Genetic selection of the honey bee (*Apis mellifera* L.) in a northern climate

Apimondia 2019

Breeding for disease / Mite resistance II

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CRSAD
Centre de recherche en sciences animales de Deschambault

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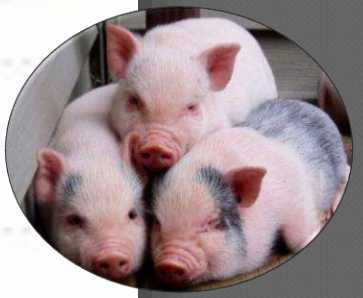
Selection in animal productions

Selection allows to concentrate and intensify desirable characteristics and minimize those that are undesirable



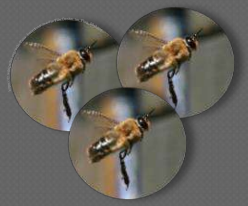
Genetic selection using quantitative genetic, has allowed to obtain spectacular progress in many animal productions

(Zuidhof et al., 2014; Minvielle, 1990)

Difficulties in the honey bees…

In honey bees, genetic selection is barely used

- Complex reproduction



Polyandric reproduction

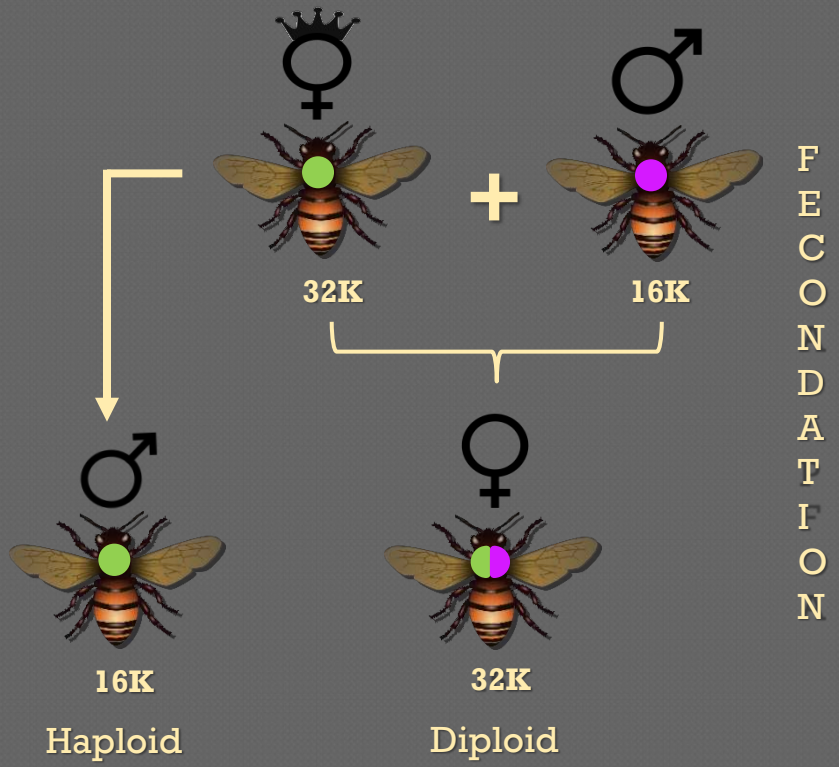
Mating on flight

Spermatozoids stored in spermatheca

&

PARTHENOGENESIS

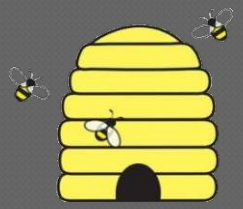
- Complex genetic model

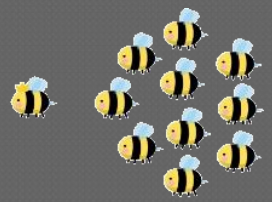


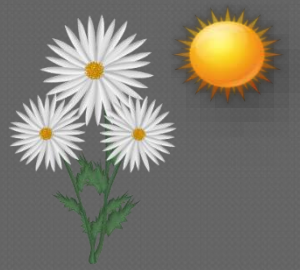
(Woyke, 1964; Winston, 1987; Laidlaw & Page, 1997; Snodgrass & Erikson, 2008)

Genetic selection is possible today

- Introduce genetic selection in an existing honey bee breeding program







$$\mathbf{P_{henotype} = G_{enotype} + E_{nvironment}}$$

Additive effects + Interactive effects

Breeding value

- Preliminary work on heritability of characteristics: Can characteristics be selected?

h^2

High: genetic progress quickly

Low: genetic progress slow

(Bienefeld & al., 2007 ; Minvielle, 1990)

Objectives

Establish a selection genetic program

Part I.

Determine heritability of performance traits important for Canadian beekeeping industry

Part II.

Introduce genetic evaluation in Centre de Recherche en Sciences Animales de Deschambault (CRSAD) honey bee breeding program

Part III.

