Wallonie

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Unité d'Entomologie fonctionnelle et évolutive

Gembloux Agro-Bio Tech Université de Liège

The Impact of Diseases Transmission in Pollinators Decline

Grégoire NOEL, 02/12/ 2016

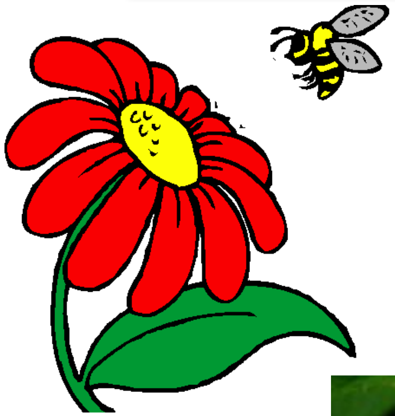
Entomology Symposium at RBINS Brussels

Principle Investigators: Pr. Frédéric Francis, Pr. Nicolas Gengler

Presentation Structure

- 1st Part : Update on pollinators decline
  - Pollination and ecosystem service
  - Pollinators diversity
  - Decline causes
- 2 th Part : Diseases Transmission Role
  - Pathogens diversity
  - Transmission pathways
  - Risk factors

Pollination and ecosystem service



Pollination = Ecosystem service = 153 billion €/year

Amount from 2005, Gallai *et al.* 2009

Fragaria sp (L.)

Pisum sativum (L.)

Orchards (apples, pears)

versus

Oryza sativa (L.)

Triticum aestivum (L.)

75% of major crops are depending on animal pollination = 35% of crop production (Klein et al. 2007)

+/- 85 % of all world plants are animal-pollinated plants (Ollerton *et al.* 2011)

Pollinators diversity ?




Aglais io (L.) *Moro sphinx (L.)* *Chlorostilbon mellisugus (L.)* *Glossophaga soricina (Pallas,1766)*




Merodon equestris (F.) *Episyrphus balteatus (De Geer, 1776)* *Bombylius major (L.)* *Cetonia aurata (L.)*




Osmia bicornis (L.) *Anthophora plumipes (Pallas, 1772)* *Andrena vaga (Panzer,1799)*

Apis mellifera L. (honey bee)

Bees diversity:
+ 20 000 sp around the world
+ 1 965 sp in Europe
+ 380 sp in Belgium

In Belgium:
One specie of *Apis*

There is a decline ?

Evidences

- Observation on the evolution of **specific richness** on wild bees, hoverflies and butterflies (Belgium, UK, Netherlands) ➔ **decrease**
- Supported by other studies on **perturbations gradient**: urbanization, agricultural intensification,…
- Also for **honeybee colonies** (Colony Collapse Disorder, **CCD**, Van Engelsdorp *et al.*, 2009)
- Even in **Tropical Regions** (Freitas *et al.* 2009)

Limitations

- A lot of inventories and distribution maps but few data on the **specific abundance**
- No **global monitoring** program and **few** at continental or regional scale!

No insights about the **magnitude** of the decline or a pollinators « crisis »

Big issues for **identification and calibration** of suitable conservation measures

So YES, pollinators decline is real !

Key drivers on pollinators decline : Habitat Degradation

First cause (sensu Potts (b) et al. 2010)

Habitat degradation:
- Rising of the urbanization
- Agricultural intensification
- Landscape homogenization

Floral resources and nesting sites losses

Flower strips from Gembloux

Floral resources

+

Nesting Site

Heriades truncorum (L.)

Set of nests for *Andrena vaga (Panzer)* and *Colletes cunicularius (L.)*

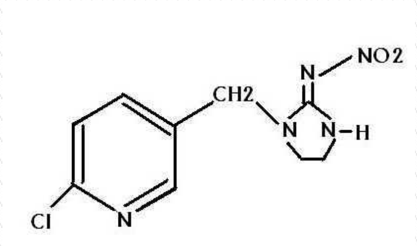
Osmia bicolor (Schrank, 1781)

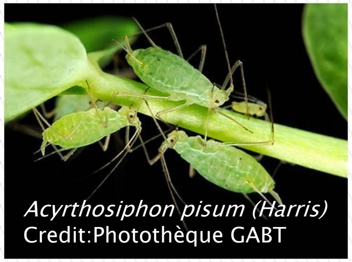
Key drivers on pollinators decline (2) : Pesticides

