Un point de vue sur les observatoires

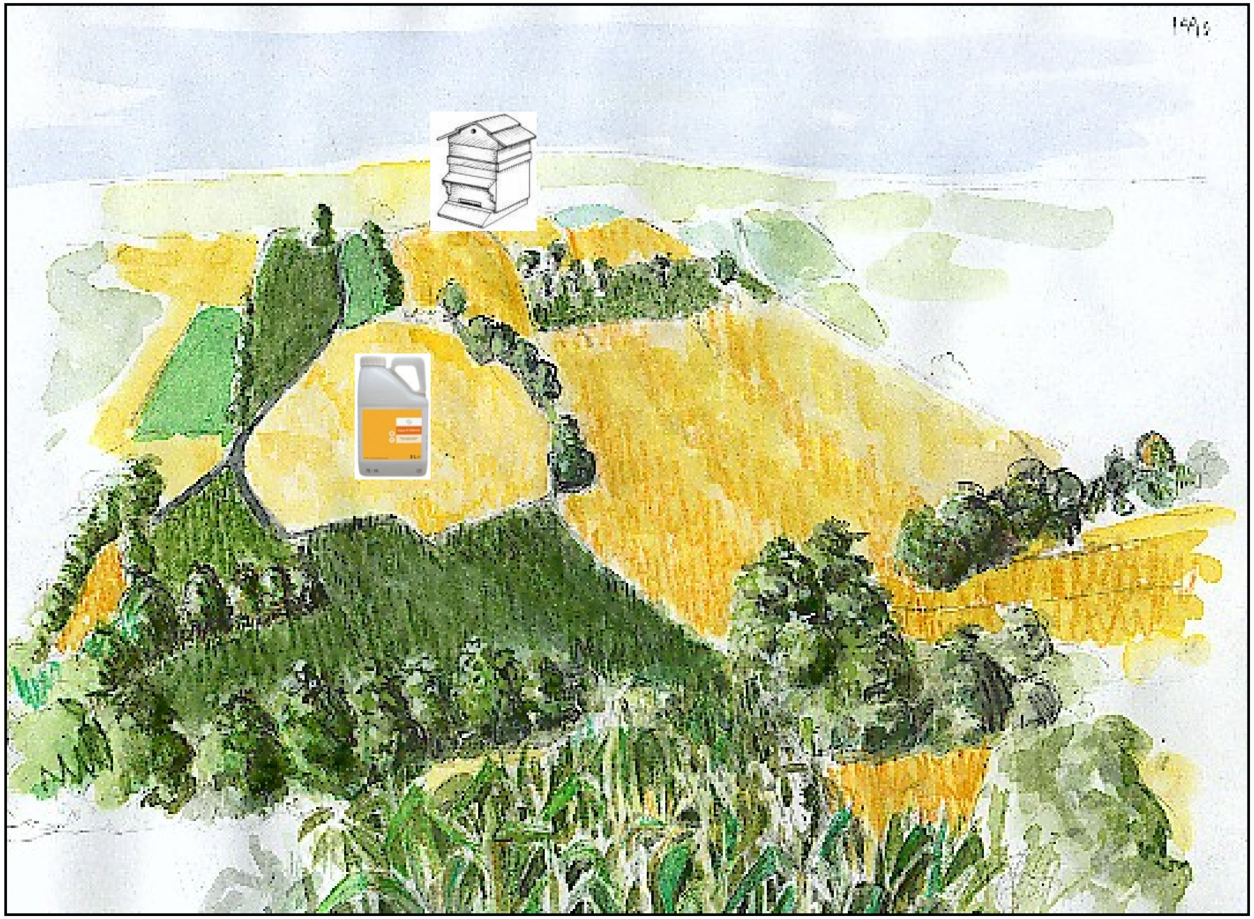
Concepts, démarches, objectifs, exemples

Axel Decourtye, André Kretzschmar, Fabrice Allier, Pascal Jourdan, Mickaël Henry, Jean-François Odoux, Pierrick Aupinel, Vincent Bretagnolle

