Effect of a common fungicide on gene expression and activity of honey bees

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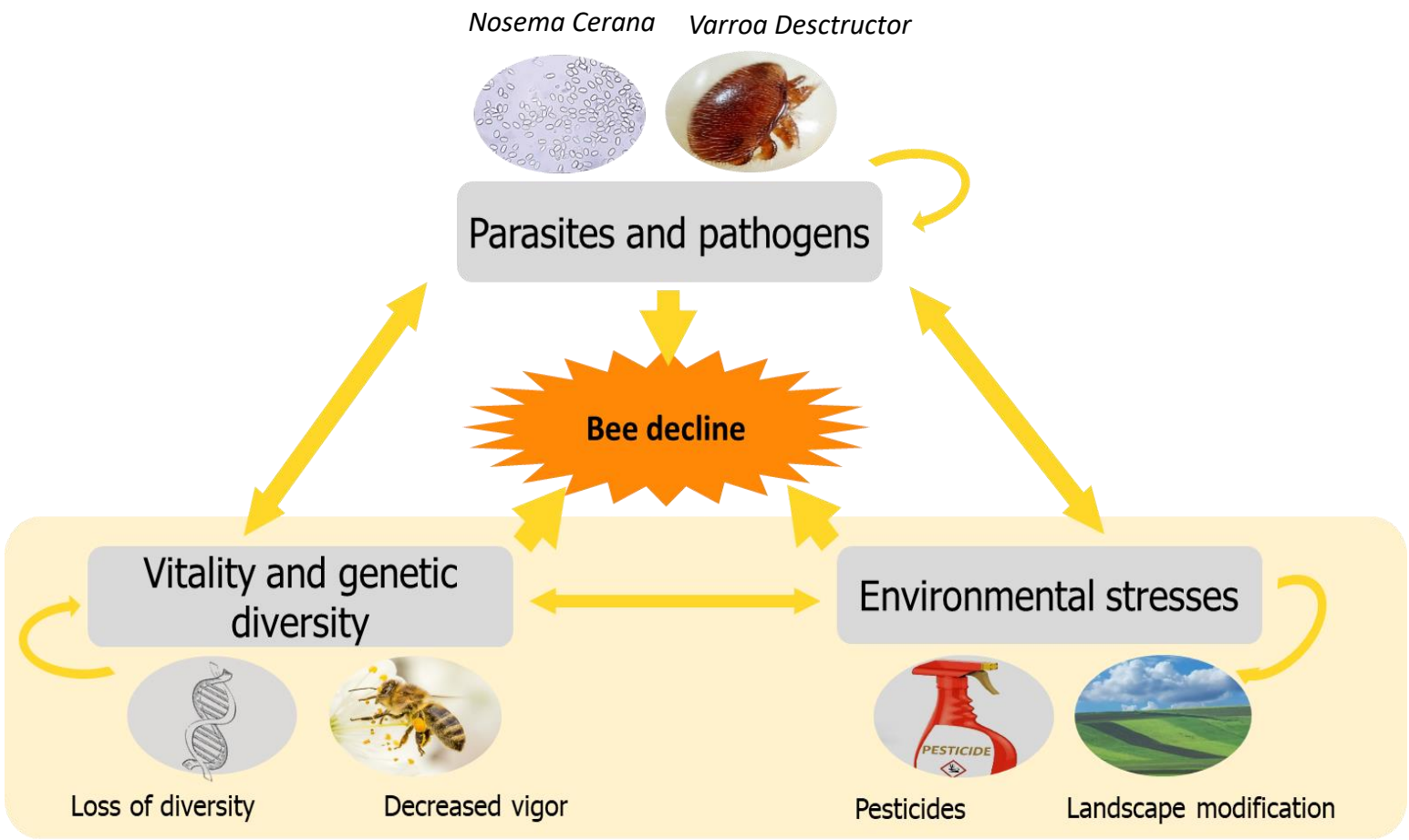
INRAE, Le Magneraud

28 - 08 - 2022

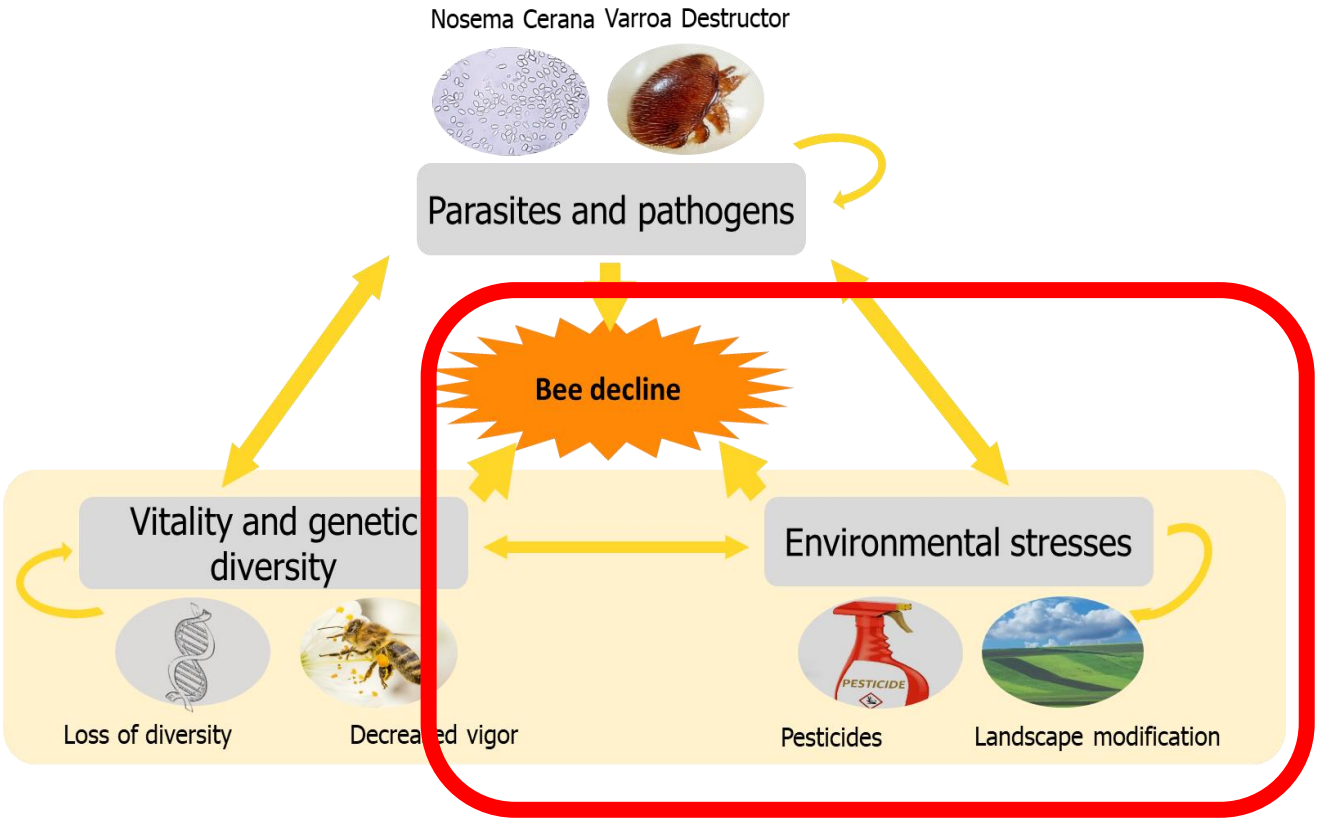
IUSSI-SF Toulouse 28-30 Août 2023

Bee decline: a multifactorial cause



Sánchez-Bayo *et al.*, *Biol Cons* (2019)
Müller *et al.*, *Basic and Applied Ecology* (2018)
Goulson *et al.*, *Science* (2015)
Potts *et al.*, *Trends in Ecology & Evolution* (2010)

