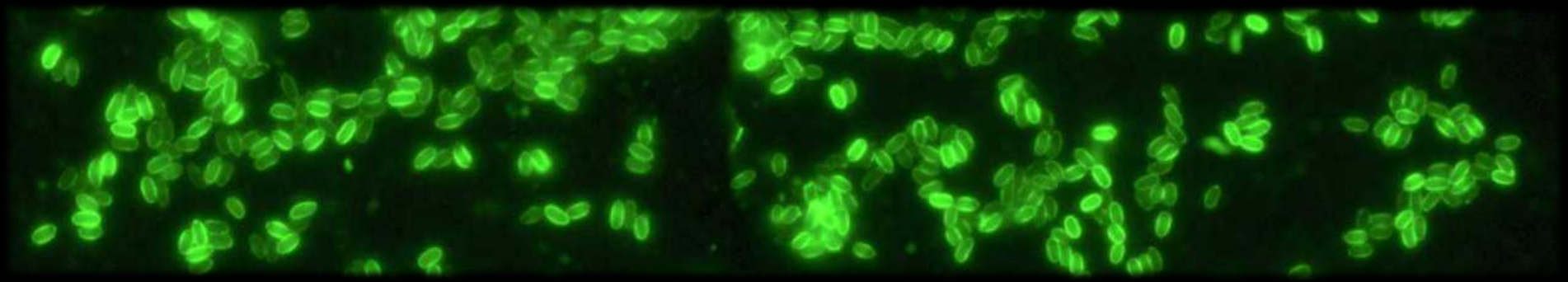
XXXXIII International Apicultural Congress

Kiev – September 30th 2013

Interactions between the parasite *Nosema ceranae* and neurotoxic insecticides in *Apis mellifera*

Julie AUFAUVRE



Laboratoire Microorganismes : Génome et Environnement
Clermont-Ferrand, FRANCE

A wide variety of stressors …

anthropogenic stressors

natural stressors

pesticides

pathogens

pesticide + pathogen

Interactions between stressors may lead to **synergistic effects***

* the combined effect of different factors is greater than the sum of their effects when taken independently

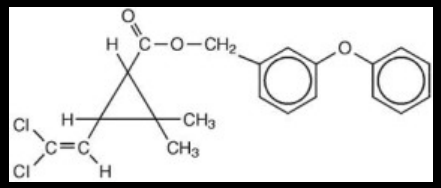
Holmstrup *et al.*, 2010

Integrated Pest Management (IPM)

= improve pests control : - more economic practices
- minimize risks to human/environment

Combine a **chemical insecticide** and a **biopesticide**

Synergistic effect on mosquito mortality :



permethrin
(pyrethroid)

+

Metarhizium anisopliae
(fungal parasite)

→

Anopheles gambiae

Farenhorst *et al.*, 2009, 2010

Integrated Pest Management (IPM)

= improve pests control : - more economic practices
- minimize risks to human/environment

Combine a **chemical insecticide** and a **biopesticide**

- to improve pesticides efficiency
- to limit chemicals use
- to counteract insect pesticide resistance

What about non-target species such as honeybees ?

Farenhorst *et al.*, 2009, 2010

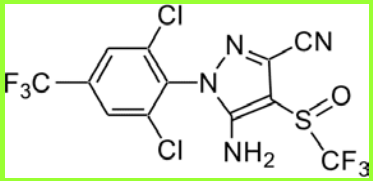
Impact of a parasite-insecticide interaction on honeybee mortality ?

Apis mellifera

Insecticides

Parasites

Impact of a parasite-insecticide interaction on honeybee mortality



fipronil

Phenylpyrazole

Neurotoxic insecticide (GABA Rec)

Treated crops: contamination of nectar and pollen

Detection of low concentrations in hive matrices

↓

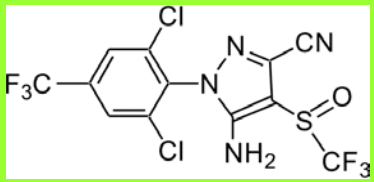
Sublethal physiological and behavioral effects

Chronic exposure to low concentrations: lethal impact ?

Impact of a parasite-insecticide interaction on honeybee mortality

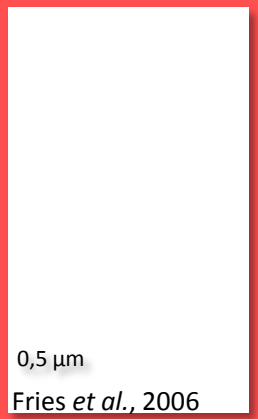
Neurotoxic insecticide

Phenylpyrazole



fipronil

+



Fries *et al.*, 2006

Nosema ceranae

Microsporidia

Obligate intracellular parasite

Infection of honeybee midgut

High prevalence in honeybee colonies

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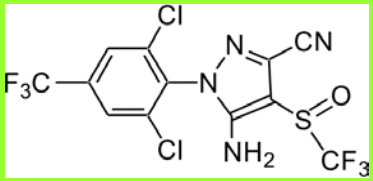
Honeybee mortality: role in colony losses ?

