



A US national survey of honey-bee pests and diseases

R. Rose ⁽¹⁾, J. Pettis ⁽²⁾, K. Rennich ⁽³⁾ & D. vanEngelsdorp ⁽³⁾

(1) United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ)

(2) United States Department of Agriculture (USDA) Agricultural Research Service (ARS) Bee Research Laboratory (BRL)

(3) University of Maryland, USA

The designations and denominations employed and the presentation of the material in this article do not imply the expression of any opinion whatsoever on the part of the OIE concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries.

The views expressed in this article are solely the responsibility of the author(s). The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by the OIE in preference to others of a similar nature that are not mentioned.

Keywords: ABPV – acute bee paralysis – *Apis cerana* – *Apis mellifera* – black queen cell virus – BQCV – deformed wing virus – DWV – honey bee – honey bee disease – honey bee pest – IAPV – *Nosema* – nosemosis – *Tropilaelaps* – United States – *Varroa* – varroosis.

Introduction

A decline in honey-bee health has been documented for years. Honey-bee health challenges are attributable to parasites, diseases, poor nutrition and environmental toxins. In the United States (USA), a national survey of honey-bee pests and diseases has been funded annually since 2009 by the United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) and coordinated in collaboration with the USDA Agricultural Research Service (ARS) Bee Research Laboratory and the University of Maryland.

This survey continues to document the prevalence and load of various honey-bee diseases, parasites and/or pests. Of particular emphasis is an attempt to document the likely absence of certain honey-bee parasites and diseases in the USA; specifically, the absence of the parasitic mite *Tropilaelaps* and other exotic threats, such as *Apis cerana* and slow bee paralysis virus (SBPV). To maximize the information gained from this survey effort, collected samples are also analyzed for honey-bee diseases and parasites known to be present in the USA. This information will help to place current and future epidemiological studies in context and thus may indirectly help investigations of emerging conditions such as colony collapse disorder (CCD).

A pilot survey in three states was initiated in 2009 to test the survey methodology. In 2010, a limited national survey was conducted in 13 states to expand and augment the baseline pest and pathogen data collected from the pilot study. From 2011 to 2013, full-scale national surveys were conducted in 30 to 34 states. We anticipate continuing this effort in 2014 to 2015.

This cross-country survey is the most comprehensive honey-bee pest and health survey to date, and provides essential disease and pest-load baseline information.

Methods

A composite sample of adult bees was collected from eight colonies in a selected apiary from 25 different beekeeper operations from 2009 to 2012 and from 24 apiaries, representing 24 beekeepers, in 2013, for each participating state or territory (except for California where sampling was doubled).

Samples were usually collected by state department of agriculture employees, who were instructed to sample colonies in apiaries that had at least ten colonies. When feasible, samplers were asked to select apiaries managed by up to 10 queen producers within their state. Of the remaining operations sampled, samplers were asked to select one of two from migratory operations (which

moved out of state and returned prior to sampling) and one of two from stationary operations (which do not move out of the state but may move within the state). When selecting migratory and stationary operations to sample, samplers were asked to section their state into four quadrants and choose an equal number of operations randomly from each quadrant. The selection criteria were meant to prioritize sampling of high-risk or high-impact operations (e.g. migratory or queen operations) while still attempting to provide data that were representative of the state.

In the apiary from a selected operation, three different composite samples were collected from eight colonies:

- a) a sample of brood-frame debris to detect *Tropilaelaps* [1]
- b) adult worker bees collected in alcohol (Fig. 1) to detect and quantify *Varroa* mites, *Nosema* spores and *Apis cerana*
- c) adult worker bees collected in a live-bee-shipping box (Fig. 2) for the analysis of viruses, e.g.:
 - acute bee paralysis virus (ABPV)
 - black queen cell virus (BQCV)
 - chronic bee paralysis virus (CBPV)
 - deformed wing virus (DWV)
 - Israeli acute paralysis virus (IAPV)
 - Kashmir bee virus (KBV)
 - slow bee paralysis virus (SBPV).

Details of the protocol for the survey can be found on the APHIS website at: www.aphis.usda.gov/plant_health/plant_pest_info/honey_bees/downloads/sampling_protocol.pdf

Results

There have been no detections of slow bee paralysis virus, the only exotic virus sampled in the survey. No diseases or parasites of bees not already known to exist in the country were discovered. Over the four-year sampling period, there was no evidence of exotic *Tropilaelaps* mites (Fig. 3) or *Apis cerana*.

As 2009 only involved the collection of samples from three states, results from this year are not necessarily comparable to those of other years, and for that reason are not given in this report.



Fig. 1
Bees are shipped in alcohol for *Nosema* and *Varroa* analysis

Varroa mites have been observed in all sampled regions, with the exception of the Hawaiian Islands of Maui, Kauai and Molokai. Mites were detected in approximately 90% of all sampled apiaries from 2010 to 2012. While the prevalence of apiaries with detectable levels of *Varroa* did not change, the overall mite load in infested apiaries increased in 2011 and 2012 from 2010 levels (Fig. 4). While the economic threshold for *Varroa* mites is seasonally and regionally specific, generally an average load of over 3 mites per 100 bees is of concern. An alarming result shows that, in 2012, 52.8% of the samples that tested positive for *Varroa* exceeded the lower threshold for possible damage to a colony from the mite.

Nosema spores were found in 47% to 57% of all sampled apiaries from 2010 to 2012 (Fig. 5). *N. cerana* was the predominant species detected, with fewer than 1.5% of all sampled apiaries testing positive for *N. apis* in 2011 and 2012.

