WHICH LANDSCAPE FEATURES INFLUENCE POPULATION ECOLOGY OF BEE COLONIES IN FARMLAND INTENSIVE CEREAL SYSTEMS?

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Large scale decrease in wild and domestic bee populations occurs today in at least three continents, up to alert public opinion and politicians. The pollination role of this phenomenon could be impacted, and have major economical consequences. The causes of this decline are still largely debated, but however above all causes, feeding and foraging resources may have become limiting, especially so in intensive farming systems. This may lead to mass mortality, and contribute to the actual decrease of honey production. But there is very limited empirical and experimental evidence so far for testing this hypothesis. More generally, our knowledge of bee ecology (population dynamics, life history traits) and foraging ecology is extremely limited in those agro-systems, though they represent the main production areas in France.
Extreme temporal shifts are observed in resources availability. The rape seed blooms in April while sunflower blooms in July, and thus crops flower availability is extremely reduced in May and June, leading to a major food shortage. The spatial heterogeneity in resource availability is due to farming system management, and spatial foraging in bee is mostly unknown in cereal agro-system.

The aim of this five years-study aims at testing landscape features in farmland habitat (crop diversity, abundance and distribution of weeds as an alternative source), influence bee ecology and may limit population ecology. We also look for determine at which spatial scale this influence is mostly marked on bee colonies development.

A monitoring has been held on fifty beehives randomly allocated in a wheat plain in France with varied landscape structures. The main measured indicators are bee population, brood area, drone breeding, hive weight or pollen harvest in one hand, and land use data in an other hand, containing crop type monitored on every field every year converted into 10 categories. We use 50 plots of 10 km^2 from which 10 random sites are chosen each year. On our study site, landscape is documented spatially continuously, thus we carried out spatial analyses step by step from 250 to 6000m around the hives.

Under the assumption that flower blooms lead to a higher fecundity and/or productivity, we tested the hypothesis that food shortage between rapeseed and sunflower blooms lead to a population fall. In addition, we predict that if there is a landscape heterogeneity between apiaries leading to alternative available food sources, that apiary will behave differently during the fall. The third aim is to identify which alternative food sources may available during the beehive fall. Woods, wild flowers, weeds, or grassland blooming could play a key-role during the food shortage period.

All along the season, our study showed that three of the four parameters measured on beehive performances follow the predicted pattern: reserves weight, population, drone brood area, but not the total brood area. There was a strong diversity between apiaries in terms of landscape distribution. Some belong to strict cereal landscape up to 3500m, while others are characterized by maize/grassland, or wood. In addition, this landscape variability vanishes from 500m to 6000m.

Using correlation between beehives reserves and percentage of crop categories, we searched for significant slope for analysing the foraging of any range. There was no effect of rape seed at any distance, but a strong effect of sunflower, combined with maize. For this crop, bees appear to forage over 1000-4000m radius. Woods clearly appears as an alternative food source, up to 5000m. Foraging ranges lie over 1000-5000m, though it can be less for grasslands. Evolution of the diversity (through Shannon index) of the pollen trap collected harvest follows exactly the predicted pattern too.

We confirm that there is a food shortage period in cereal landscape farming systems, between rape and sunflower blooms, leading to major population crashes in beehive population dynamics (except for brood). We also confirm that bees can find alternative food sources in some cases, which increases heterogeneity if apiary response to landscape features. Alternative food sources can be woods, weeds or grasslands. The landscape spatial scale is time dependant. However, we did not detect any effect of rapeseed because of its abundance feature, and we failed to detect any alfalfa effect, conversely to results obtained in 2008. In terms of foraging range, we found indirectly that in the food shortage period, the bees fly up to 4 km, and especially in the 3500-4000m ring around.

In conclusion, our preliminary results suggest that food shortage in intensive cereal farmland habitat may be a critical driver of bee population dynamics (including adult survival, brood production, and honey/reserves production), and thus may shed new light on the debate of the causes of bee collapse colony disorder?

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