Pesticides



- Fungicides not well documented
- Non-target species are complex to study and likely underestimated
- Sublethal and combined effects on bees

Sánchez-Bayo *et al.*, *Biol Cons* (2019)
Müller *et al.*, *Basic and Applied Ecology* (2018)
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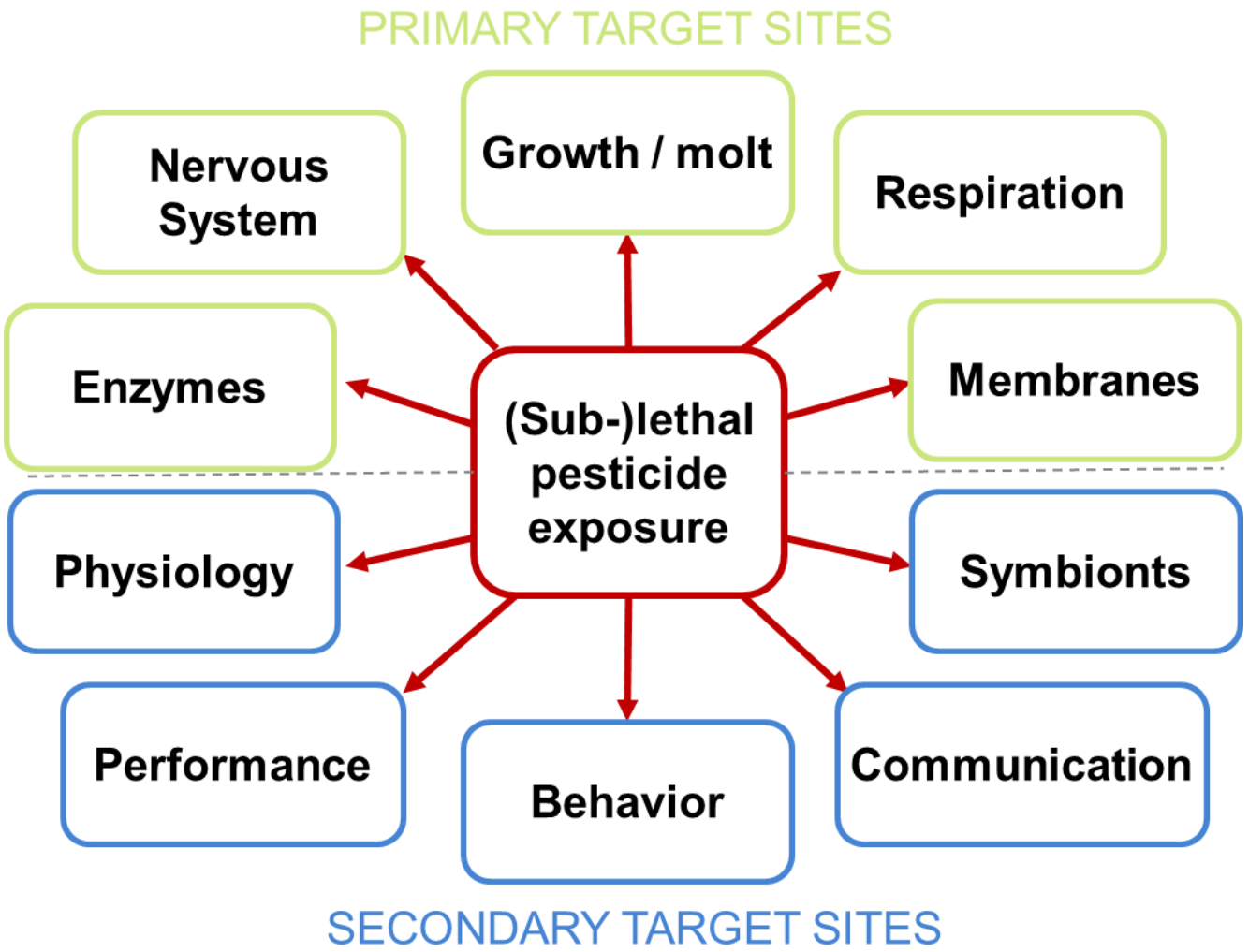
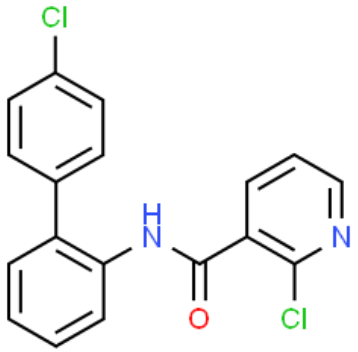
Sublethal effects of pesticides



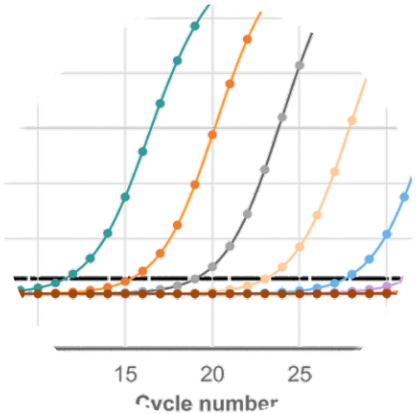
Effects of pesticides on individuals

Sánchez-Bayo *et al.*, *Biol Cons* (2019)
Müller *et al., Basic and Applied Ecology* (2018)
Goulson *et al., Science* (2015)
Potts *et al., Trends in Ecology & Evolution* (2010)

What is the impact of exposure to Boscalid on the physiology and capacities of *Apis mellifera*?