Impact of a parasite-insecticide interaction on honeybee mortality

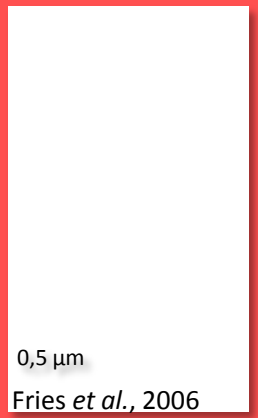
Neurotoxic insecticide

Phenylpyrazole



fipronil

+



Fries *et al.*, 2006

Nosema ceranae

Microsporidia

Eukaryote

Obligate intracellular parasite

Experiment performed under laboratory conditions

D0

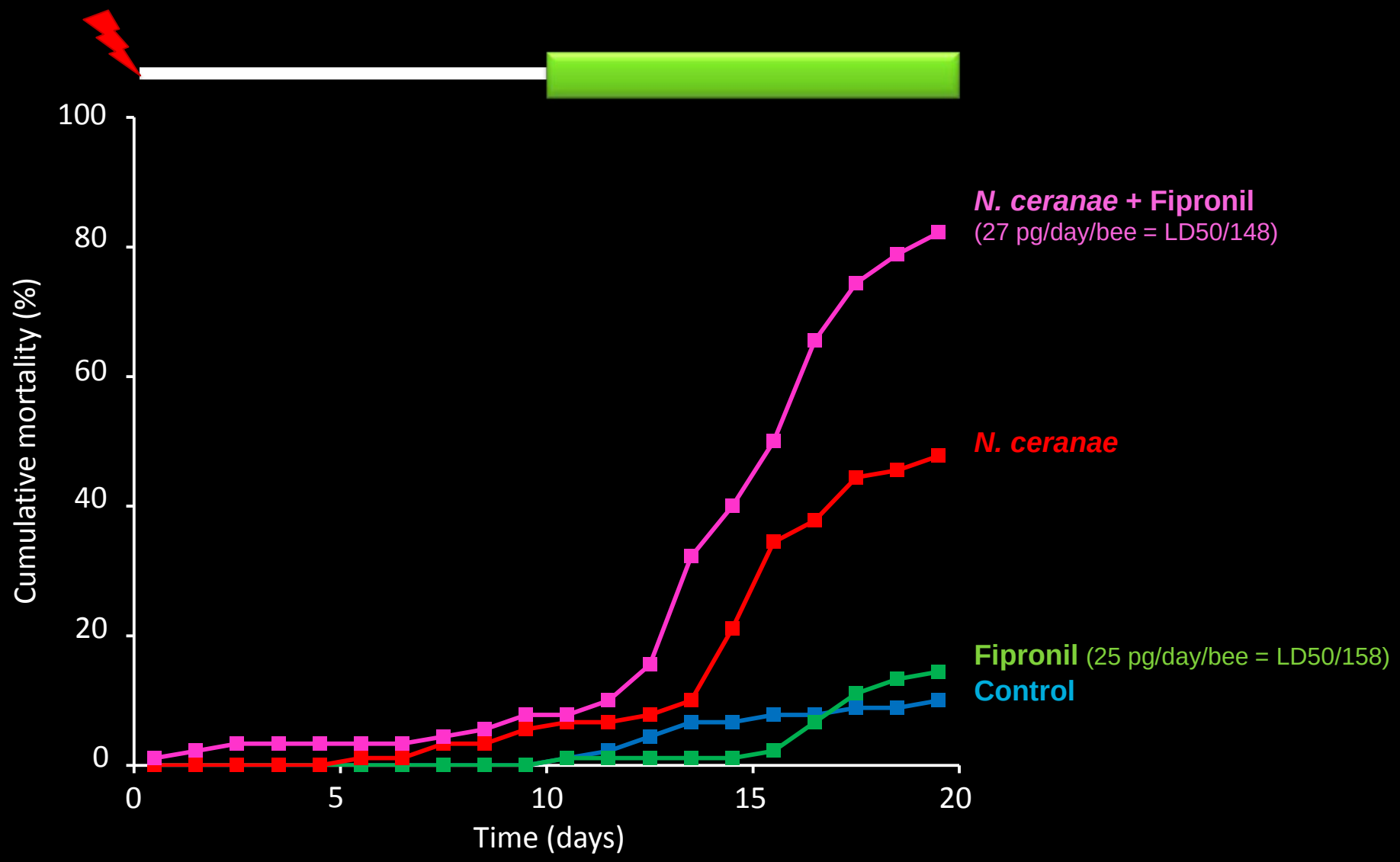
D10

D20

N. ceranae infection
125 000 spores / bee

chronic exposure :
sublethal dose of fipronil
daily consumption ≈ LD50/150

Impact of a parasite-insecticide interaction on honeybee mortality



N. ceranae-fipronil combination → synergistic effect on honeybee mortality
Same result obtained under *N. ceranae*-thiacloprid combination

Vidau *et al.*, 2011

Does the exposure sequence to stressors have an impact on synergy ?

Apis mellifera

Insecticides

Parasites

Is the exposure sequence to stressors important ?

Insecticide

Parasite

Impact of a simultaneous exposure to stressors ?

1 Parasite 2 Insecticide

Are infected bees more susceptible to low insecticide concentrations ?

1 Insecticide 2 Parasite

Is the infection more virulent in a host previously exposed to a chemical ?