Israeli acute paralysis virus (IAPV), acute bee paralysis virus (ABPV) and black queen cell virus (BQCV) were



© Dennis van Engelstorp (UMD)



Fig. 2
Bees are shipped live in a ventilated box for viral analysis

© Bart Smith (USDA ARS)



Fig. 3
Comparison of a *Varroa* mite (left) to a *Tropilaelaps* mite (right)

commonly found, with their prevalence apparently fluctuating between states and seasons. The most commonly identified viruses were DWV and BQCV, which were found in all states sampled.

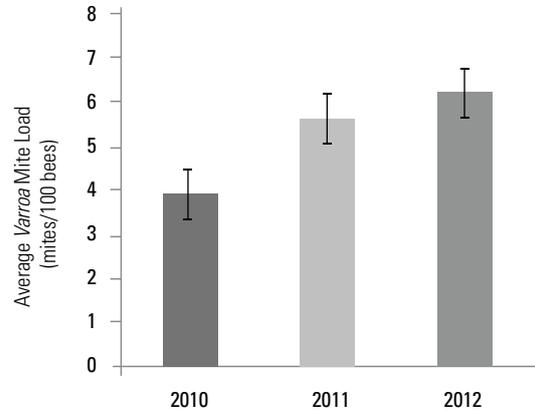


Fig. 4
Average *Varroa* mite load (95% confidence interval shown)

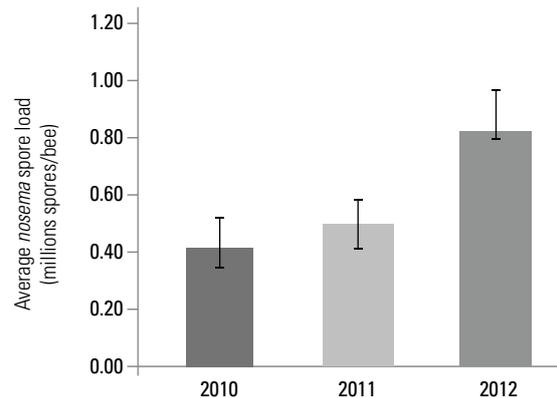


Fig. 5
Average *Nosema* spore load (95% confidence interval shown)

Discussion

Pollination is responsible for USD 15 billion in added crop value in the USA each year. Specialty crops such as nuts, berries, fruits and vegetables are particularly reliant on honey-bee pollination for fruit set. Of the 2.6 million colonies of bees in the USA, the almond crop in California alone requires 1.5 million colonies, and this need is projected to increase significantly in the future. There is growing concern that, if honey-bee health cannot be improved, beekeepers will be unable to meet the demand for this and other crops.

The USDA sponsored the National Survey of Honey Bee Pests and Diseases with the primary goal of validating the belief that the exotic parasitic mite *Tropilaelaps*, the problematic *Apis* species *A. cerana*, and the slow bee paralysis virus (SBPV) are not present in the country. This information is required to justify the continued blocking of honey-bee exports from countries that either have these species of concern, or do not have a survey protocol in place to ensure that these species are not present. Further, the survey provided an opportunity to establish baseline information on the prevalence of honey-bee diseases and parasites known to be present in the USA.

Tropilaelaps spp., an Asian parasitic mite (several species in the genus *Tropilaelaps* are recognised) of honey bees, feeds on honey-bee brood. Its parasitic feeding actions act as vectors for viruses, weaken or kill parasitized brood, and can cause infected colonies to abscond which then spread the mites to new areas (Fig 3). *Tropilaelaps* mites can complete their life cycle in one week, and thus this mite can out-compete the *Varroa* mite when both mites are present in a hive. Currently, there are no known *Tropilaelaps* mites in the USA.

This survey has also confirmed that the exotic *Apis cerana*, or Asian honey bee, and slow bee paralysis virus (SBPV) are not known to be in USA apiaries. *A. cerana* is now confirmed in northern Australia. It is smaller but very similar in appearance to *A. mellifera*, well adapted to warmer climates, builds smaller colonies, and is known to swarm many times during the year. In tropical areas (e.g. the Solomon Islands), *A. cerana* has been shown to out-compete *A. mellifera* in nectar and pollen gathering and exhibits a propensity for robbing European honey-bee stores. Its honey yield is far less than *A. mellifera*, making it a less valuable bee for commercial honey production.

Identifying exotic species was the primary objective of this survey; a secondary goal was to acquire baseline information on the levels of other honey-bee diseases and parasites known to be present in the USA. *Varroa* mite loads were seen to increase in each year of the survey. It is not known what the cause is but possible explanations include fewer beekeepers treating their hives for *Varroa*, mites becoming resistant to the available treatments or an improved snapshot of the actual mite infestation across the country.

The survey results are used to gauge the overall health of colonies, to create a baseline disease level, and to facilitate the interpretation of ongoing and future epidemiological studies. These baseline data, including historic data from research institutions such as the USDA ARS Bee Research Laboratory and other ongoing field sampling and management surveys, have been incorporated into a single database as part of the Bee Informed Partnership, which is funded by the USDA National Institute of Food and Agriculture.

**More information about the Bee Informed Partnership:
www.beeinformed.org**

**More information about the national survey of honey bee pests and diseases, including annual reports:
www.aphis.usda.gov/planthealth/honeybees**

Acknowledgements

We would like to acknowledge the beekeepers who voluntarily allowed their hives to be sampled and the state apiary specialists who collected samples. We also acknowledge the teams at the USDA ARS Bee Research Laboratory and University of Maryland who have contributed to this survey.

Reference

1. Pettis J.S., Rose R., Lichtenberg E.M., Chantawannakul P., Buawangpong N., Somana W., Sukumalanand P. & vanEngelsdorp D. (2013). – A rapid survey technique for *Tropilaelaps* mite (Mesostigmata: Laelapidae) detection. *J. econ. Entomol.*, **106**, 1535–1544.