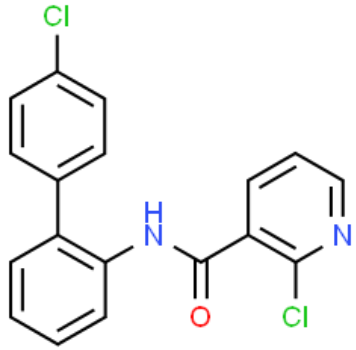
Boscalid



Impact of a fungicide

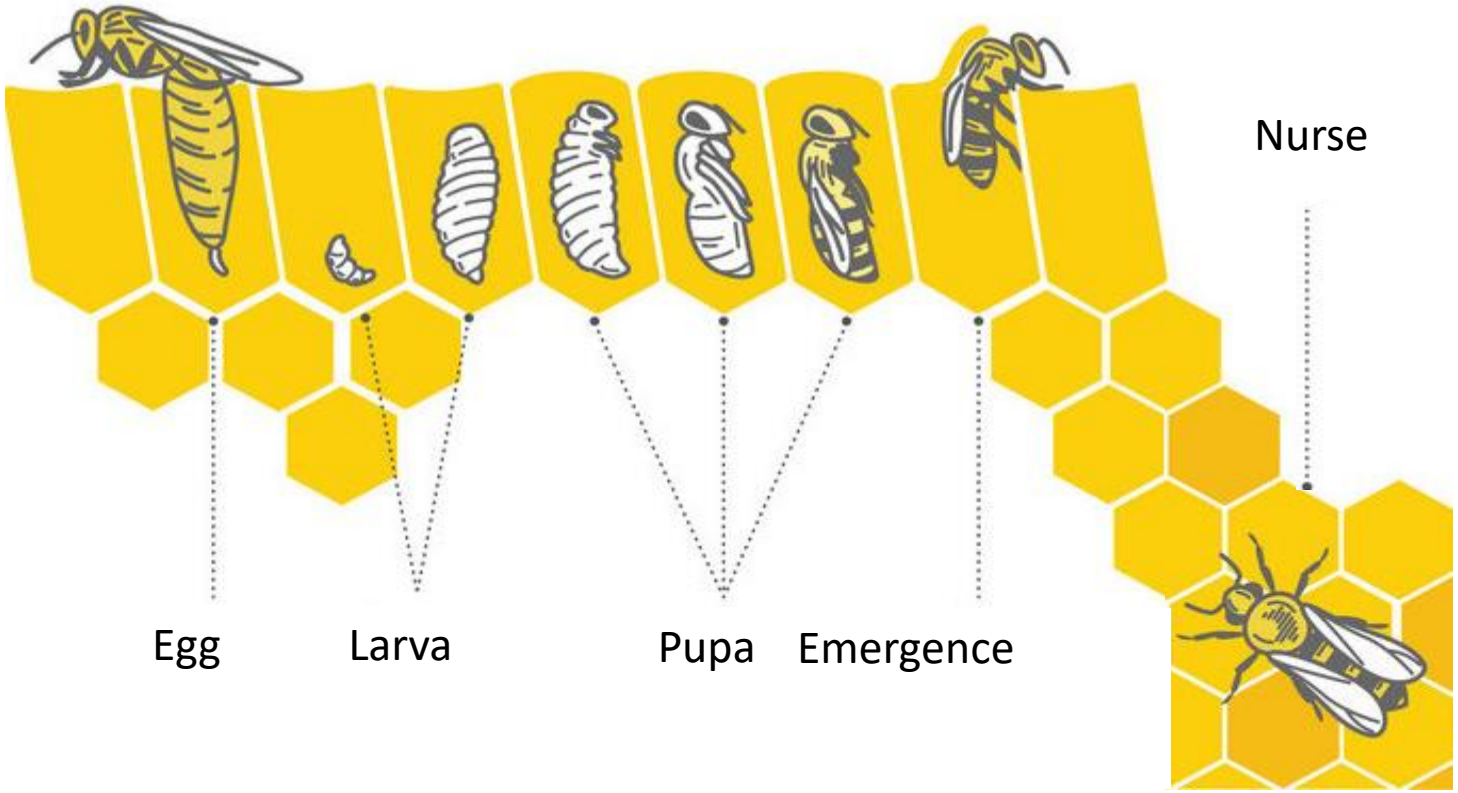
Boscalid: Fungicide

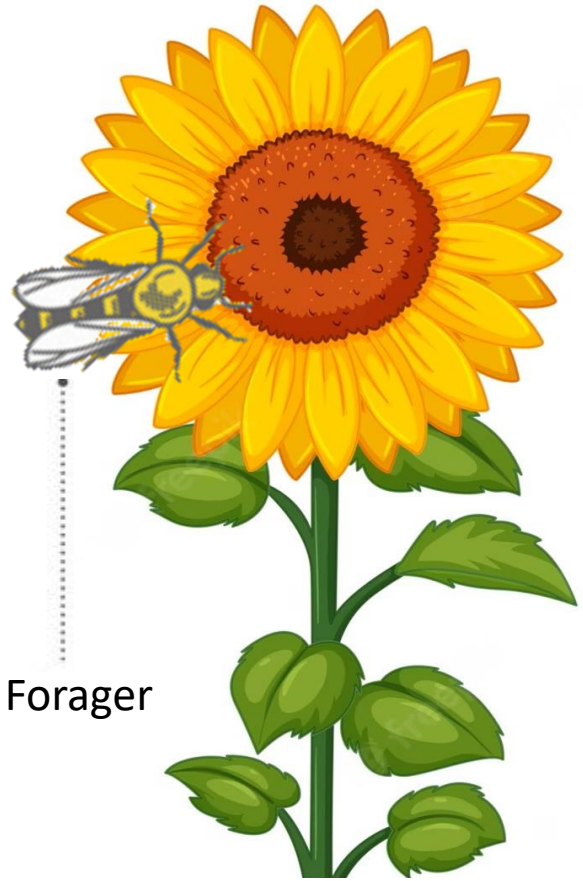
- Carboxamide family
- Inhibits ATP production (blocks ATP activity of enzyme the succinate dehydrogenase)



- Against brown rot, gray mold...
- In the orchards, on rapeseed...
- High dose (high LD50)
- In many commercial solutions (Pictor Pro ®, Pristine®, Cantus ® ....)