ACTA – Le réseau des instituts des filières animales et végétales
Centre d'Études Biologiques de Chizé
INRA
ITSAP Institut de l'abeille
UMT PrADE

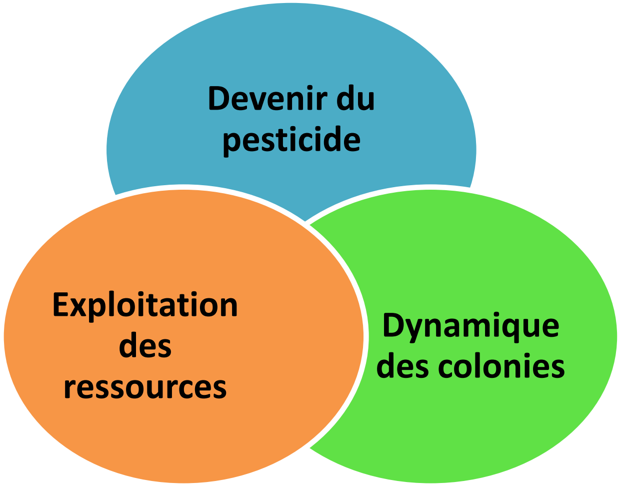
+ réseau des ADA

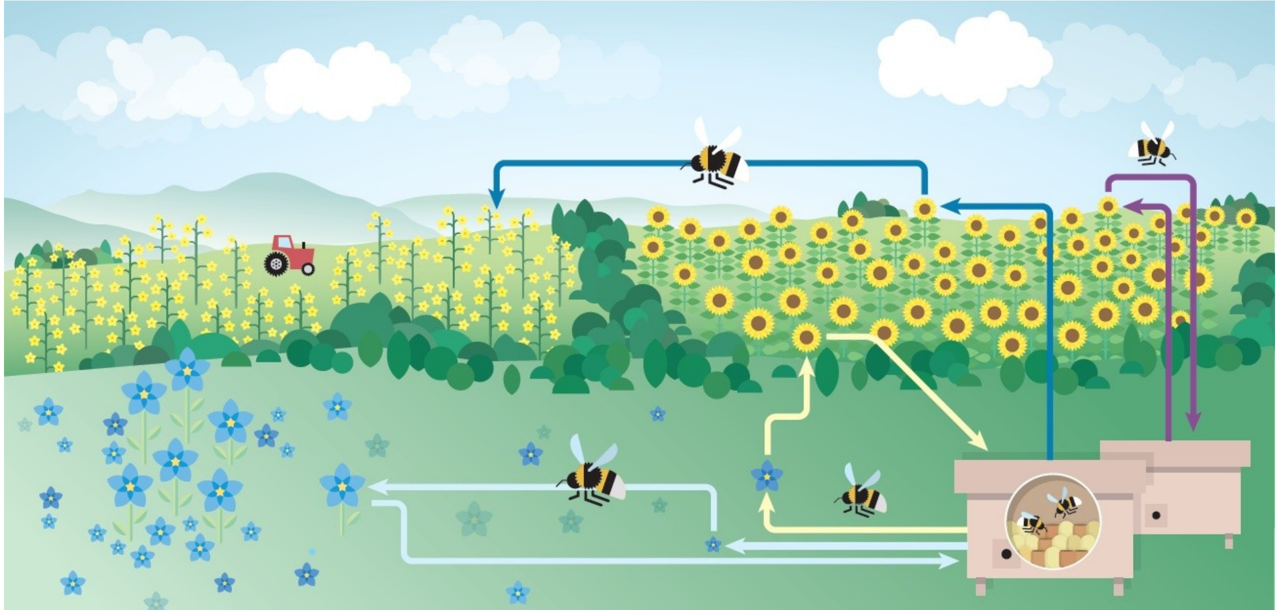
Changeons d'échelle !



Dépassons la vision réductrice : 1 parcelle/1 produit/1 rucher

Comment relier 3 compartiments aux processus complexes ?