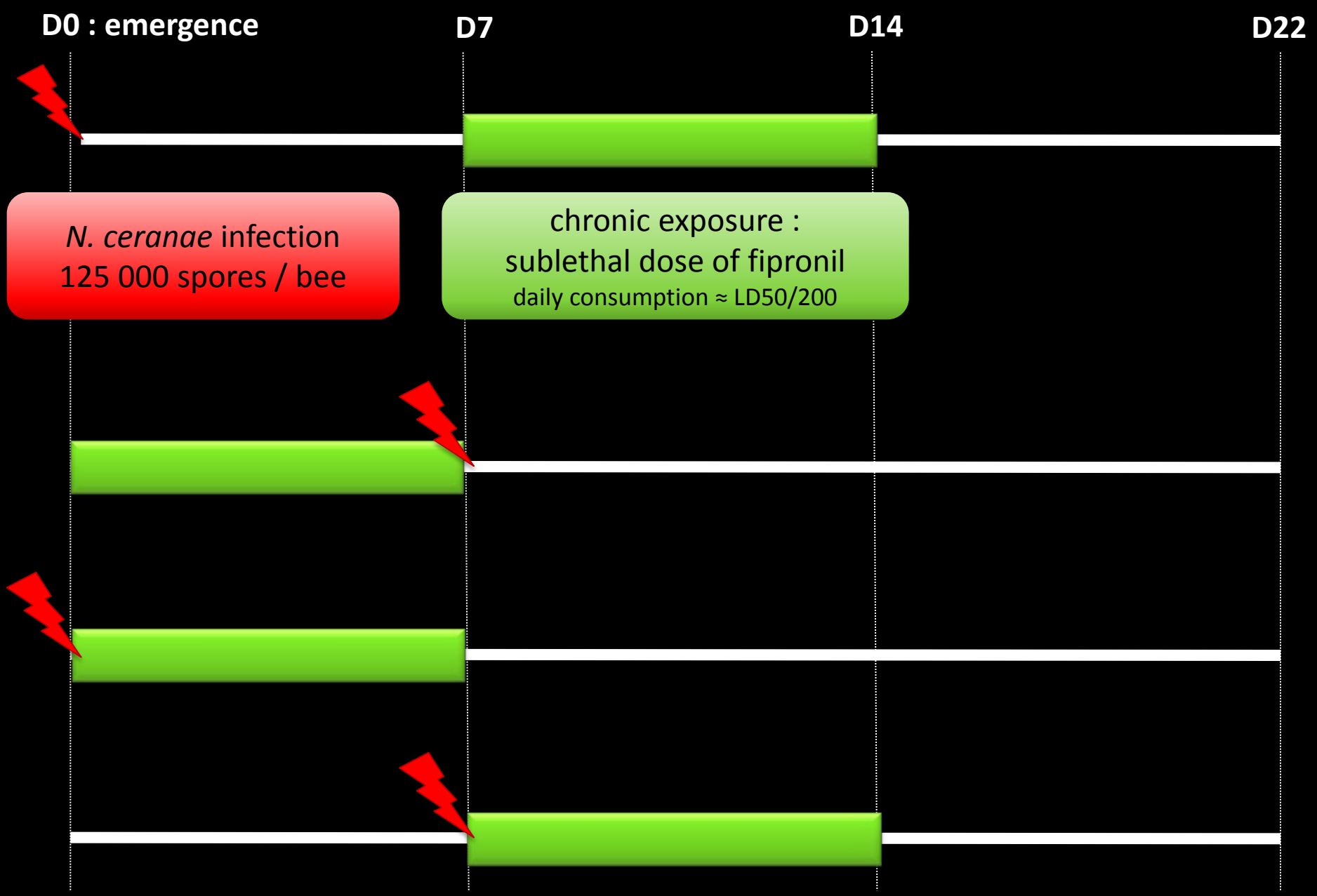
Does the three scenarios always lead to a synergistic effect or not ?