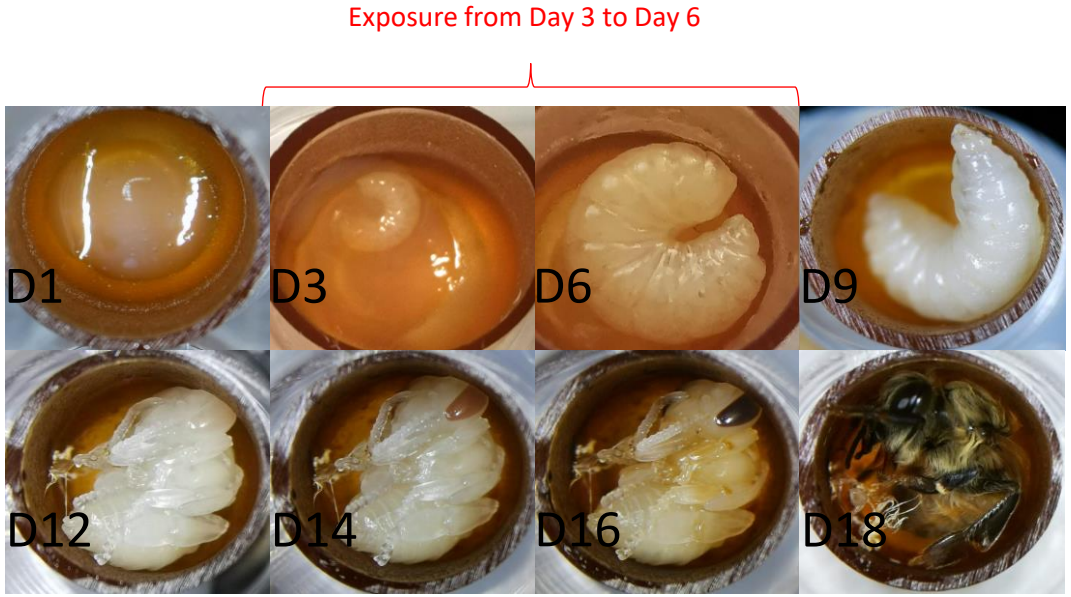
Life cycle of *Apis mellifera* workers





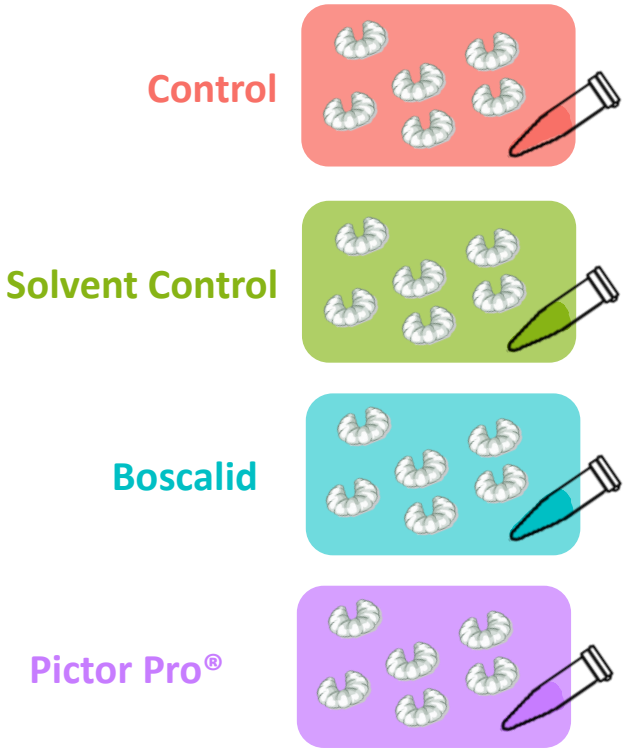
Chronic exposure in the larval phase

Protocol developed by INRAE and adopted at the OECD



- Dietary exposure
- Representative dose of the one found in the environment

Modality of exposure

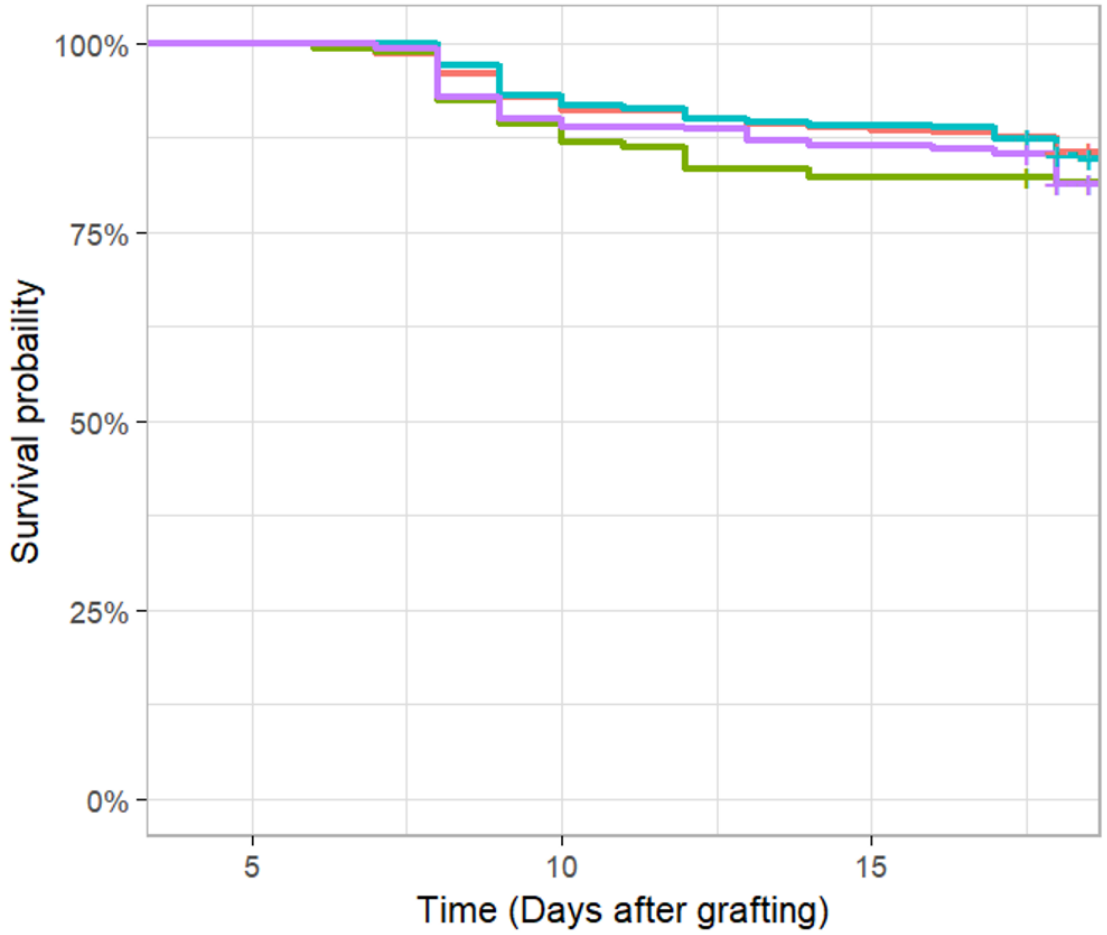


In vitro rearing

Experimental approach *in vitro*

Mortality
Delays emergence

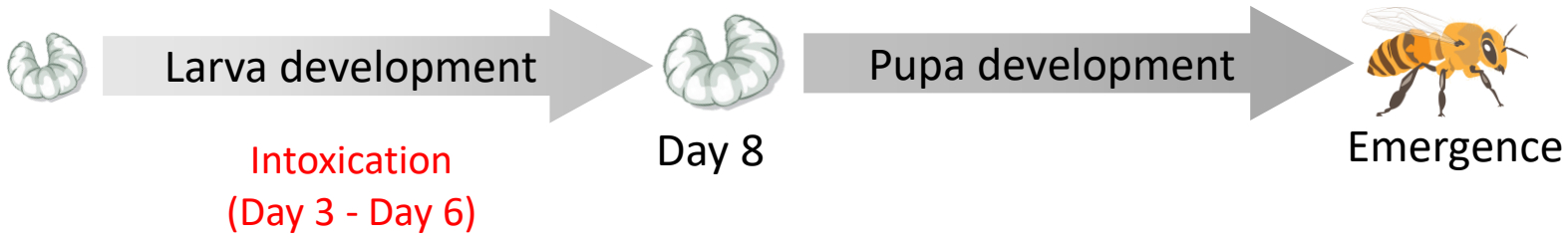
Larva Mortality



No impact of Boscalid on mortality

Are there any physiological differences in adult workers?