Pesticides → **Insecticides**

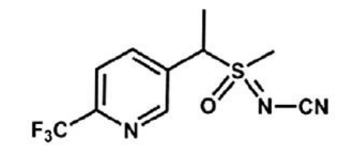
- **Systemic neurotoxic** molecules ➔ Pollen and nectar
- Affect foraging capacities, generate spatial disorientation, …
- Appearance of **resistance** to target pest species

- **<u>Also</u> systemic neurotoxic** molecules ➔ targets pests as sap-sucking insects but no **sub-lethal studies for pollinators**
- Global spread **risks**, similar as neonics





Acyrthosiphon pisum (Harris)
Credit:Photothèque GABT



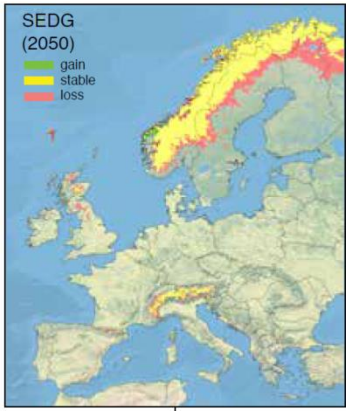
Sulfoxaflor (SFX): SFI-7

Neonicotinoids → **Sulfoximines**

Key drivers on pollinators decline (3) : Climate Changes

- **Impact well studied for gradual changes but none for extreme events !**
- Danger 1 for plant-pollinator interactions : changing patterns of spatial and temporal co-occurrence
- Danger 2 for pollinator-pollinator interactions: Competition may increase with an extension/restriction of distribution ranges

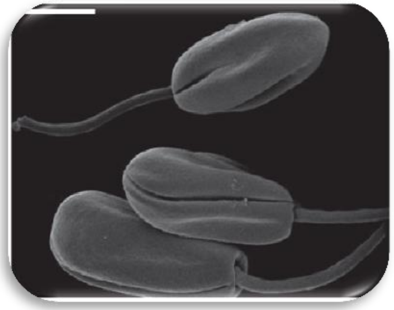
Bombus alpinus (L.)
Credit P. Rasmont



Simulation example
P. Rasmont *et al.* 2015

Key drivers (4): Pathogens

Most studied pollinator !



Crithidia mellificae (Langridge, 1967)

Apis mellifera (L.)

Nosema ceranae (Fries, 1996)

+ parasitoids
+ bacterias

Varroa destructor (Anderson, 2000)

Mechanical vector

Biological activator

++Co-infections
++Viruses titers

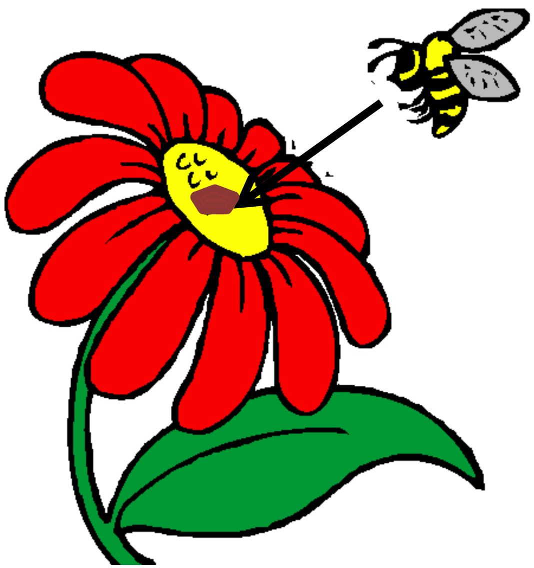
Intraspecific transmission

- By oral-fecal pathway: feces, pollen, nectar, royal jelly, trophallaxis
- By contact: overcrowding, forced confinement, aggression, pillage, robbery among colonies
- By sexual transmission
  - Mating events (drones ➔ queen)
  - Queen contaminated ovaries ➔ eggs (fertilized or not)
- By ecto- and endoparasites