Osborne, 2012

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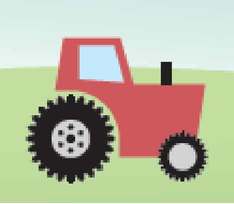
Besoin de simplification, de variables intégrantes : indicateurs

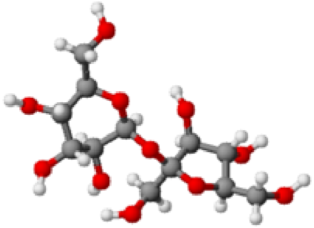
Permettent de mesurer de façon objective et simple un phénomène complexe.

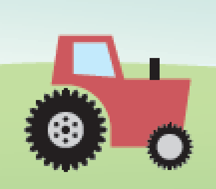
Usage des pesticides

Pression = Exposition

Impact sur les populations







Indicateurs d'usage des pesticides

Aujourd'hui

- IFT : Indice de fréquence de traitement
- NODU : nombre de doses unité
- QSA : Quantité de substances actives

Limites

- Pas prise en compte des traitements de semences
- Amalgames de produits
- Données brutes parfois imprécises, voire biaisées

Demain ?

- Spatialisation des traitements sur un territoire

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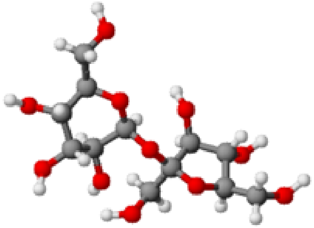

Indicateurs de pression

Aujourd'hui

- Analyses des résidus dans nectar, pollen, cire, abeilles

Limites

- Problèmes d'identification de la source
- Interprétation incomplète sur « effets cocktails », chroniques, faibles doses
- LOQ des analyses multi-résidus trop élevées
- Problèmes de la dégradation des produits
- Couteux

Demain ?

- Risque de contamination du nectar et du pollen
- Modélisation du butinage en fonction du paysage, et de la météo

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Indicateurs d'impact

Aujourd'hui

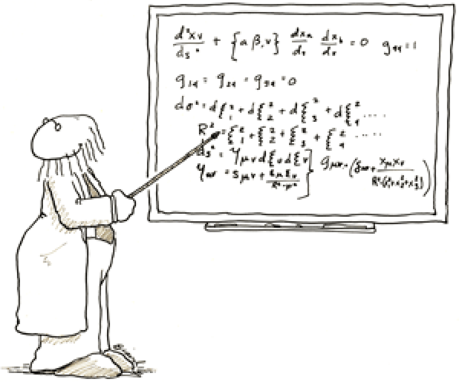
- Taille des populations
- Couvain, ponte
- Poids
- Réserves

Limites

- Echelles souvent réduites
- Compromis difficile entre grandes échelles/précision (détection d'affaiblissement)
- Couteux