fipronil

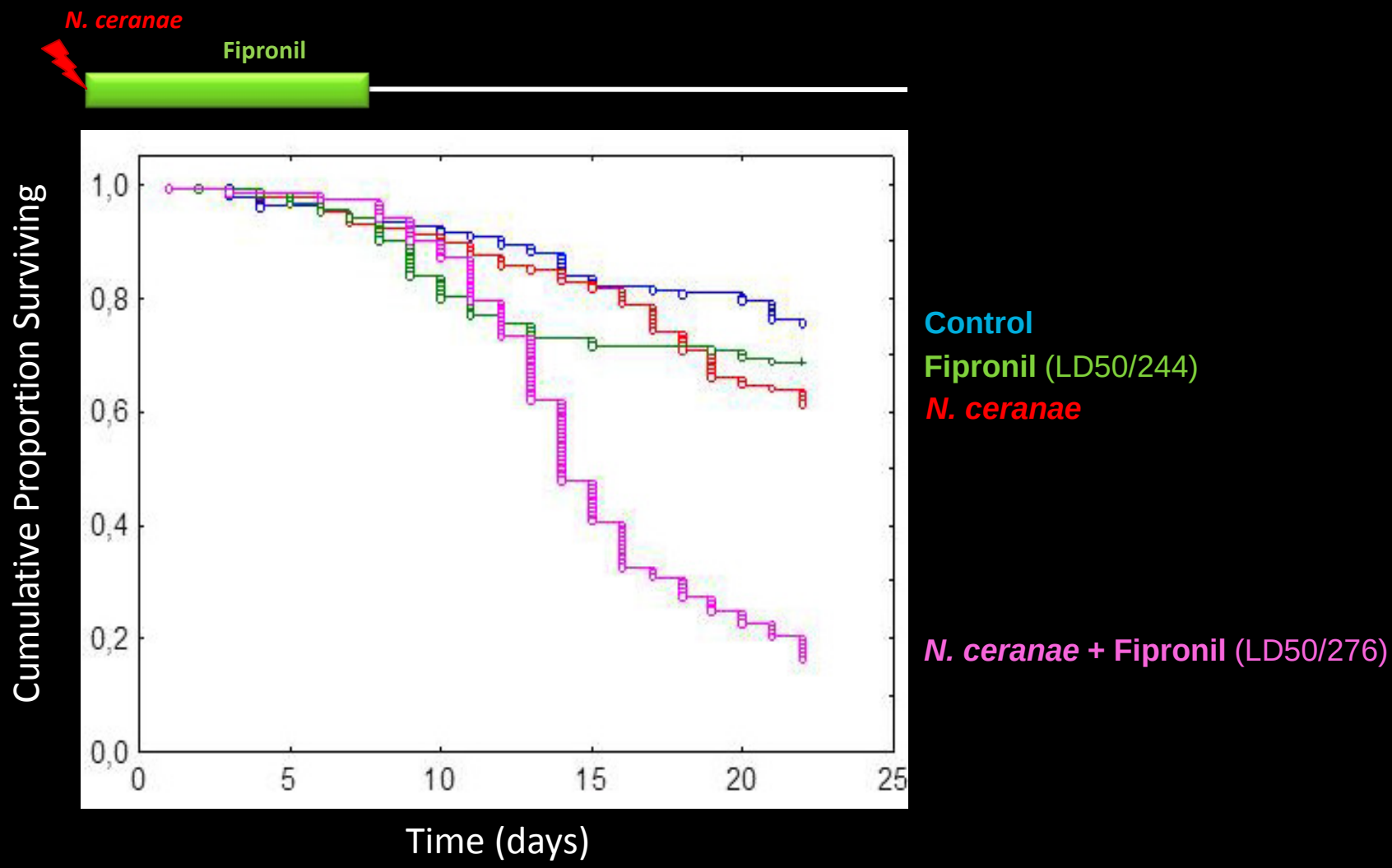
+

N. ceranae

Is the exposure sequence to stressors important ?

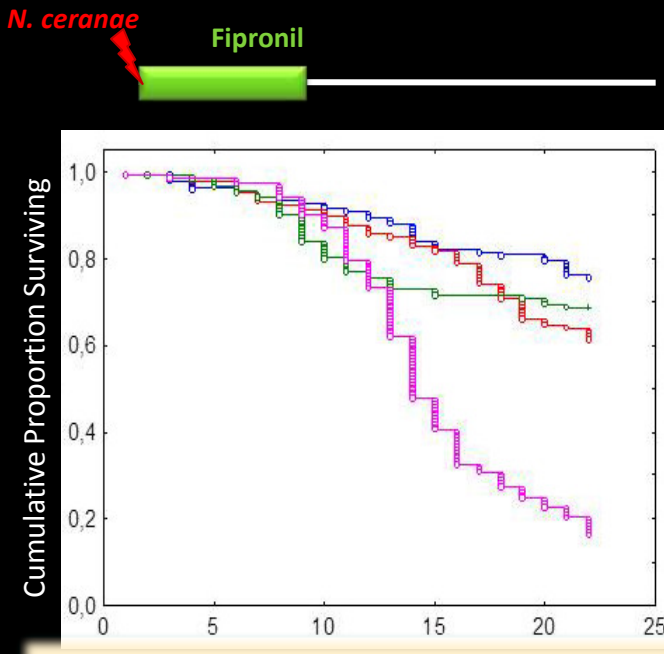


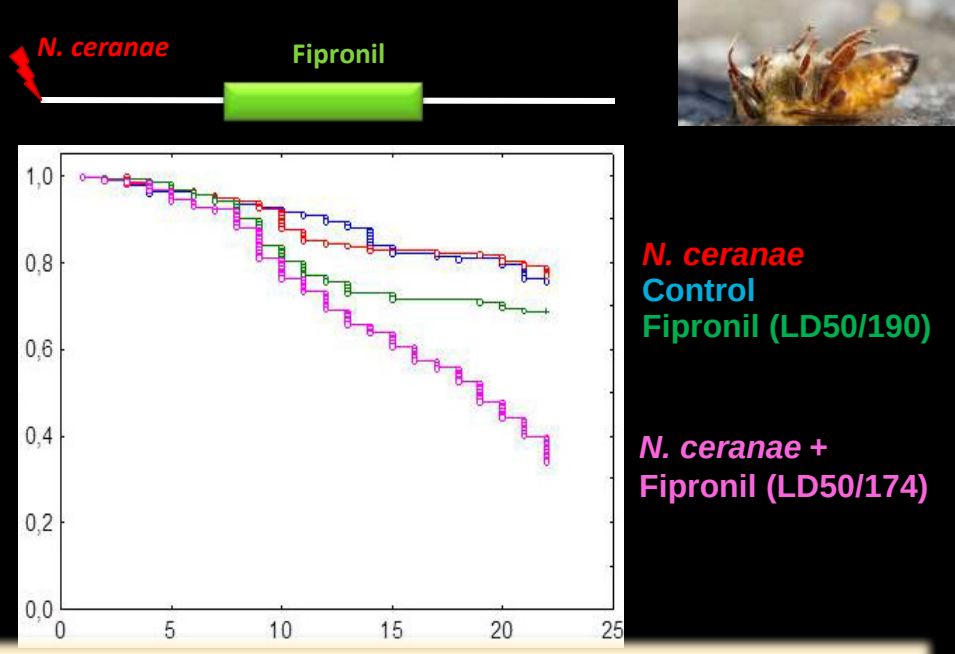
Is the exposure sequence to stressors important ?



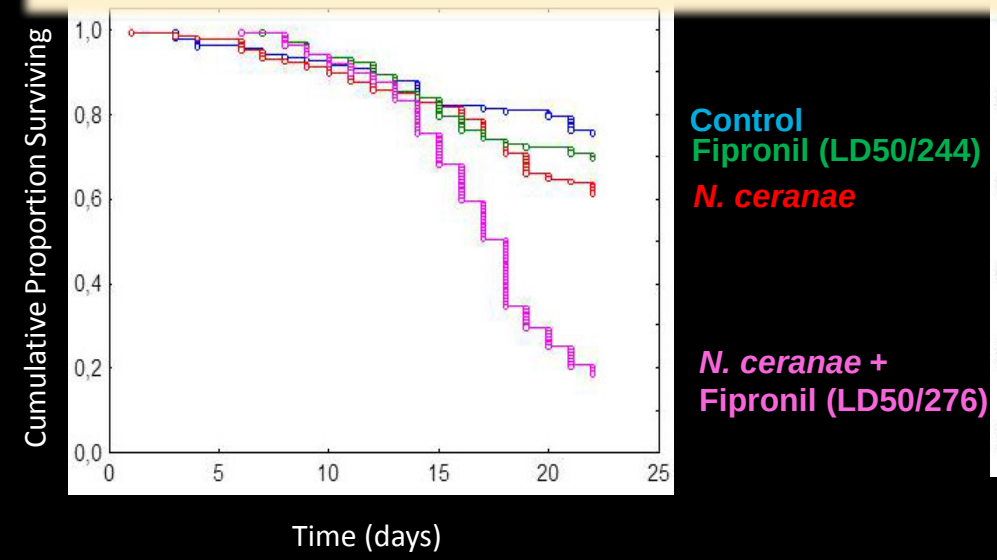
N. ceranae-fipronil combination → synergistic effect on honeybee mortality

