



The COLOSS *BEEBOOK* Volume II, Standard methods for *Apis mellifera* pest and pathogen research: Introduction

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Received 29 July 2013, accepted for publication 30 July 2013.

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Keywords: COLOSS, *BEEBOOK*, honey bee, *Apis mellifera*, research, standard methods, laboratory, field, pests, disease, diagnosis

The COLOSS *BEEBOOK* is a practical manual compiling standard methods in all fields of research on the western honey bee, *Apis mellifera*. The COLOSS network was founded in 2008 as a consequence of the heavy and frequent losses of managed honey bee colonies experienced in many regions of the world (Neumann and Carreck, 2010). As many of the world's honey bee research teams began to address the problem, it soon became obvious that a lack of standardized research methods was seriously hindering scientists' ability to harmonize and compare the data on colony losses obtained internationally. In its second year of activity, during a COLOSS meeting held in Bern, Switzerland, the idea of a manual of standardized honey bee research methods emerged. The manual, to be called the COLOSS *BEEBOOK*, was inspired by publications with similar purposes for fruit fly research (Lindsley and Grell, 1968; Ashburner, 1989; Roberts, 1998; Greenspan, 2004).

Production of the *BEEBOOK* began after recruiting international experts to lead the compilation of each research domain. These senior authors (first in the author list) were tasked with recruiting a suitable team of contributors to select the methods to be used as standards and then to report them in a user-friendly manner (Williams *et al.*, 2012).

The initial *BEEBOOK* project is divided into three volumes: The COLOSS *BEEBOOK*, Volume I: Standard methods for *Apis mellifera* research; The COLOSS *BEEBOOK*, Volume II: Standard methods for *Apis mellifera* pest and pathogen research; and The COLOSS *BEEBOOK*, Volume III: Standard methods for *Apis mellifera* product research.

Papers in the *BEEBOOK* are organized according to research topics. The authors have compiled those methods selected as the 'best' in each domain of research. These methods are for both laboratory and field research. We recognize that it is often necessary to use methods from several domains of research to complete a given experiment with honey bees. Whenever there is a need for multi-disciplinary approach, the manual describes the specific instructions

necessary for a given method, and cross references all general methods from other papers as necessary. For example, identifying a subspecies of honey bee can be done using genetic tools. The general instructions to use microsatellites are given in the molecular methods paper (Evans *et al.*, 2013), whereas the specific method appropriate for subspecies identification is described in the paper on ecotypes and subspecies identification (Meixner *et al.*, 2013). Consequently, one would visit the ecotypes paper to determine how to identify a given subspecies. That paper will then refer to the molecular methods paper when discussing microsatellites specifically.

The reader may wonder about the difference between the *BEEBOOK* and existing standards provided by the Office International des Epizooties (OIE), and the European Organisation for Economic Co-operation and Development (OECD). In the *BEEBOOK*, we often refer to OIE, OECD, and other standards, since they describe methods to diagnose pests and diseases (OIE) or to perform, for example, routine analyses for toxicity tests (OECD). The *BEEBOOK*, however, goes well beyond diagnosis and routine analyses by describing the methods to perform research on the honey bee and associated organisms. Where necessary, the *BEEBOOK* recognizes existing standards such as those provided by the OIE and OECD, and presents a harmonized compendium of research methods, written and reviewed by an international team of scientists.

In addition to producing a bench-friendly manual, and in an effort to make the methods broadly available, every paper forming the *BEEBOOK* is also available as open access articles in several special issues of the *Journal of Apicultural Research*.

To further build on the availability of digital media, a novel concept was developed around the manual. An online version of the manual was created, where each method can be discussed and improvements suggested. Development work on the online *BEEBOOK* platform started in 2009, and the current iteration can be found at

www.coloss.org/beebook. On the platform, each webpage describing a method has a comment field, which can be used to suggest changes or additions. Users can thus assist with the improvement and further development of the *BEEBOOK*. Once sufficient updates have accumulated online, a new print version of the manual can then be edited and published. Such a Wiki-like tool is especially useful for following fast evolving fields, such as for molecular protocols.