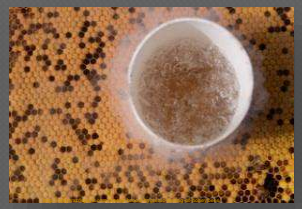
Determine if drone selection has an impact on the breeding value and if it can improve genetic gain

Choice of characteristics important for Canadian beekeeping industry

Parts I., II. et III.

Health

Hygienic behaviour



Freeze-killed brood test

Cleaning capacity of the colonie (%)

Varroa destructor infestation level

Natural mite fall method

Sticky boards

Production

Honey production

Weighing honey super

Kg honey / colony

Rusticity

Winter consumption

Kg sucrose syrup consumed

Before / after winter

Spring development

Brood surface (early June)

Nb of all cells occupied by immature workers honey bees

(Chapleau ,1988; Harris et al., 2003; Perez-Sato et al., 2009; Giovenazzo & Dubreuil, 2011;Pernal & Clay 2015)

Material & methods

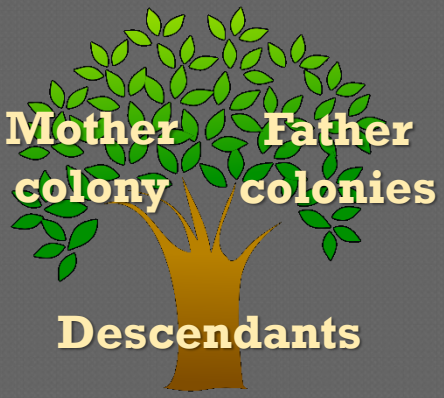
Part I.

- Pedigree database

2010-2019

CRSAD breeding program

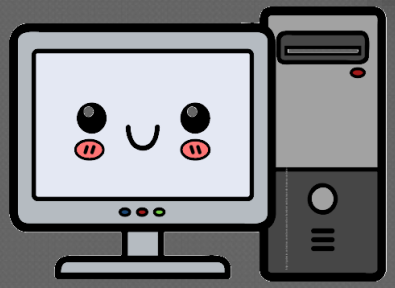
100 colonies / year



- Performance database

Colonies
- Rusticity criterium
- Production criterium
- Health criterium

Estimation heritabilities of performance traits



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BLUP-animal statistic model
(Bienefeld & al., 2007)

Results - Heritability

$$Heritability,\ h^2 = \frac{Additive\ genetic\ variance}{Phenotypic\ variance}$$

	h^2_{CRSAD}	
Honey production	0.20	✓
Spring development	0.36	✓
Winter consumption	0.10	✓
Hygienic behavior	0.18	✓
Varroa destructor infestation level	0	✗

$h^2 < 0.2 \rightarrow$ low

$h^2 > 0.4 \rightarrow$ hight

(Minvielle, 1990)

Results – Genetic correlations

Genetic correlations indicate the tendency of 2 characteristics to vary in the same direction (+), in the opposite direction (-) or to be unrelated.

	Honey production	Spring development	Winter consumption	Hygienic behavior
Honey production				
Spring development	0.50			
Winter consumption	0.02	0.17		
Hygienic behavior	0.11	0.05	0.23	

(Minvielle, 1990)

Pearson correlation coefficient

Conclusion

$\frac{4}{5}$ Characteristics of interest are heritable

✓ Characteristics of interest are unrelated or positively correlated

↓

Several characteristics can be selected simultaneously

Bee Happy !!!

Our genetic selection will be efficient!

Projet scope

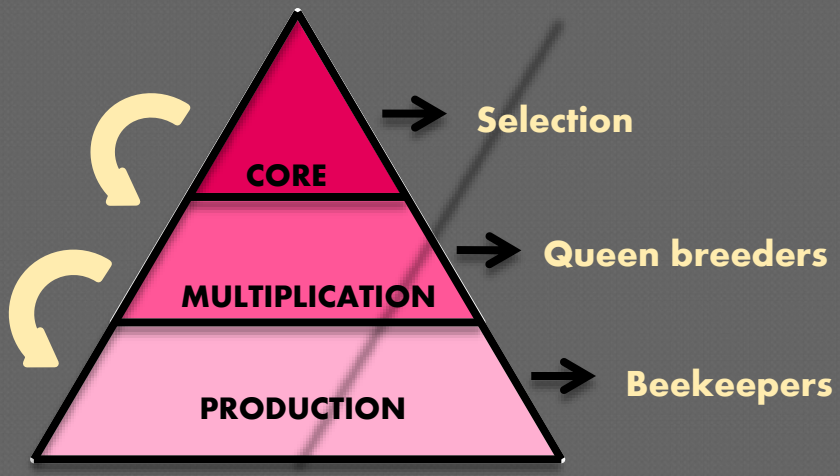
Improve honey bee genetic in Quebec:

Adapted to northern climates

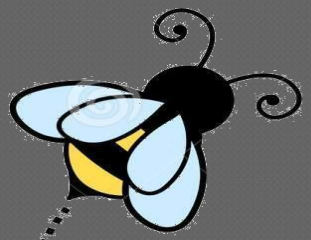
Productivity

Development

Overwintering capacity



Next step:
Spreading genetic progress!



Thanks !

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