Trophallaxis phenomenon in *Apis mellifera (L.)*

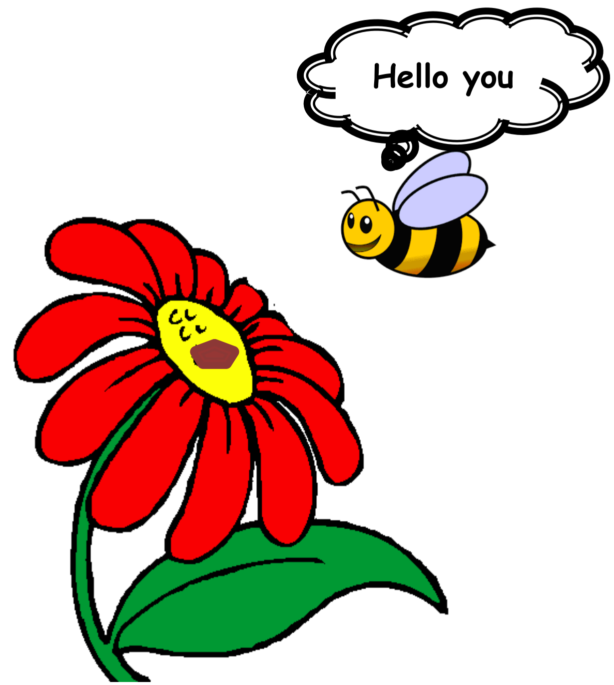
Interspecific transmission

- Indirect Transmission: **Flower sharing,** oral–fecal transmission



Feces deposition

Pollen contamination



Exposition to a new host

Interspecific transmission (2)

- Direct transmission:
  - By predators (wasps, hornets), nest robber
  - Predation by cuckoo bees, social parasitism

Vespula germanicus (L.)

Bombus vestalis (Fourcroy, 1785)

Risk factors

Host-immunosuppression

Globalization of commercial exchanges

Increasing transmission factor

Sociality

Pathogens nature and host relatedness

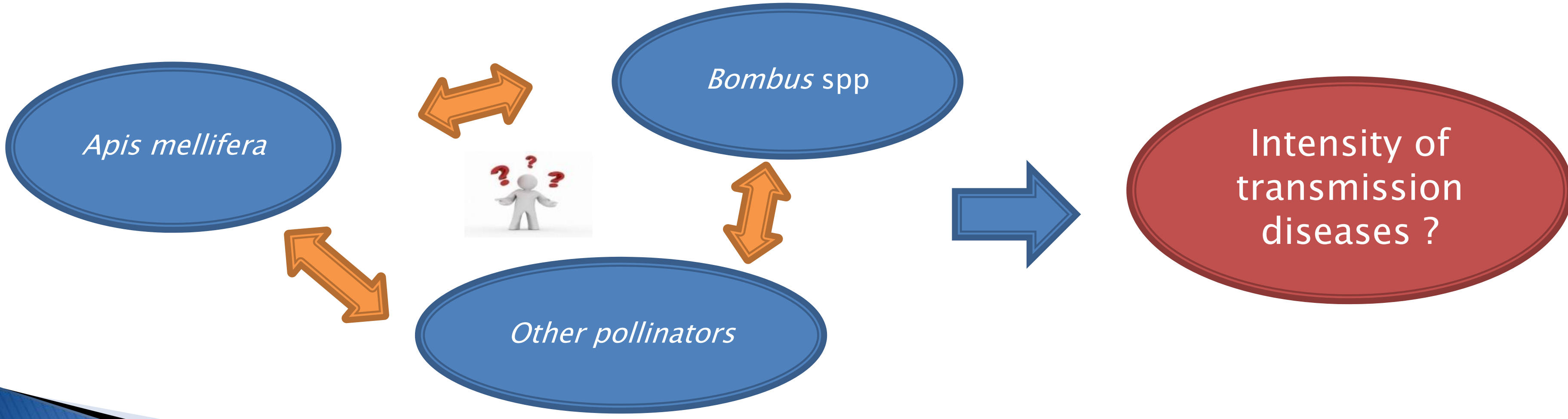
Pollinators health concern

Varroa destructor *(Anderson, 2000)*

Deformed Wing Virus (DWV) on *A. mellifera*

Knowledges gaps

- Prevalence and infection outside *Apis* genus ?
- Viral life cycle ?
  - Transmission routes not well characterized !
  - Virulence
- Bigger threat from managed species (*Bombus terrestris, Apis mellifera,…*)
- Epidemiological dynamics in multi-host systems ?



Take-home message: synergetic effects !!