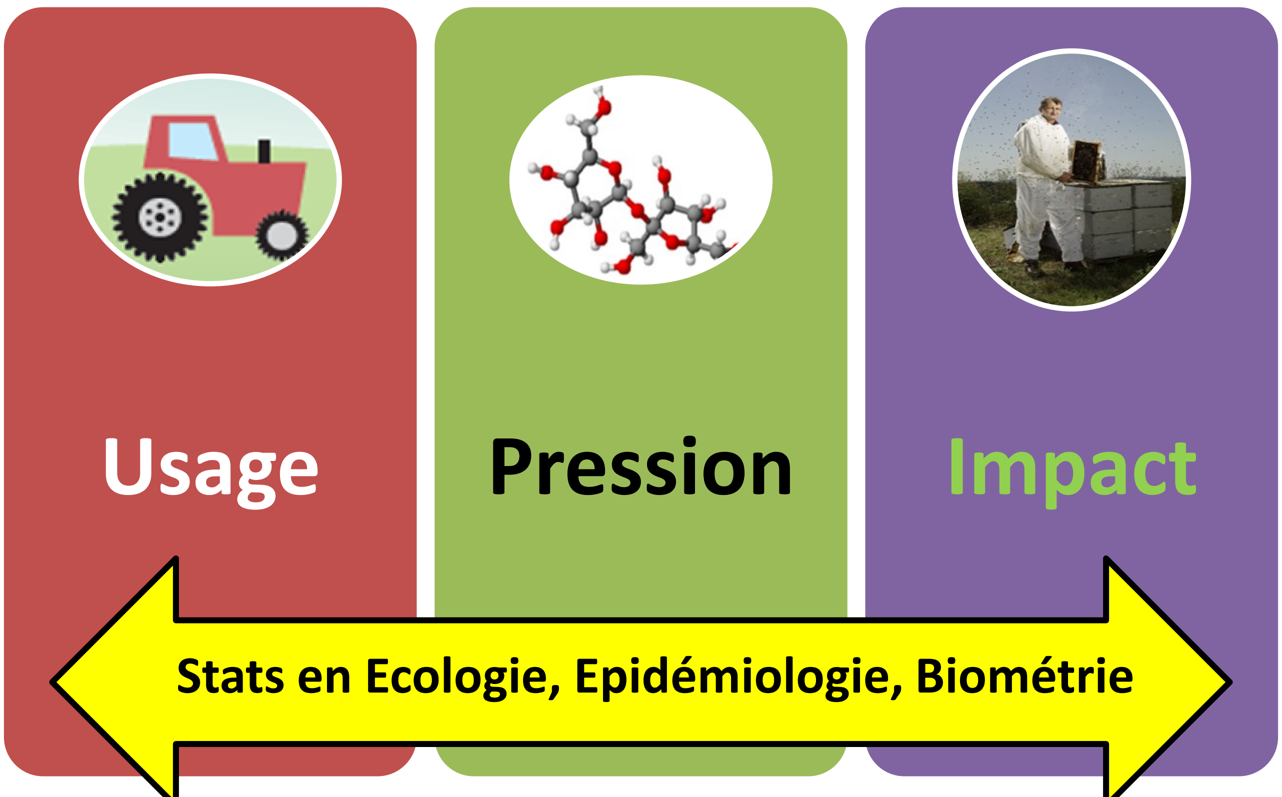
Demain ?

- Indicateurs physiologiques (vitéllogénine)
- Traits de vie individuels
- Enregistrements automatiques (balance, compteur…)



Relations statistiques entre les indicateurs

Trop souvent sous-estimé !



Prise en compte de la co-exposition

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PLoS one

High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health

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Abstract

Background: Recent declines in honey bees for crop pollination threaten fruit, nut, vegetable and seed production in the United States. A broad survey of pesticide residues was conducted on samples from migratory and other beekeepers across 23 states, one Canadian province and several agricultural cropping systems during the 2007–08 growing seasons.

Methodology/Principal Findings: We have used LC/MS-MS and GC/MS to analyze bees and hive matrices for pesticide residues utilizing a modified QuEChERS method. We have found 121 different pesticides and metabolites within 887 wax, pollen, bee and associated hive samples. Almost 60% of the 259 wax and 350 pollen samples contained at least one systemic pesticide, and over 47% had both in-hive acaricides fluvalinate and coumaphos, and chlorothalonil, a widely-used fungicide. In bee pollen were found chlorothalonil at levels up to 99 ppm and the insecticides aldicarb, carbaryl, chlorpyrifos and imidacloprid, fungicides boscalid, captan and myclobutanil, and herbicide pendimethalin at 1 ppm levels. Almost all comb and foundation wax samples (98%) were contaminated with up to 204 and 94 ppm, respectively, of fluvalinate and coumaphos, and lower amounts of amitraz degradates and chlorothalonil, with an average of 6 pesticide detections per sample and a high of 39. There were fewer pesticides found in adults and brood except for those linked with bee kills by permethrin (20 ppm) and fipronil (3.1 ppm).

Conclusions/Significance: The 98 pesticides and metabolites detected in mixtures up to 214 ppm in bee pollen alone represents a remarkably high level for toxicants in the brood and adult food of this primary pollinator. This represents over half of the maximum individual pesticide incidences ever reported for apiaries. While exposure to many of these neurotoxicants elicits acute and sublethal reductions in honey bee fitness, the effects of these materials in combinations and their direct association with CCD or declining bee health remains to be determined.