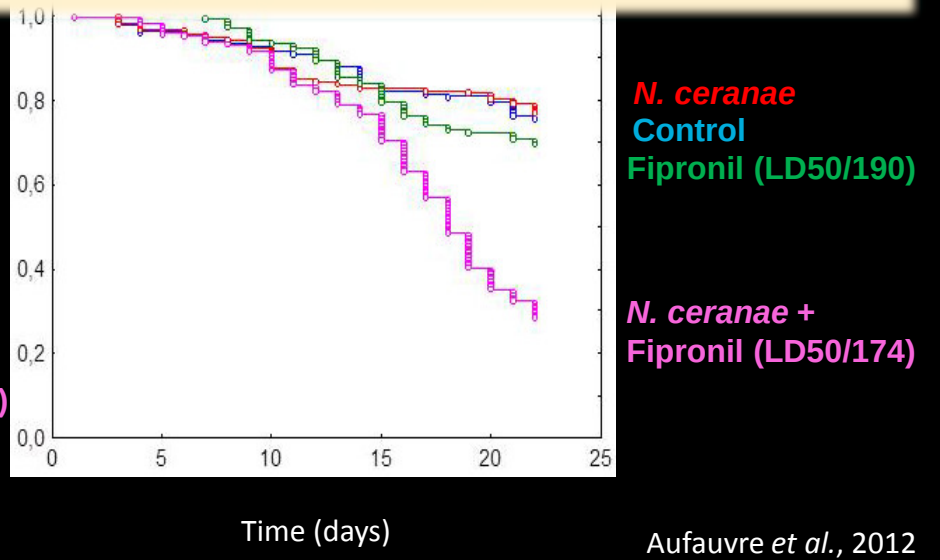
Aufauvre *et al.*, 2012





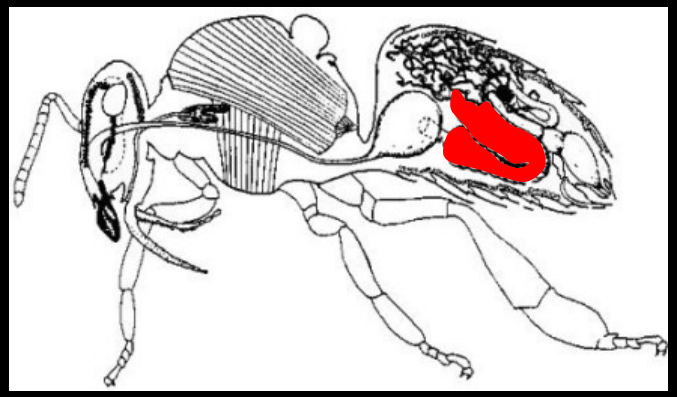
Co-exposure leads to a synergistic effect on honeybee mortality
independently of the exposure sequence to stressors