Experimental approach *in vitro*



SCIENTIFIC REPORTS

OPEN

Time-to-death approach to reveal chronic and cumulative toxicity of a fungicide for honeybees not revealed with the standard ten-day test

Received: 3 January 2018
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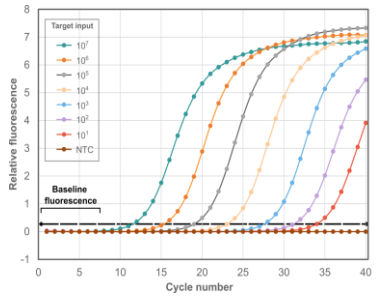
Noa Simon-Delso[1], Gilles San Martin[2], Etienne Bruneau[1] & Louis Hautier[2]

Experimental approach *in vitro*



Gene expression analyse
(qPCR - 2-ΔΔ CT)

SCIENTIFIC REPORTS

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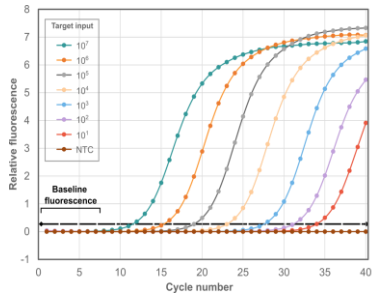
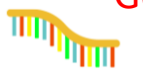
Experimental approach *in vitro*

- Reference
  - Actine
  - Ribosomal Proteine (L8)

- Detoxification :
  - Cythochrome P450
  - Catalase
- Immunity:
  - Prophenoloxidase
- Mitochondrial Activity:
  - Cytochrome b
  - Succinate dehydrogenase
- Development:
  - Vitellogenin
  - Hexamerin 70b





Gene expression analyse
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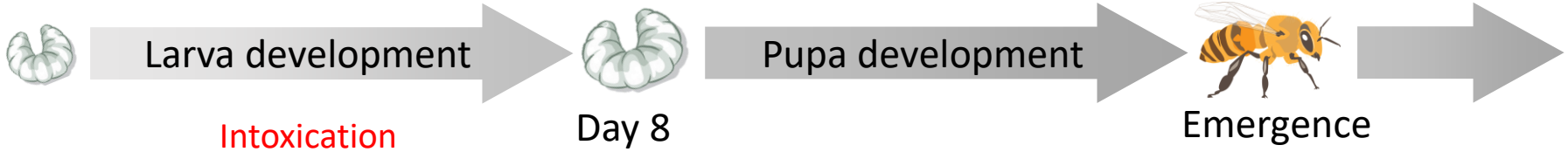
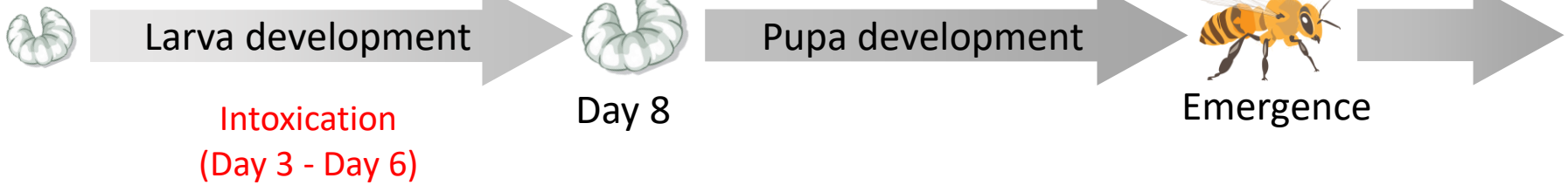
Experimental approach *in vitro*



Intoxication
(Day 3 - Day 6)

In field conditions?

Experimental approach *in vitro*



Intoxication
(Day 3 - Day 6)

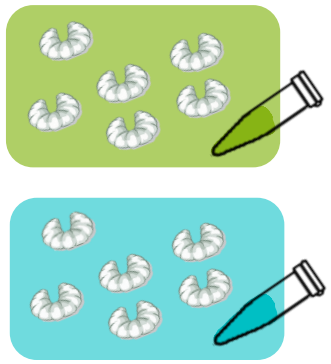
Day 8

In field conditions?

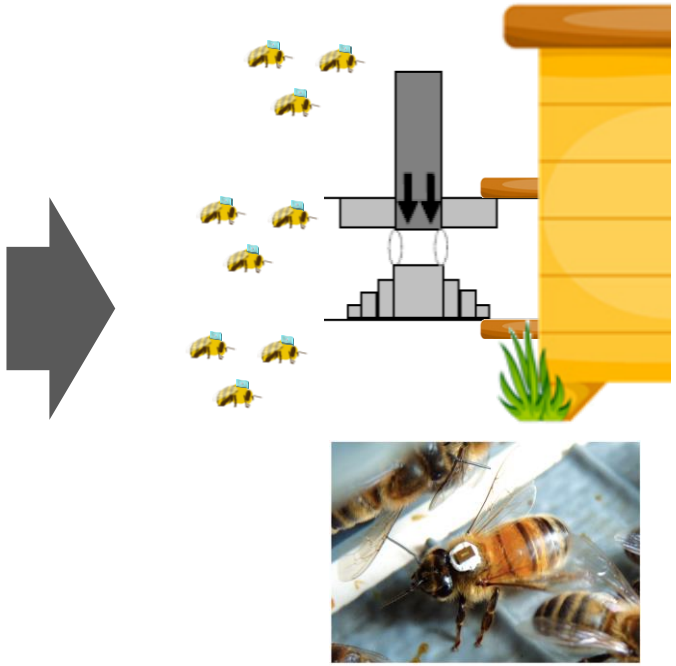
Released workers into the RFID hive

Solvent Control

Boscalid



In vitro rearing



→ 3 sessions

RFID system

- Radio Frequency Identification
- Follow the bees all their lives
- Identify the bees as they leave and enter the hive