First (sensu Potts (b) et al. 2010)

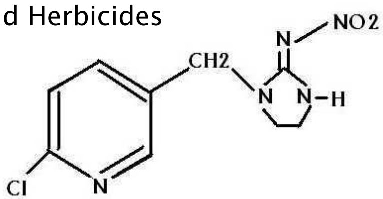
Habitat degradation:
- Rising of the urbanization
- Agricultural intensification
- Landscape alteration

Climatic changes

Osmia cornuta (Latreille, 1805)
on *Fragaria sp (L.)*

Pathogens transmission:
Varroa destructor (Anderson, 2000)

Pesticides :
Insecticides and Herbicides



Globalization of commercial exchanges

Supplementary informations

- Credit for all bees pictures from Prof. NJ Vereecken (ULB) https://www.flickr.com/photos/nico_bees_wasps/
- Atlas Hymenoptera website: http://www.atlashymenoptera.net/
- BELBEES Project: http://www.belbees.be/fr-fr
- SAPOLL Project: http://sapoll.eu/
- BWARS (UK) website : http://www.bwars.com/
- Other sustainable projects (see paper from Vanbergen *et al.* 2013)

Thanks

SELAPIS PROJECT TEAM

Prof. Frédéric Francis

Prof. Nicolas Gengler

Julien Bebermans

Grégoire Noël

Unité d'Entomologie fonctionnelle et évolutive

Bonus !

Colletes hederae
(Schmidt & Westrich, 1993)
in action on *Hederae helix (L.)*

Thanks you for your attention!

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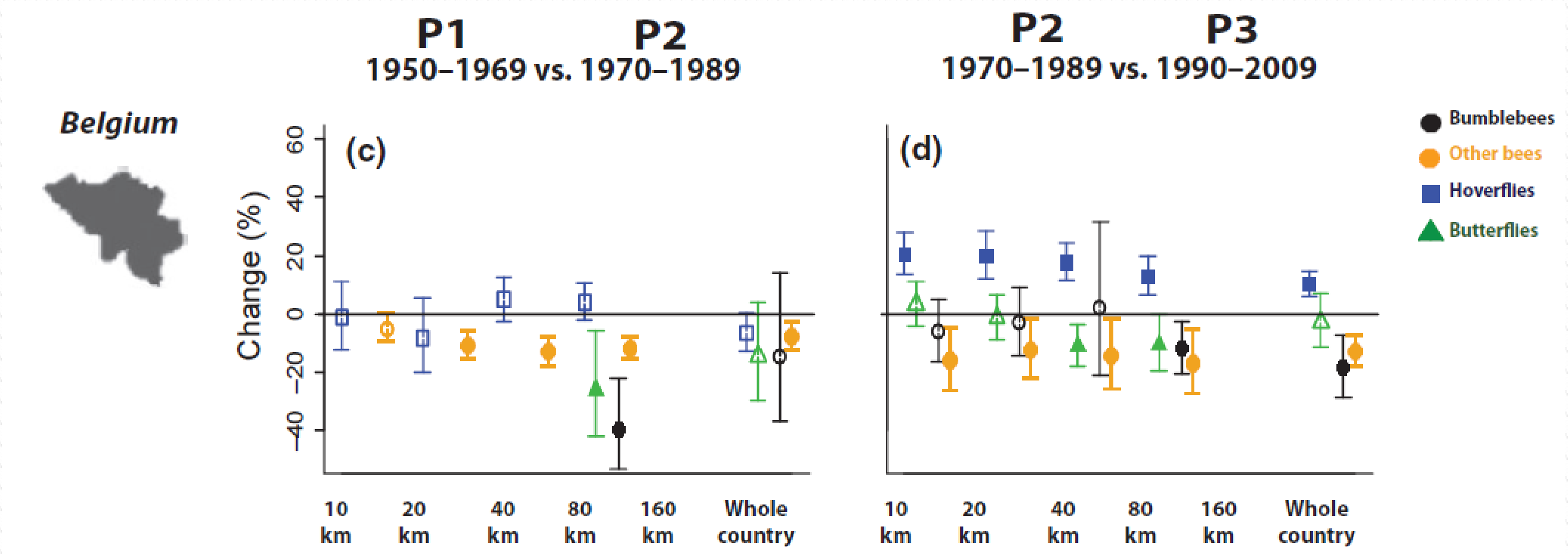
Evidences

- Observation of the decline on **specific richness** on wild bees, hoverflies and butterflies (Belgium, UK, Netherlands)



<u>**Example :**</u> Evolution of specific richness of pollinators in Belgium (Carvalheiro *et al*. 2013)

There is a decline ?

