

Honey bees, indicator of health and the environment

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Report of the discussion sessions on RESEARCH NEEDS

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OBJECTIVE

To identify knowledge gaps and research needs to underpin a monitoring scheme using bees as a sentinel/indicator for the environment.

GENERAL REMARKS

To better frame the discussions, we would first like to highlight two potential points of complexity. First, we seem to deal with three types of 'health': bee health, environmental health and human health. Although they may be (to some extent) inter-linked, knowledge gaps and related research recommendations are likely quite different for each. E.g. research on varroosis clearly concerns bee health, but it is not important for human health. Second, within bee health, one can conduct studies at the level of individual bees, bee colonies, or above. Though again inter-linked, related research questions can be quite different, as widely acknowledged in the field of epidemiology. Knowledge gaps/research needs that were spontaneously identified mostly addressed *bee health*, both on the level of *individuals* and *colonies*.

During the discussion, bee health was generally considered as a complex issue, with scant research and understanding. Some knowledge gaps identified refer to bee health itself, whereas others seem to refer to methodological issues, i.e. to a set-up of a credible cost-effective monitoring scheme for bee health. Although the latter is probably most relevant in this context of the workshop, both are inter-linked and therefore presented together.

Research recommendations follow the three-section structure of the electronic consultation (questionnaire). Summary results of this e-consultation are also included here, based on the (notably extensive) answers from five respondents. Below, 'Bee' refers to the European honey bee (*Apis mellifera*), unless otherwise stated.

A. RESEARCH NEEDS CONCERNING BEE COLONY HEALTH**➤ Research needs identified during the discussions:**

- + There is no consensus yet on the variable(s) that are most indicative for “bee health” (but it won’t be a single one). A literature review on proxies for bee health would be most welcome. A baseline from existing and newly generated knowledge for what makes a “healthy colony” needs to be established. You may want to keep different outcomes (or combination of outcomes) in order to define bee health. More research is needed on natural (background) variation, as well. Therefore, it would not be good idea to restrict the variables right from the start of monitoring.
- + Need for research on the microbial profile of pollen and bees (bacteria and fungi, including yeasts), as this might be linked to exposure to chemicals and contaminants (e.g. pesticides, fungicides, antibiotics) and thus to the quality of the environment. Microbial profiles and environmental quality may subsequently affect fermentation of the pollen and hence the nutritional/health status of bees. Only few publications have linked bee health with pollen fermentation so far.
- + Comparative studies between ‘native’ (if still existing) and ‘cultivated’ bee populations, for example with regard to internal exposure to antibiotics.
- + A suggestion was raised on the role of wax, which is re-used, as a reservoir for diseases, chemical and/or contaminants. There was some disagreement on this, as no sound scientific arguments seem to exist. Some do not consider this a burning issue. Yet, some laboratory experiments could already be informative as to the possibility to sterilize wax before re-use (e.g. check on the effect of temperature/sterilization on resistance of pathogens). FYI: FASFC Scientific Committee is currently performing a study/risk assessment on the residue problem of wax and the potential influence on human health through the consumption of honey (products).

➤ Research needs identified by the E-consultation:

- + More research is needed on the impact of microbial diversity, including yeasts, associated with honey bees and hive health.
- + More research is needed on pathways and effects of contaminants and pathogens.

B. RESEARCH NEEDS CONCERNING STRESSORS**➤ Research needs identified during the discussions:**

- + The COLOSS Beebook on standard methods for *Apis mellifera* research is definitely a good starting point for many methodological issues. Yet, this is a science-centered work, and not (always) fit for monitoring purposes. Adaptations should thus be explored.

- + If non-*Apis mellifera* species are included, then new methods may need to be developed and validated. E.g., so far, there are no tests available for bumblebees or other wild bees.
- + Many questions on toxico-dynamics remain to be addressed. What chemicals & contaminants are present in which matrices? How/where are they accumulated/degraded/metabolized? What (if any) are their synergetic effects (cf. chemical cocktails)? Chronically toxic chemicals/contaminants (as opposed to acute chemicals/contaminants) prove a particular challenge here.
- + Chemicals/contaminants range beyond insecticides as well, also shown by findings of fungicides in bees.
- + What are the best matrices to monitor stressors? Bee bread and bee wax? It would be good to analyse both, but this is expensive. We need more residue data and thresholds for residues based on risk assessment for all different matrices.
- + Methods should screen for as many putative pathogens simultaneously. If only the more classic set of pathogens are studied (the 'usual suspects'), several other, nonetheless crucial, associations can be missed out
- + Research on the number of samples that are needed to have a representative outcome, on detection levels for chemicals & contaminants, and generally, on standardization/calibration/proficiency of methods and tools. (Cf. CODA-CERVA's experience on the failure of BeeDoctor methods.)
- + Research on (effects of) 'new' viruses/potential harmful contaminants.
- + Research on effects of the storage/preservation of samples.

➤ **Research needs identified by the E-consultation:**

- + Testing of tools (validate) to detect and quantify pathogen exposure, in particular for use as early warning systems;
- + Developing methods to detect chemicals/contaminants and metabolites;
- + Developing methods, identify relevant and useful indicators and reveal causal relations;
- + Microbial components in nectar and pollen as pathways for dispersal of micro-organisms; their effect on bee product quality;
- + Methodological aspects of contaminant detection and on microbial diversity associated with honey bees.
- + Treatment of bee pathogens. Good Management (Veterinary) Practices. Best methods; residue; risks for bee products; effective (or not).

C. RESEARCH NEEDS CONCERNING CONTEXTUAL VARIABLES

Additional contextual variables (besides landscape & genetics) playing an important role in bee health were identified: biotic context, governance and local knowledge.

➤ *Research needs identified during the discussions:*

- + Research on the capacity of other species in acting as a reservoir for disease (epidemiology). For example, the same pathogens may be present in both bumble bees & honey bees; when bumble bees carry a pathogenic agent, is it a real threat to honey bees?
- + Need for similar research in different regions, as EU policy cannot be based on a single region (results might be very context dependent). We need a sound basis for extrapolation across regions/scales.
- + Research on the importance of genetic diversity/bee varieties with regard to susceptibility for disease. We noticed contradicting answers in the questionnaire: genetic diversity is important (some bee varieties might be more resistant to diseases than others); nonetheless, all bee species are susceptible. Improve natural resistance/tolerance against bee pathogens (selection methods, good Bee-Keeper Practices).
- + Research to know how to account for the size of sampling areas (e.g. it might depend N-S; industrial versus rural; etc.). What is the most relevant spatial measure to take into account?
- + Research on the importance of local knowledge and governance.

D. ADDITIONAL ISSUES RAISED DURING THE DISCUSSIONS

- + We need central databases collecting data from all types of analyses, as well as reference material. This already exists, both on a national (FASFC) and a European level (ANSES). In EPILOBEE, existing and well-functioning databases for fieldwork (FASFC: FOODLIMS) and laboratory results (FASFC: Extlab ; CODA-CERVA: LIMS) databases have been used to handle/store the data, as well as a newly developed (ANSES) international database. From all of these recipients, all partners involved can obtain the extracted data for analysis. The advice would be to (1) stick to these databases as much as possible; and/or (2) if an additional database is deemed necessary, to make sure it can easily communicate / is compatible-complementary to the existing ones (especially the Belgian ones, to avoid multiple data-registrations).
- + Questionnaires can create scientifically useful data in a cheap way. However, the individual questions need to be well-thought-out in advance. Particular attention needs to be paid to a consensus=harmonized list of definitions and nomenclature.