

Le Corps professoral de
Gembloux Agro-Bio Tech - Université de Liège vous prie
de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Monsieur LECLERCQ Gil,

**Titulaire d'un diplôme de master bioingénieur en sciences et technologies de l'environnement,
à finalité spécialisée,**

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,
le 20 septembre 2017, à 15 heures précises (personne ne sera admis après cette heure),
en l'auditorium Z1 (Zoologie, bât. 9),
Passage des Déportés, 2, à 5030 GEMBOUX.

Cette dissertation originale a pour titre :

« Phenotyping hygienic behavior and studying diversity in honey bees
(*Apis mellifera* L.): methodological issues and solutions ».

Le jury est composé comme suit :

Président : Prof. L. WILLEMS, Vice-président du Département AGROBIOCHEM,
Membres : Prof. F. FRANCIS (Promoteur), Prof. N. GENGLER (Copromoteur), Prof. M.
GEORGES, Dr B. K. NGUYEN, Dr J. VAN DEN HEUVEL (Wageningen University & Research,
Pays-Bas), Prof. D. VANENGELSDORP (University of Maryland, USA).

Abstract

Honey bees (*Apis mellifera* L.) are a crucial resource for world agriculture. The global honey bee population has largely increased over the last five decades. In contrast, honey bees have been declining in several regions, especially in the northern hemisphere. Among the factors responsible for these regional declines, the parasitic mite *Varroa destructor* plays a central role and is considered as the main threat for apiculture. A sustainable solution to the problems caused by *V. destructor* is to breed *Varroa*-resistant honey bees. It can be achieved by directly importing *Varroa*-resistant – or putatively resistant – honey bees. However, in this research project, in Belgium, the choice was made to study the diversity of honey bees in Wallonia, and to select, within this “local” diversity, *Varroa*-resistant honey bees. This approach requires methods to accurately phenotype *Varroa*-resistance traits, and methods to study the diversity in honey bee populations. In this thesis, I decided to work on these methods, which later on will maybe allow reaching these goals. Two main objectives were developed: (1) solving the controversy and methodological issues regarding the quantification of hygienic behavior in honey bee colonies, and (2) designing a new method to study the diversity of honey bee admixed populations covering a large-scale area, using pool-based sequencing data. The hygienic behavior of workers contributes to the social immunity of honey bee colonies. It consists in detecting and removing unhealthy or dead brood. In this thesis, we reviewed the drawbacks and benefits of hygienic behavior, as well as the bioassays designed to quantify this behavior in honey bee colonies. We concluded that, while hygienic behavior was efficient against some brood diseases, it was difficult to draw any definitive conclusion on the efficiency of this behavior against *V. destructor*. Hygienic behavior likely contributes to *Varroa*-resistance, but the controversy is fueled by the use of inappropriate bioassays to quantify the hygienic removal of *Varroa*-infested brood. In our experiments, we showed that a commonly used bioassay, the freeze-killed brood removal bioassay, was unreliable to approximate the benefits arising from the hygienic removal of *Varroa*-infested brood. In a second part, we reviewed how human has contributed to reshape the diversity of honey bee populations worldwide, except in Africa. Human management was illustrated to lead to increase the proportion of admixed populations, sometimes to the detriment of subspecies populations. A new approach to study the admixture of hybrid honey bee populations was presented. It was based on a reduced representation of the genome (through genotyping-by-sequencing). In this approach, we enabled the use of pool-based sequencing data by simulating an individual genotype for each pool. Finally, some conclusions and discussion were brought on a few perspectives and research avenues about (1) the phenotyping of hygienic behavior towards *Varroa*-infested brood, and (2) the study of admixture in honey bee populations.