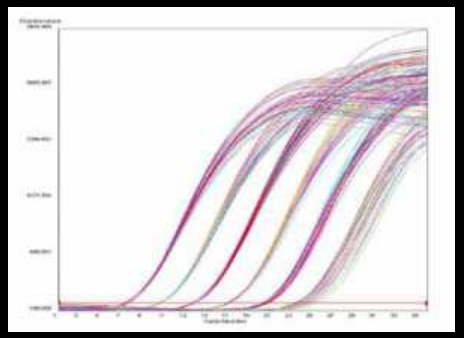




Aufauvre *et al.*, 2012

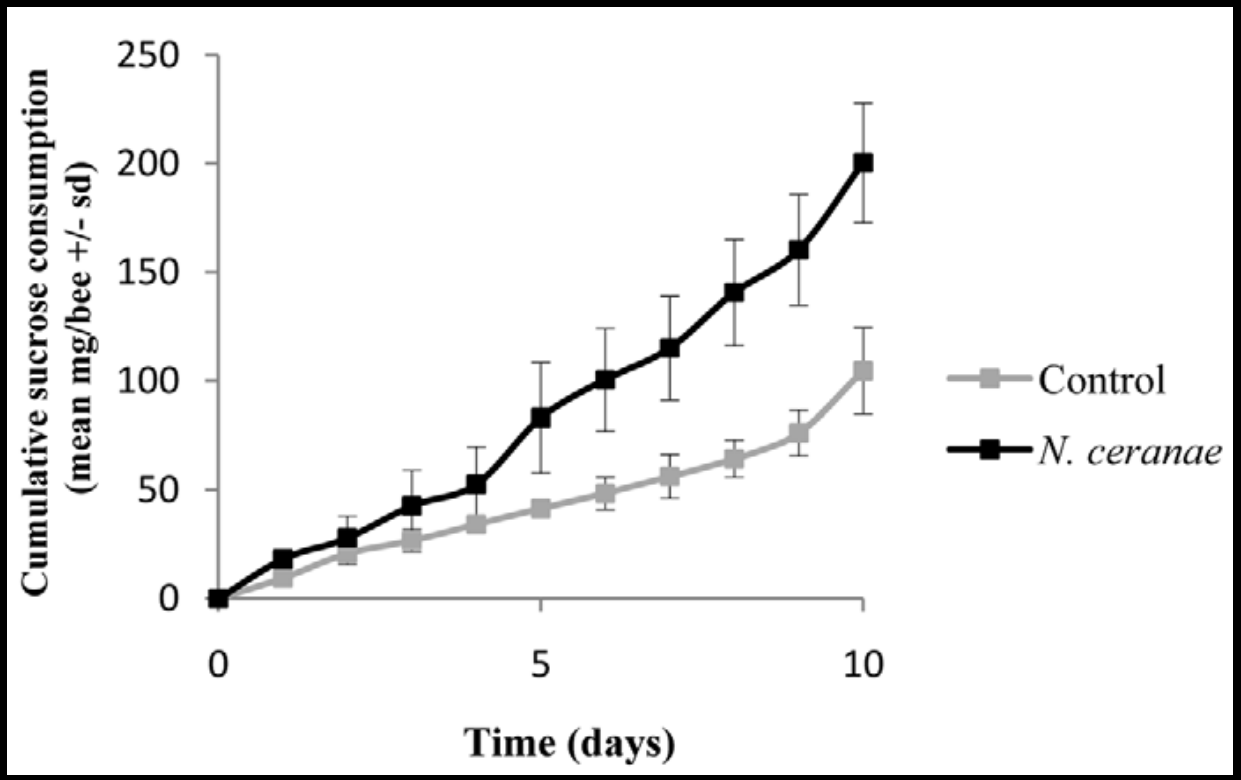
Response to parasite and insecticide





→Honeybee sucrose consumption

Increase in sucrose consumption under *N. ceranae* infection ?

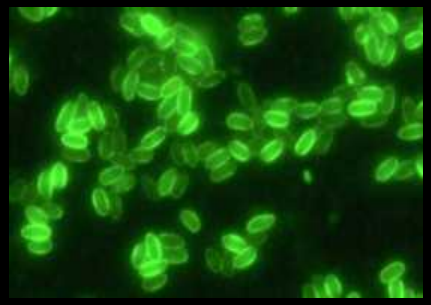


BUT *N. ceranae* infection does not always increase host consumption

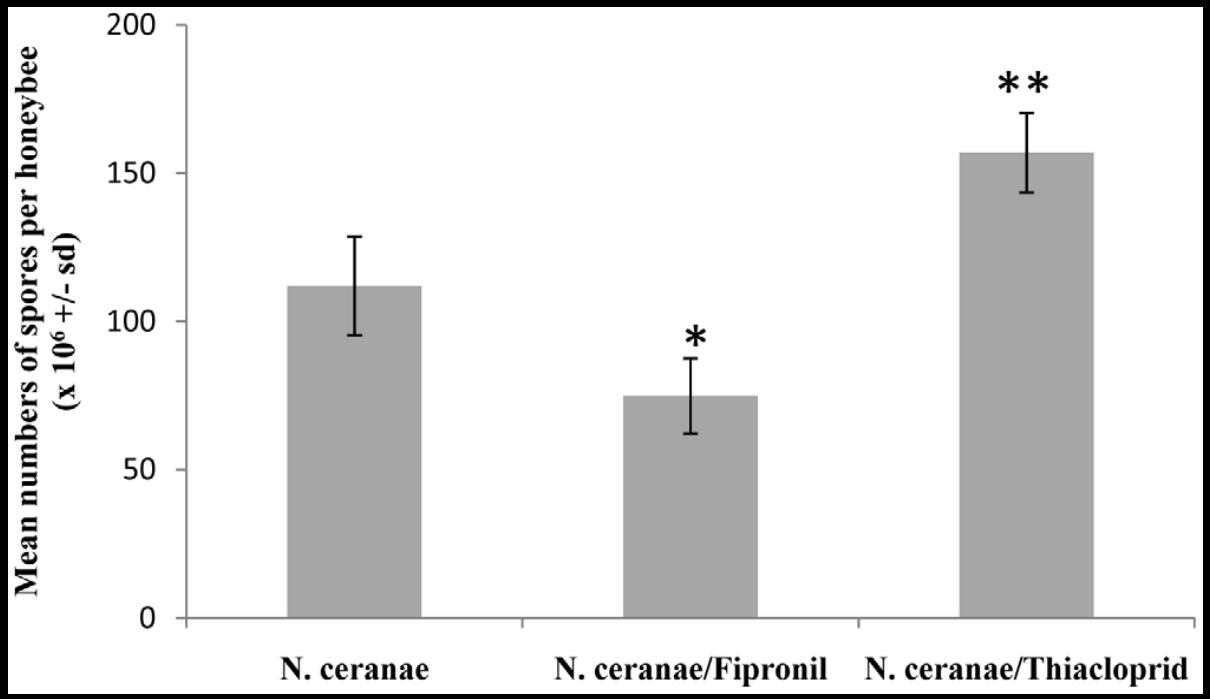
Honeybee consumption might be influenced by other parameters during trials

(Mayack & Naug, 2009 ; Alaux *et al.*, 2010 ; Martín-Hernández *et al.*, 2011 ; Vidau *et al.*, 2011 ; Aufauvre *et al.*, 2012)

→Parasite development



Does chronic exposure to insecticide influence *N. ceranae* development ?