RFID system

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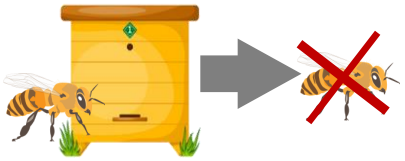
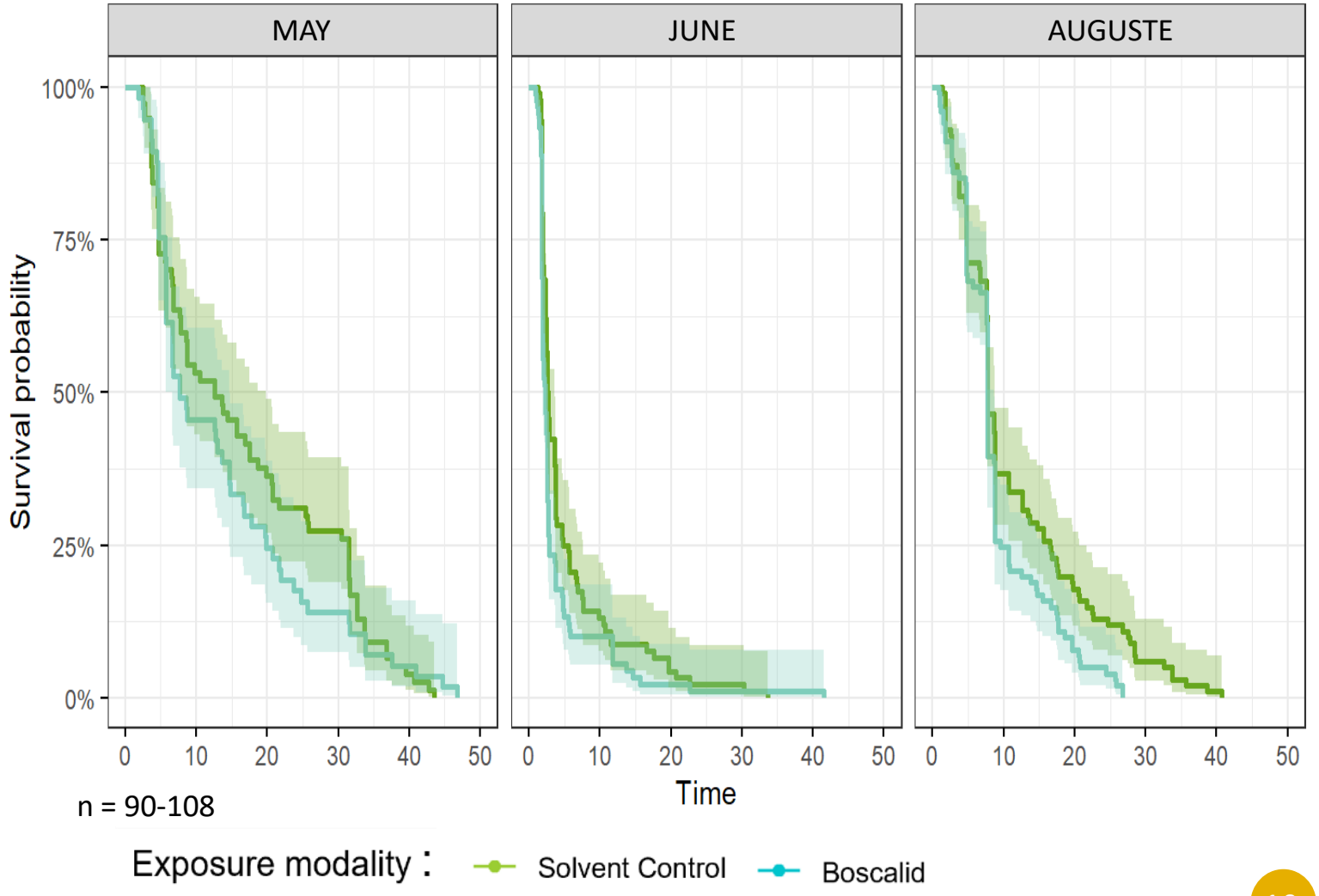
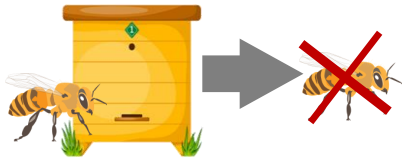