The *BEEBOOK* is a tool for all who want to do research on honey bees. It was written in such a way that those new to honey bee research can use it to start research in a field with which they may not be familiar. Of course, such an endeavour is often limited by the availability of complex and expensive machinery and other equipment. However, provided access to and training on the necessary equipment are secured, the instructions provided in the *BEEBOOK* can be followed by everyone, from undergraduate student to experienced researcher. All details on how to implement instructions are given.

The editors and author team hope that the *BEEBOOK* will serve as a reference tool for honey bee and other researchers globally. As with the original *Drosophila* book that evolved into a journal where updates and new methods are published, we hope that the honey bee research community will embrace this tool and work to improve it. The online platform is open for everyone to use and further contribute to the development of our research field.

The study of honey bee pests and pathogens is globally relevant and remarkably varied. The major impact of bee pests and pathogens on the well-being of honey bees has led to considerable research in this field. Consequently, the editorial and author team felt it necessary to develop a volume focused solely on protocols related to studying the pests and pathogens of western honey bees.

This effort resulted in the production of Volume II of the COLOSS *BEEBOOK*: Standard methods for *Apis mellifera* pest and pathogen research. Here, 98 international scientists from 22 countries have collaborated to produce 12 chapters including over 500 protocols related to studying honey bee pests and pathogens. The chapters are grouped into three sections. The first section focuses on protocols related to honey bee epidemiology. They include: epidemiology itself (vanEngelsdorp *et al.*, 2013) and survey methods for estimating colony losses (van der Zee *et al.*, 2013). The second section includes chapters focused on honey bee pests and they include: small hive beetles (Neumann *et al.*, 2013), tracheal mites (Sammataro *et al.*, 2013), *Tropilaelaps* mites (Anderson *et al.*, 2013), varroa (Dietemann *et al.*, 2013), and wax moths (Ellis *et al.*, 2013). The third and final section includes chapters listing protocols for studying honey bee pathogens. Included in this section are chapters on: American foulbrood (de Graaf *et al.*, 2013), European foulbrood (Forsgren *et al.*, 2013), fungi (Jensen *et al.*, 2013), nosema (Fries *et al.*, 2013), and viruses (de Miranda *et al.*, 2013). It was our intention to be exhaustive when working with senior authors to develop the chapters included in this volume. We

hope that we have included all of the relevant research pests and pathogens (including emerging ones such as *Tropilaelaps* spp.), but recognize that, as with any undertaking of such size, we may have overlooked important topics, and other pests and pathogens may emerge in the future. If so, this can be addressed via the online *BEEBOOK* platform (www.coloss.org/beebook), leading to an improved version in the future. We hope that the information provided herein will assist everyone interested in investigating the pests and pathogens of the honey bee.

The western honey bee remains a fascinating research topic, and one of timeless significance considering the bee's importance for food production and ecosystem sustainability. We hope that we and our team of international colleagues have produced a resource that will be useful into perpetuity. We also hope that you will find research on honey bees, their pests and pathogens to be professionally rewarding and intellectually stimulating.

Acknowledgements

The COLOSS (Prevention of honey bee COLony LOSSes) network aims to explain and prevent massive honey bee colony losses. It was funded through the COST Action FA0803. COST (European Cooperation in Science and Technology) is a unique means for European researchers to jointly develop their own ideas and new initiatives across all scientific disciplines through trans-European networking of nationally funded research activities. Based on a pan-European intergovernmental framework for cooperation in science and technology, COST has contributed since its creation more than 40 years ago to closing the gap between science, policy makers and society throughout Europe and beyond. COST is supported by the EU Seventh Framework Programme for research, technological development and demonstration activities (Official Journal L 412, 30 December 2006). The European Science Foundation as implementing agent of COST provides the COST Office through an EC Grant Agreement. The Council of the European Union provides the COST Secretariat. The COLOSS network is now supported by the Ricola Foundation - Nature & Culture.

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