Different chemicals have opposite effects on parasite development

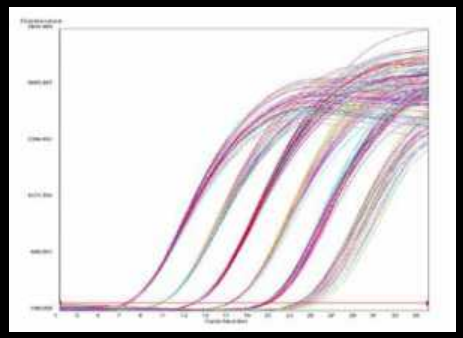
Fipronil also induces various effects depending on the considered trial

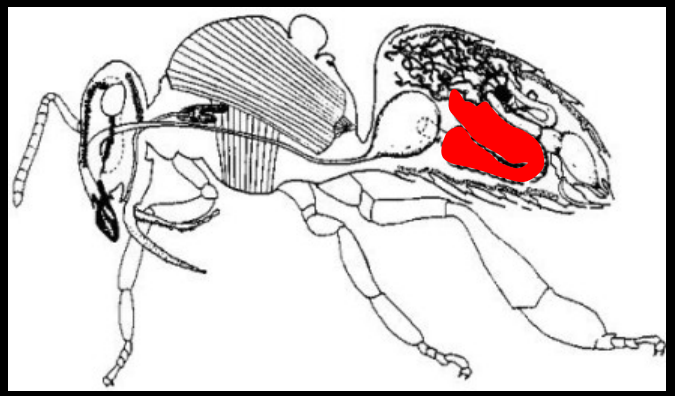
Parasite development might be influenced by other parameters

(Vidau *et al.*, 2011 ; Aufauvre *et al.*, 2012)

Investigation of honeybee midgut response at the molecular level

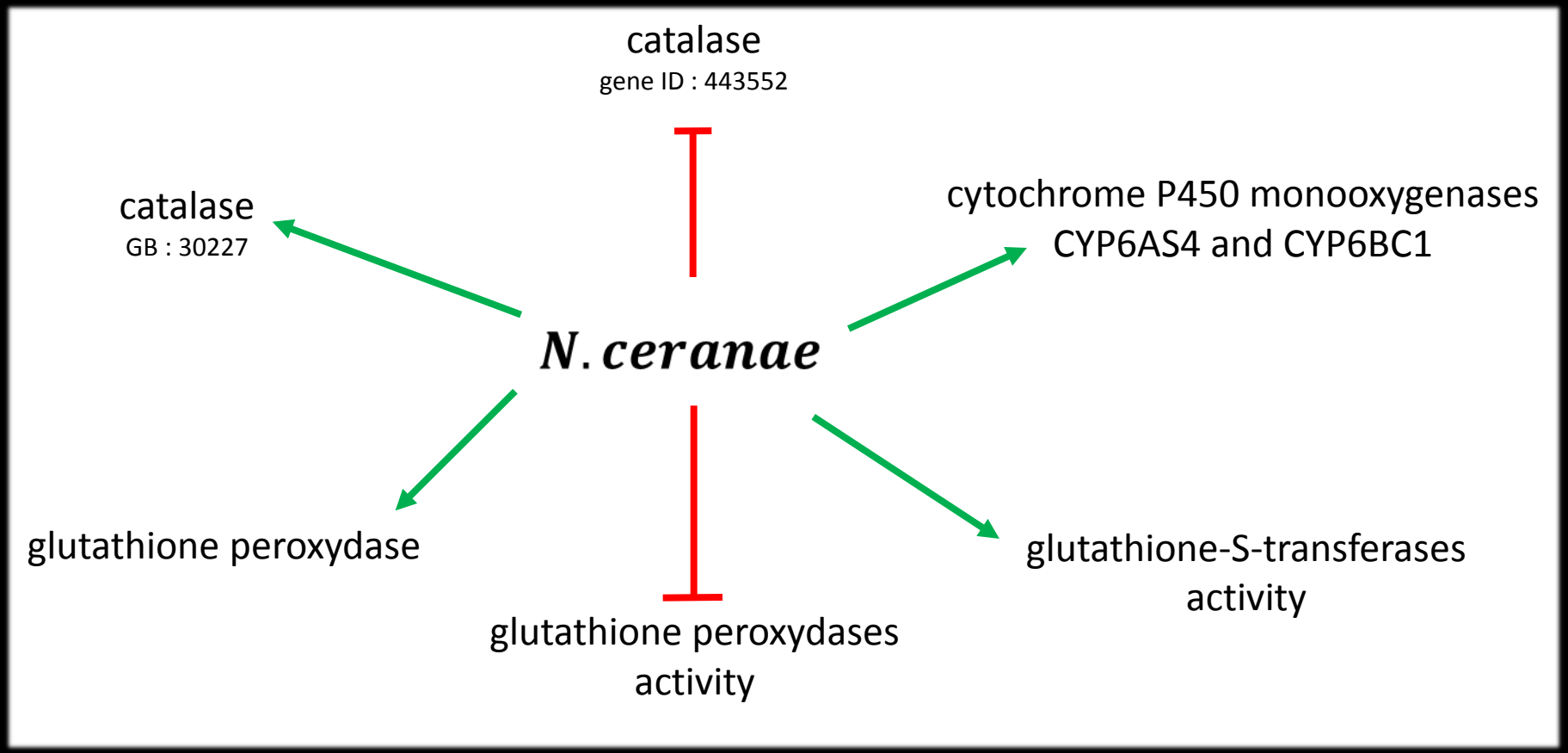
→ Transcriptomics : RNA-Seq and qRT-PCR





(Vidau *et al.*, 2011 ; Aufauvre *et al.*, 2012)

