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# Honey bees and beekeepers as environmental researchers: Results, limits, opportunities

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Beekeepers are more and more involved in studies on honey bees and the environment. With their special equipment and knowledge, they can participate in scientific studies by providing data or samples. Several such investigations have resulted in scientific publications and innovations have been made to offer beekeepers a low-threshold participation. These innovations include non-invasive sampling matrices and methods to analyse samples taken by beekeepers. The involvement of beekeepers also includes some limits, most of which are typical for environmental studies or other studies involving citizens, like sample logistics or data protection issues.

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## 1. Introduction

Bees (Apiformes), a group comprised of more than 20,000 species, are important and popular insects, often subject of Citizen Science studies. Koffler et al. [1] concluded after reviewing 88 studies that these studies do produce new knowledge, apply methods to improve data quality, and invest in open access publishing. Notably, they found that volunteer participation was mainly restricted to data collection. The main research subjects they identified were beekeeping, followed by distributional ecology, data quality, natural history, plant-pollinator interactions, volunteer assessment, and landscape ecology. This underlines that, for some years now, there are well-established projects in which researchers cooperate with beekeepers managing honey bees (*Apis mellifera*) for profit or for hobby under the sometimes vaguely used term Citizen Science. In the past, studies with beekeeper involvement were typically conducted in highly developed countries but see Requier et al. [2] for strategies to increase participation in developing countries.

At the talk given at the Austrian Citizen Science Conference 2022, we presented our own experiences and thoughts on collaboration with beekeepers in research. The sections are entitled 'results', 'opportunities', and 'limits' whereby the quotation marks of section headings are intentional as 'limits', for example, are relative.

## 2. 'Results':

The data and research findings gained in collaboration with beekeepers as citizen scientists is documented in several peer reviewed scientific articles. For example, the specialist data obtained with the help of beekeepers participating in scientific research have proved to be valuable to understand the honey bees' interaction with the available floral resources and allowed generalized conclusions about the suitability of different landscapes for honey bees [3][4].

Other ongoing investigations make use of this academic-practitioner cooperation to investigate the host-parasite relationship of the introduced mite *Varroa destructor* [5] or the presence of the invasive bee *Megachile sculpturalis* [6].

## 3. 'Opportunities':

The demographics, motivation, and skills of beekeepers participating in the INSIGNIA project as Citizen Scientists was studied by Gratzer and Brodschneider [7]. This contributory project takes advantage of honey bees collecting (chemical) information on the environment while foraging in large areas around their hives. Beekeepers were equipped and trained to collect standardized samples from their honey bee colonies for laboratory analysis. The research found that beekeepers are a highly specialized group and are highly motivated to participate in studies on the environment. The results they obtain from this research is of great interest for them, as they do care about the welfare of their bees as well as the quality of hive products they produce for human consumption. For the success of such a study, use of standardized sampling and good preservation methods without contaminating the sample are important. In the last few years, research has progressed in developing and validating storage and shipping options for Citizen Scientists. Quaresma et al. [8] showed that to identify botanical origin of bee collected pollen

samples with ITS2 metabarcoding, no cold chain or difficult chemical preservation is needed anymore. Citizen scientists can dry samples with materials safe for the user (silica gel bags), which allows shipping of samples at room temperature. Other researchers refined analytical methods to make use of DNA in pollen from honey (a well-preserved matrix) for Citizen Science research [9]. Non-invasive and non-destructive sampling matrices, such as the APIStrips [10] or silicone wristbands [11], can be inserted into the hives to collect environmental pollutants. Hornby et al. [12] developed a standardised way of identifying colours in pollen samples using a smartphone, which also enables participation of colour-blind people.

## 4. 'Limits':

In this section, we want to point to issues which we do not necessarily find limiting in involving beekeepers in research, but which evolved as crucial points to consider in the past. An example, probably valid for many Citizen Science projects, is the conformity to GDPR. Next to personal details related to the Citizen Science beekeeper, research projects described in this study often also involves details such as the number, location, and health status of honey bee colonies. When these are sampled to study environmental pollution, great attention needs to be given so as to not contaminate samples on their long journey from the Citizen Scientist beekeepers' hives to the analytical lab [13]. This journey includes more hands than typically involved in research. Gratzer and Brodschneider [7] showed that for beekeeper Citizen Scientists, personalized data feedback is the highest form of recognition for participation. This includes the risk of premature dissemination of data, with sometimes undesired consequences. Finally, while no empiric data is available on this yet, Citizen Scientists could have ethical issues when it comes to destructive sampling of honey bees or materials of the nest. The further development of non-destructive sampling matrices as described above is therefore important to have a low threshold offer for Citizen Scientists.

## 5. Conclusion:

Beekeepers are well suited to participate in research on honey bees. The limits identified in this paper are probably similar to limits experienced in other studies on the environment involving citizens, whereas the opportunities summarized here are unique for beekeeper participation in research. The past few years saw great innovations making use of this potential, which will lead to a prospering collaboration of beekeepers and science. In most ongoing studies so far, beekeepers are contributing data or samples with more involvement of beekeepers in study design (co-creation) being left desired.

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