The Effects of Cattle Grazing on Spring Foraging Potential of Honeybees and Wild bees

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**Abstract**

Pastures make up a significant part of the uncultivated open areas in Israel, and are used mainly for cattle grazing for the beef industry. Pastures provide a wide range of ecosystem services. Natural open areas and the nectar and pollen resources they provide to bees, are increasingly limited as a result of rising land development pressures. Grazing lands are therefore also used for honeybee foraging. This overlap between cattle and apiculture industries, calls for the development of integrated landscape management strategies which will enable multiple uses of open land. Cattle grazing directly affects plant richness, abundance and community composition; it may also affect bee activity, honey yield and hive strength by altering the quality of the habitat and the bees' foraging resources, especially in the spring. Furthermore, grazing may affect wild bee communities in pastures and in surrounding natural habitats. Wild bees provide significant pollination services to wild plants and crops; furthermore, they are efficient bioindicators of the state of the environment. During the last decade populations of both honeybees and wild bees have been in decline in many parts of the world. Pastures are therefore of increasing ecological and economic importance for sustaining both cattle and wild and domesticated bee communities.

The main question posed in this thesis concerns the effect of cattle grazing on bee diversity and activity in pastures during the spring; the field component of the study focuses on examining the direct effect of cattle grazing on plant richness, abundance and composition, and the subsequent effect on bee community and bee-plant interactions. An additional question presented in this research through greenhouse experiments addresses the effect of climate, temperature and water availability on nectar production of bees' main forage plants, *Sinapis alba* and *Trifolium clypeatum*.

Field work was conducted in 6 pairs of cattle grazing plots and adjacent ungrazed plots, in three different geographic locations in Israel: Karei Deshe experimental station, Ramat Hanadiv and Lachish. At each site, data were collected in 3-6 rounds of sampling, including plant and bee surveys, during the spring of 2012 and the spring of 2013.

The high degree of variance found in the effects of cattle grazing on plants and bees among years, sites and plots within sites, make it difficult to reach general conclusions regarding the extent to which cattle grazing affects the foraging potential of bees. However, importantly, the majority of analyses did not indicate negative effects of cattle grazing on honeybees and wild bees. The main findings from this work, which are in agreement with previous results, indicate that grazing and seasonality, and sometimes their interactions, affect the community composition and richness of the bees' forage plants and the relative abundance of flowers. As expected, flower richness was higher in most of the grazed plots than in ungrazed plots, in all sites and both years. These differences were either limited to peak bloom or seen throughout the blooming season. In contrast, the effect of cattle grazing on absolute flower abundance was variable, and seasonality had a greater effect than grazing. Plant community composition was the most sensitive of the plant parameters tested; differences were observed among the treatments in the relative abundance of plant species, and in some cases also in the species composition, particularly during blooming peak and late spring.

The majority of the analyses showed no negative effects of cattle grazing on honeybees or wild bees; some of the parameters measured revealed positive effects, particularly for honeybees, and others showed no significant effects at all. Grazing had its main effect on the identity of the forage plants, rather than on overall bee activity. Despite concerns raised by beekeepers, cattle grazing was not shown to decrease the forage potential of open landscapes for bees, and might even positively affect floral diversity and abundance. Furthermore, grazing increases habitat heterogeneity, which contributes to biodiversity. However, previous work has indicated negative effects of either overly high or overly low grazing intensities on bee communities. The current study emphasizes the importance of ungrazed areas for increasing the diversity, overall availability and seasonal complementarity of nectar and pollen sources. Hence, maintaining a mosaic of grazed and ungrazed patches will provide the greatest nectar and pollen resources throughout the season. Moreover, ungrazed patches may provide important nesting sites for wild bees, particularly for above ground cavity and stem nesters.

Greenhouse experiments showed negative effects of water and temperature stress on nectar production by the flowers of both *Sinapis alba* and *Trifolium clypeatum*, as well as on the duration of their blooming period. The variability found among plots in the field study may thus be derived from climate effects on nectar availability and resultant changes in flower attractiveness for bees. Further research is necessary to examine the effect of climatic variables in grazing effects on bees under field conditions.

In summary, in light of the increasing shortage of natural open areas and the decline in availability of nectar and pollen resources in Israel, there is a need for integrated management of pasture lands. The findings of this study contribute to our limited knowledge of the effects of grazing on bee communities, and show that these effects will be mediated mainly by the identity and phenology of the main forage plants blooming during the spring, and that negative effects may be mitigated by the presence of nearby ungrazed patches.