Evidences

- Observation of the decline on **specific richness** on wild bees, hoverflies and butterflies (Belgium, UK, Netherlands)
- Supported by other studies on **perturbations gradient**: urbanization, agricultural intensification,…
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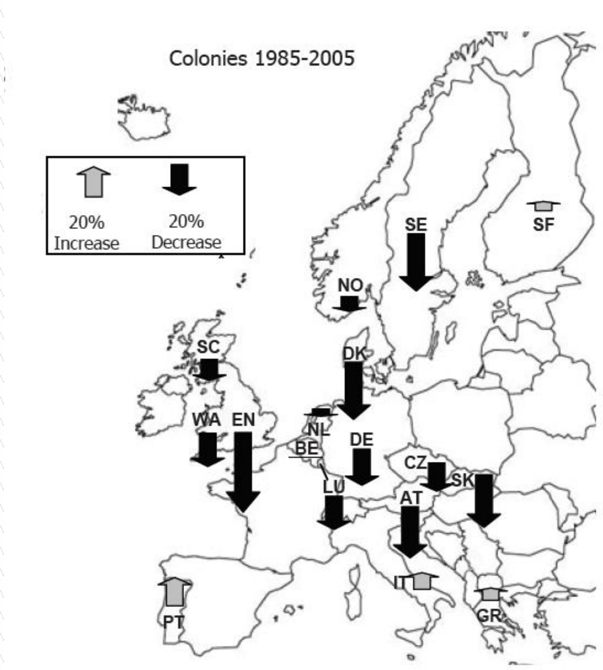
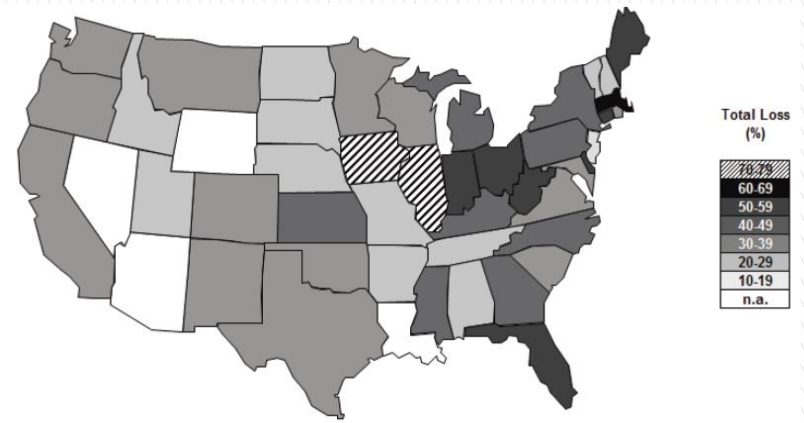


Potts (a) *et al.*, 2010

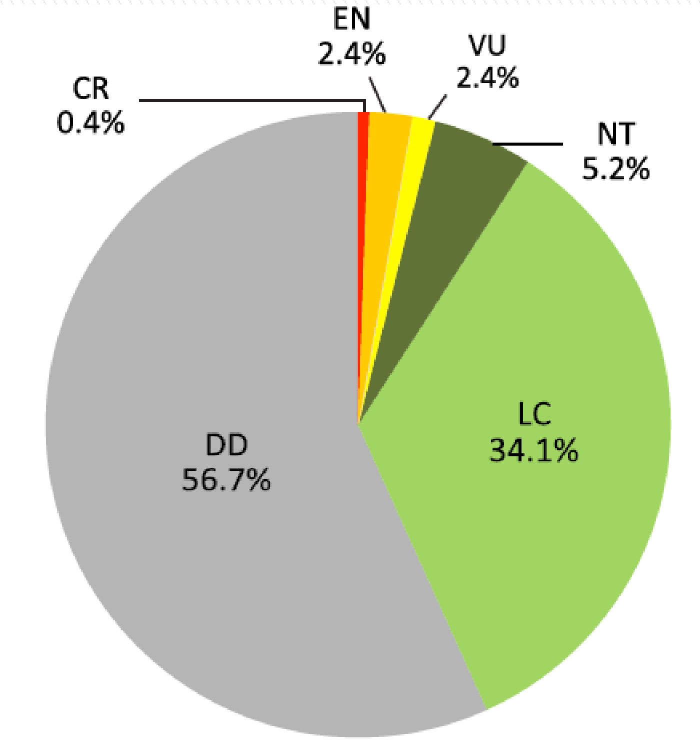


Van Engelsdorp *et al.*, 2009

Apis mellifera (L.)

There is a decline?

Limitations



- A lot of inventories and distribution maps but few data on the **specific abundance**
- No **global monitoring** scheme and **few** at continental or regional scale!

Status summary from the red list of the European wild bees (Ntot = 1965 sp).
CR = Critical Danger ; EN = Endangered; VU = Vulnerable;
NT = Near Threatened; LC = Least Concern; **DD = Deficient Data**
Niéto *et al.* 2013