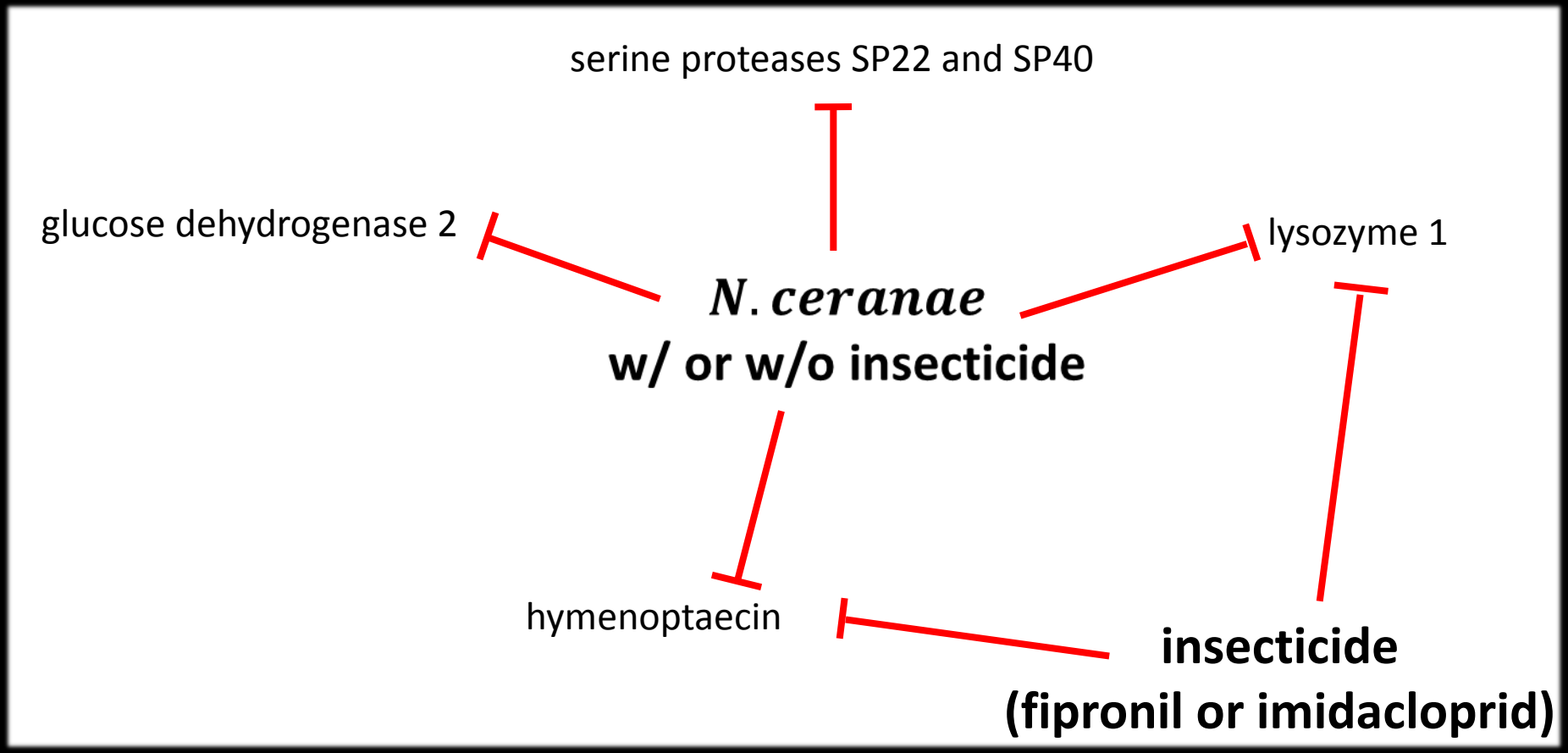
→Honeybee defenses : DETOXIFICATION



N. ceranae influences midgut detoxification
BUT no significant impact of a chronic exposure to fipronil or imidacloprid

(Vidau *et al.*, 2011 ; Dussaubat *et al.*, 2012 ; Aufauvre *et al.*, 2013 *in prep.*)

→Honeybee defenses : IMMUNITY



Potential immunotoxicity effect of phenylpyrazole and neonicotinoid insecticides ?

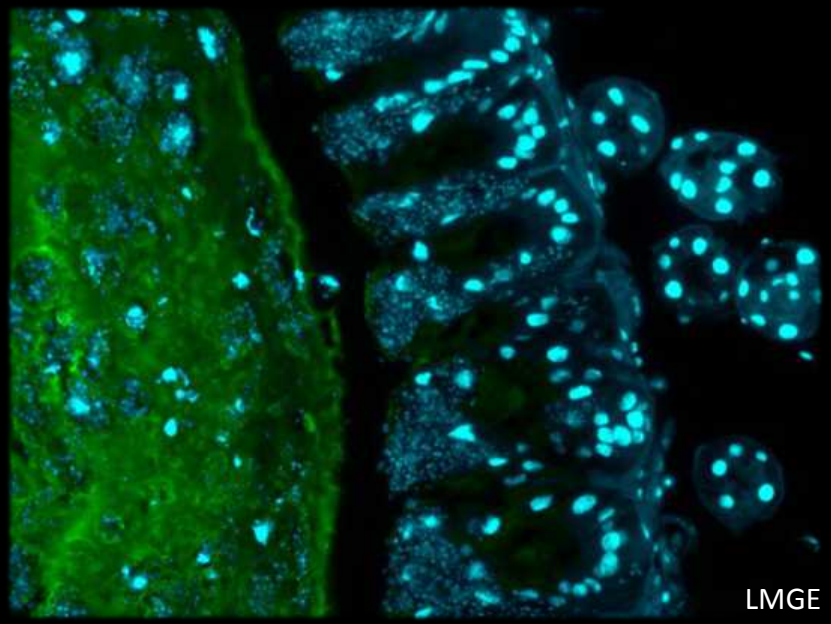
(Antúnez *et al.*, 2009 ; Chaimanee *et al.*, 2012 ; Dussaubat *et al.*, 2012 ; Aufauvre *et al.*, 2013 *in prep.*)

→Honeybee response to parasite and/or insecticide

Transcriptional analyses of midgut transcripts by RNA-Seq and qRT-PCR
→ Aufauvre *et al.*, 2013 *in prep.*

Investigate the honeybee response to a parasite, to insecticides, and to a combination of both stressors

Further analyses using complementary approaches:
- transcriptomics
- proteomics
- metabolomics
- histopathology
- physiology : ROS production



LMGE

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Thank you !

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