Survival in the hive

Lifespan is shorter in session 2





Survival in the hive

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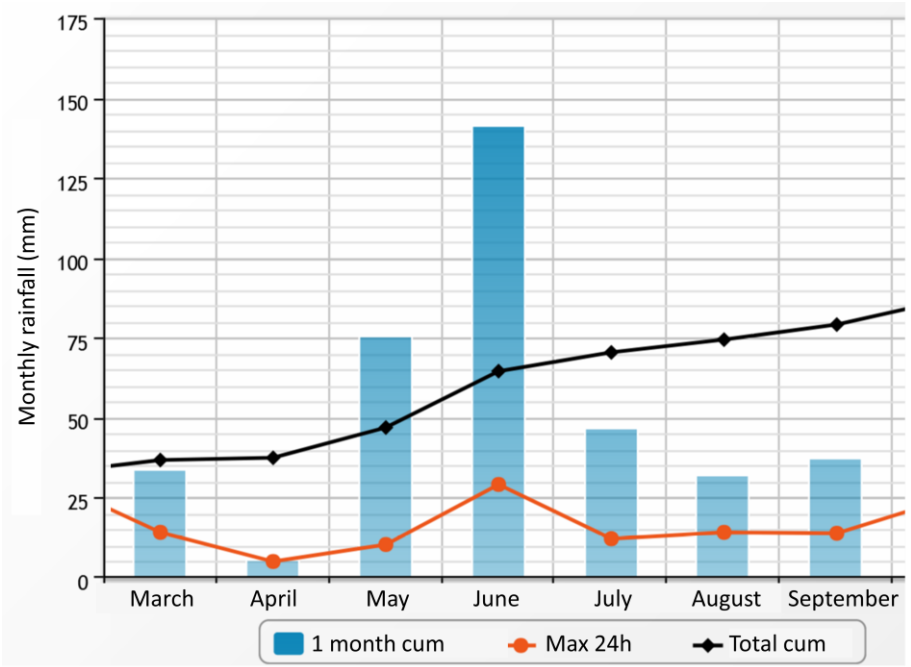
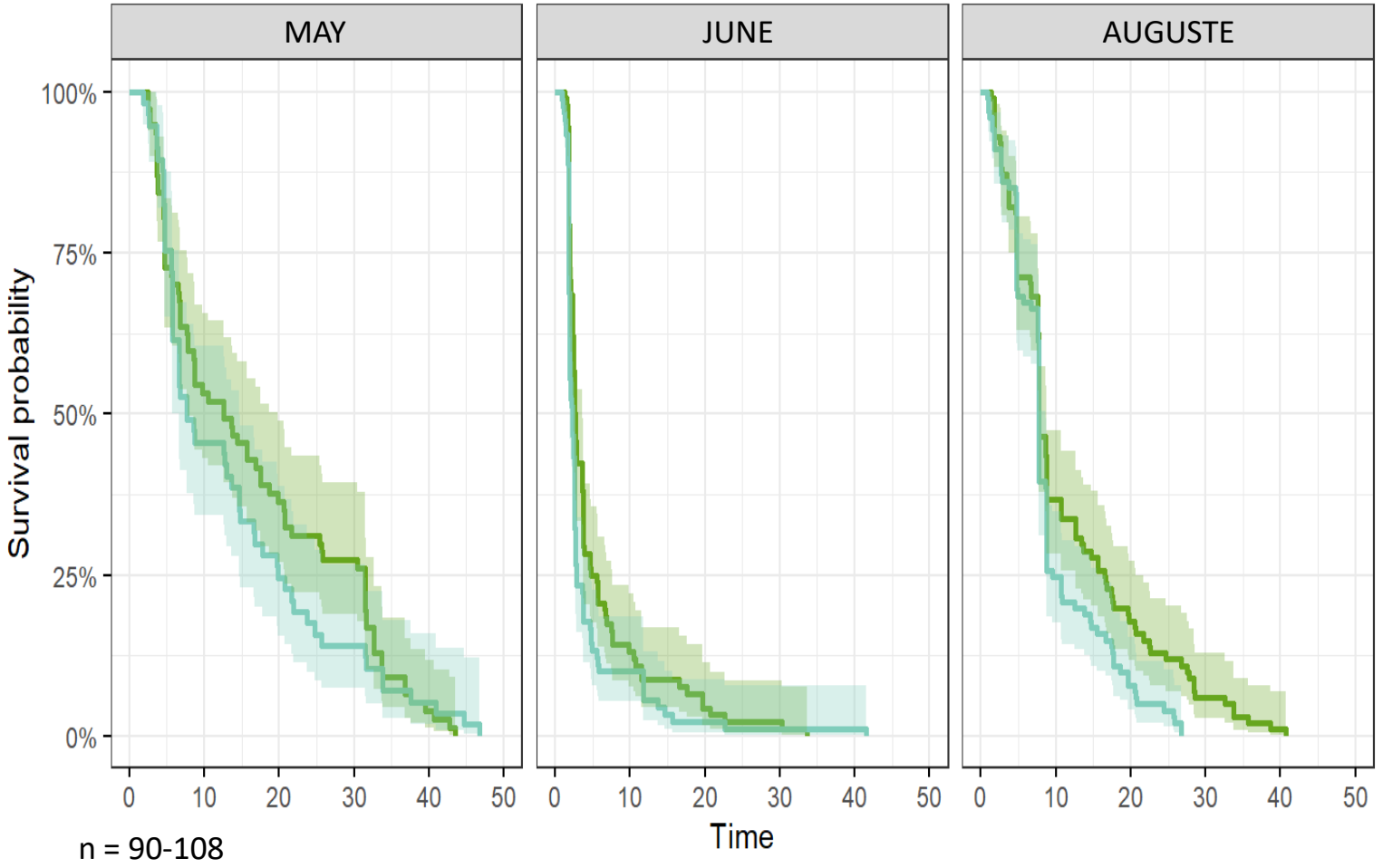
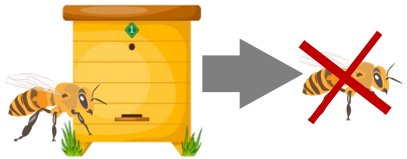
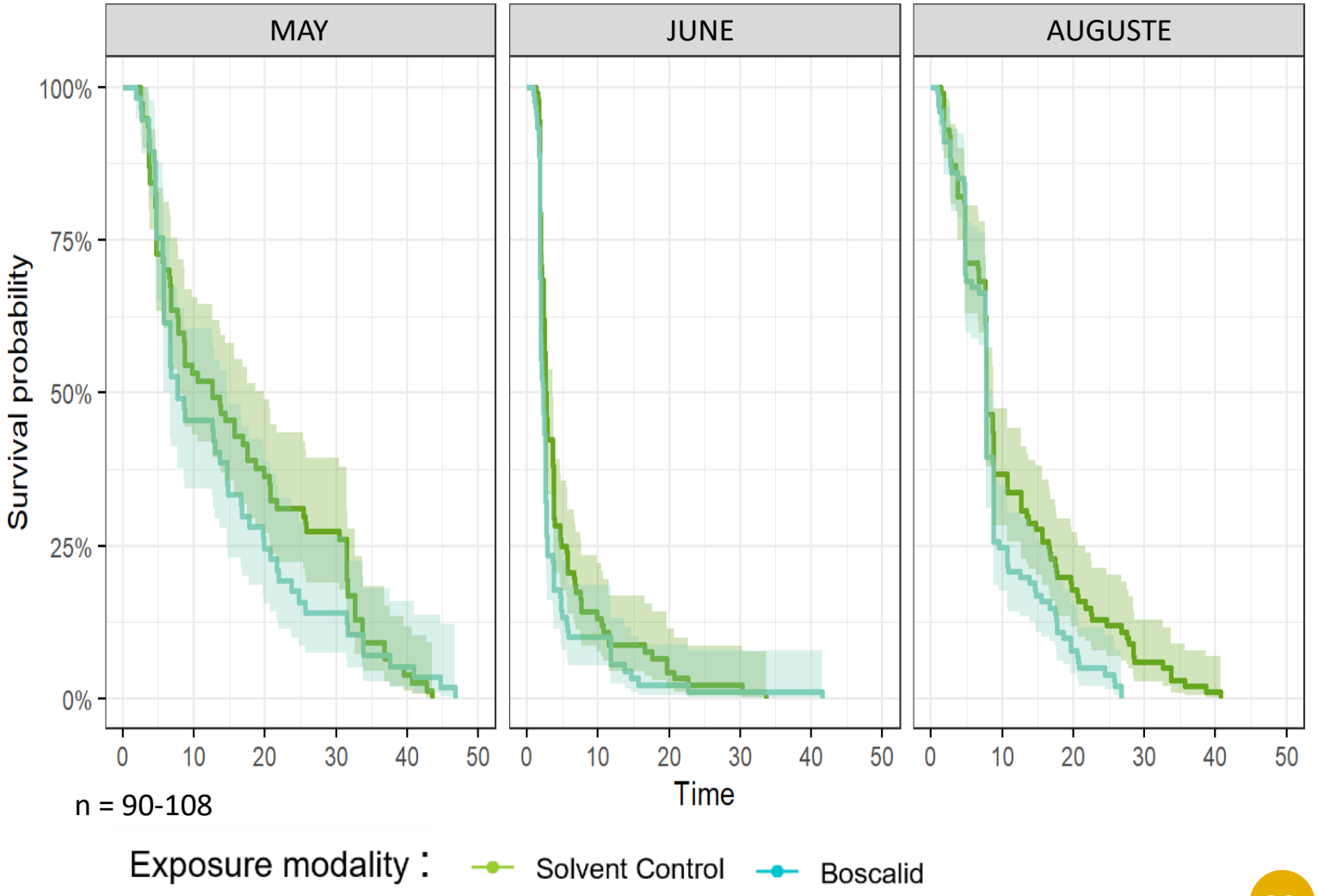






