homogeneous. PHQ was higher between April and July, when pesticide applications in agricultural areas were also higher, and strongly decreased in August and September. Landscape composition differently affected pollen diversity and pesticide residues. In fact, landscape composition had no effect on pollen diversity from April to August, however, in September the diversity increased with increasing semi-natural areas (MALAGNINI *et al.*, 2022). While honey bees were able to collect heterogeneous pollen independently of landscape composition from spring to mid-summer, the scarcity of floral resources in late summer may turn semi-natural areas into key habitats. On the other hand, the effect of landscape composition on pesticide residues was independent of the sampling season. In fact, pesticide residues increased with increasing

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

Our work highlighted that seasonality and landscape composition strongly affected the diversity of pollen collected by honeybees and pesticide residues in pollen, both of which are key factors for ensuring bee colony health. As it has been shown that pollen quality can influence the response of bees to pesticides (BARASCOU *et al.*, 2021), it is therefore advisable for beekeepers to evaluate landscape composition before placing beehives, in order to maximise floral resources around the hives and thus the diversity of pollen collected by bees, while minimising the likelihood of high pollen contamination by pesticides.

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REFERENCES

BARASCOU L., SENE D., BARRADU AL., MICHEZ D., LEFEBVRE D., MEDRZYCKI P., DI PRISCO G., STROBL V., YANEZ O., NEUMANN P., LE CONTE Y. & ALAUX C., 2021. Pollen nutrition fosters honeybee tolerance to pesticides. *R. Soc. Open Sci.*, 8: 210818.

DI PASQUALE G., ALAUX C., LE CONTE Y., ODOUX J.F., PIOZ M., VAISSIÈRE B. E., BELZUNCES L.P. & DECOURTYEL A., 2016. Variations in the availability of pollen resources affect honey bee health. *PLOS One*, 11(9): e0162818.

GOULSON D., LYE G.C. & DARVILL B., 2008. Decline and conservation of bumble bees. *Annu. Rev. Entomol.*, 53: 191–208.

HUNG K.L.J., KINGSTON J.M., ALBRECHT M., HOLWAY D.A. & KOHN J.R., 2018. The worldwide importance of honey bees as pollinators in natural habitats. *Proc. R. Soc. B. Biol. Sci.*, 285: 20172140.

MALAGNINI V., CAPPELLARI A., MARINI L., ZANOTELLI L., ZORER R., ANGELI G., IORIATTI C. & FONTANA P., 2022. Seasonality and landscape composition drive the diversity of pollen collected by managed honey bees. *Front. Sustain. Food Syst.*, 6: 865368.

MCART S.H., FERSCH A.A., MILANO N.J., TRUITT L.L. & BOROCZKY K., 2017. High pesticide risk to honey bees despite low focal crop pollen collection during pollination of a mass blooming crop. *Sci. Rep.*, 7: 46554.

POTTS S.G., BIESMEIJER J.C., KREMEN C., NEUMANN P., SCHWEIGER O. & KUNIN W.E., 2010. Global pollinator declines: trends, impacts and drivers. *Trends Ecol. Evol.*, 25: 345–353.

ROLLIN O. & GARIBALDI L.A., 2019. Impacts of honeybee density on crop yield: a meta-analysis. *J. Appl. Ecol.* 56: 1152–1163.

ROULSTON T.H. & CANE J.H., 2000. Pollen nutritional content and digestibility for animals. *Plant Syst. Evol.*, 222: 187–209.

STONER K.A. & EITZER B.D., 2013. Using a hazard quotient to evaluate pesticide residues detected in pollen trapped from honey bees (*Apis mellifera*) in Connecticut. *PLOS One*, 8(19): e77550.

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