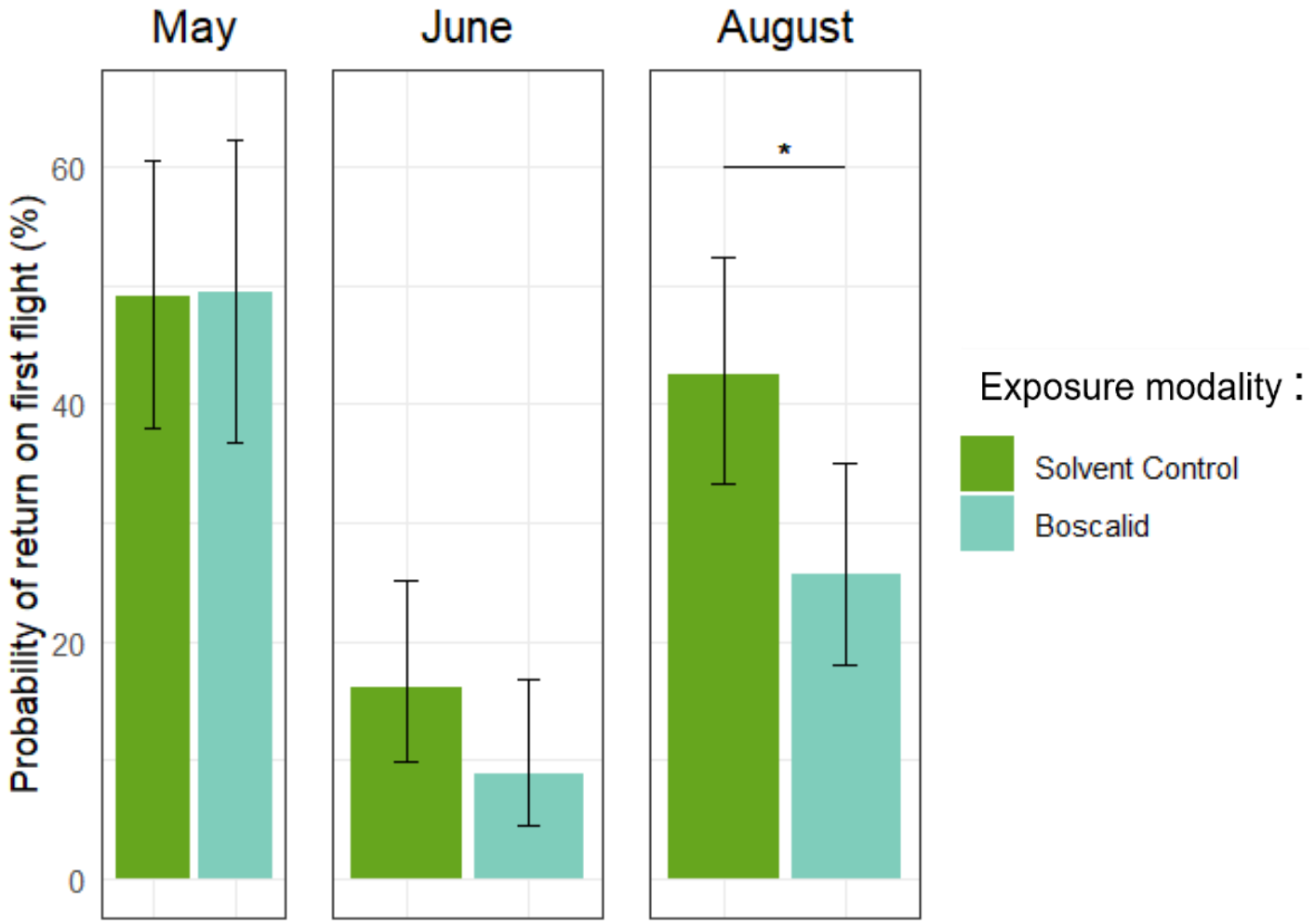
Survival in the hive

- Lifespan is shorter in session 2
- No difference between the exposure modalities for session 1 and 2
- Significant difference between control and Boscalid larvae exposure modalities for replicate 3

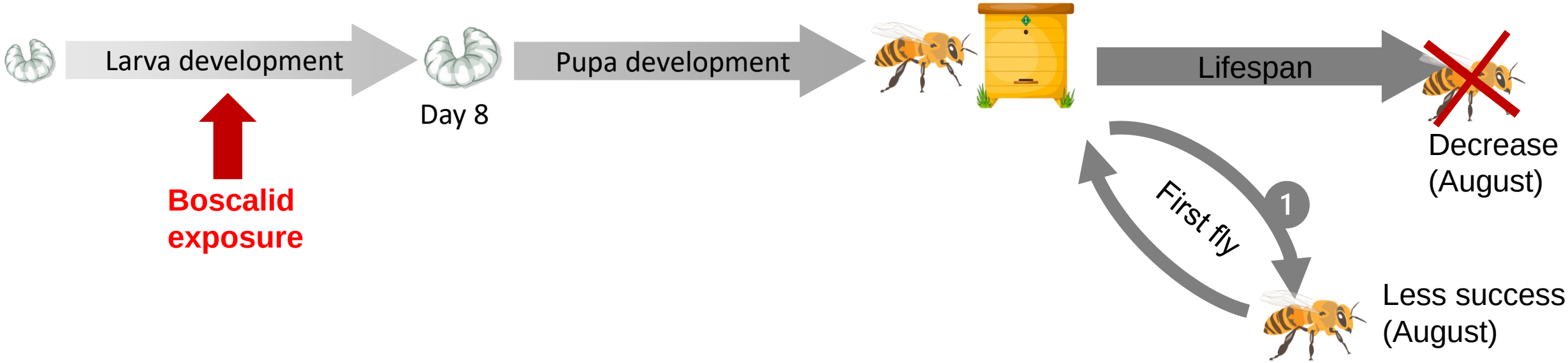


Successful of first flight

- Less success in June
- No difference between exposure in May and June
- **Significant difference between exposure modalities for control and Boscalid larvae in August**



n = 90-108 ; * : p <0,05



- Exposure to Boscalid at the larval stage has a delayed effect
- Effect of Boscalid on Vitellogenin related to development
- The effects of Boscalid in workers capacities change throughout the season

Thanks to the team from INRAE du Magneraud and the University of Poitiers:

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- Maxime Pineaux
- Elisa Gomes
- Manon Desaivres
- Tiffany Laverre
- Pierrick Aupinel
- Fabrice Requier
- Freddie-Jeanne Richard

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ECOPHYTO 2+ : EXPLORA Project (PI F-J Richard)