Citation: Mullin CA, Frazier M, Frazier JL, Ashcraft S, Simonds R, et al. (2010) High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health. PLoS ONE 5(3): e9754. doi:10.1371/journal.pone.0009754

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Competing Interests: The authors have declared that no competing interests exist.

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PLoS one

Exposure to Sublethal Doses of Fipronil and Thiacloprid Highly Increases Mortality of Honeybees Previously Infected by *Nosema ceranae*

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Aubière, France, 3 INRA, UMR 406 Abeilles & Environne…

Abstract

Background: The honeybee, *Apis mell…*
performed for twenty years suggest tha…
action of pathogens and chemicals are…
were poorly investigated in honeybee…
honeybee sensitivity to sublethal doses…

Methodology/Finding: Five days after…
controls, (ii) infected with *N. ceranae*, (ii…
infected with *N. ceranae* and exposed 1…
10 days p.i. to thiacloprid. Honeybee m…
content was evaluated 20 days after inf…
infected honeybees were exposed to su…
opposite effects on microsporidian spo…
that *N. ceranae* infection induced an i…
ethoxycoumarin-O-deethylase activity.

Conclusions/Significance: After exposu…
ceranae-infected honeybees than in u…
mortality, however, did not appear stro…
hypothesis that the combination of the…
contribute to colony depopulation.

Citation: Vidau C, Diogon M, Aufauvre J, Fontbonne …
Honeybees Previously Infected by *Nosema ceranae*. …

Editor: Elizabeth Didier, Tulane University School of …

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environmental microbiology

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Environmental Microbiology (2010) 12(3), 774–782 doi:10.1111/j.1462-2920.2009.02123.x

Interactions between *Nosema* microspores and a neonicotinoid weaken honeybees (*Apis mellifera*)

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Summary

Global pollinators, like honeybees, are declining in abundance and diversity, which can adversely affect natural ecosystems and agriculture. Therefore, we tested the current hypotheses describing honeybee losses as a multifactorial syndrome, by investigating integrative effects of an infectious organism and an insecticide on honeybee health. We demonstrated that the interaction between the microsporidia *Nosema* and a neonicotinoid (imidacloprid) significantly weakened honeybees. In the short term, the combination of both agents caused the highest individual mortality rates and energetic stress. By quantifying the strength of immunity at both the individual and social levels, we showed that neither the haemocyte number nor the phenoloxidase activity of individuals was affected by the different treatments. However, the activity of glucose oxidase, enabling bees to sterilize colony and brood food, was significantly decreased only by the combination of both factors compared with control, *Nosema* or imidacloprid groups, suggesting a synergistic interaction and in the long term a higher susceptibility of the colony to pathogens. This provides the first evidences that interaction between an infectious organism and a chemical can also threaten pollinators, interactions that are widely used to eliminate insect pests in integrative pest management.

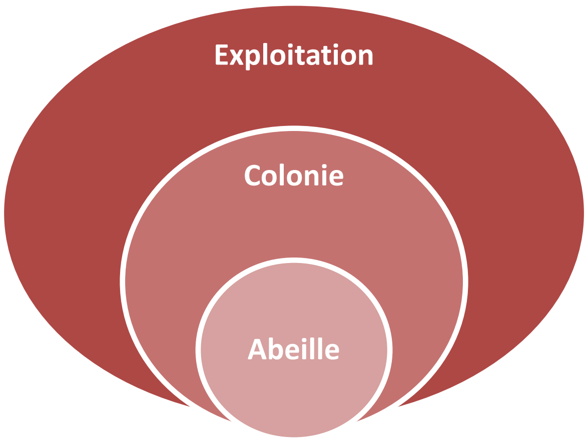
Received 16 July, 2009; accepted 27 October, 2009. *For correspondence. E-mail: cedric.alaux@avignon.inra.fr; Tel. (+33) 4 32 72 26 18; Fax (+33) 4 32 72 26 02.

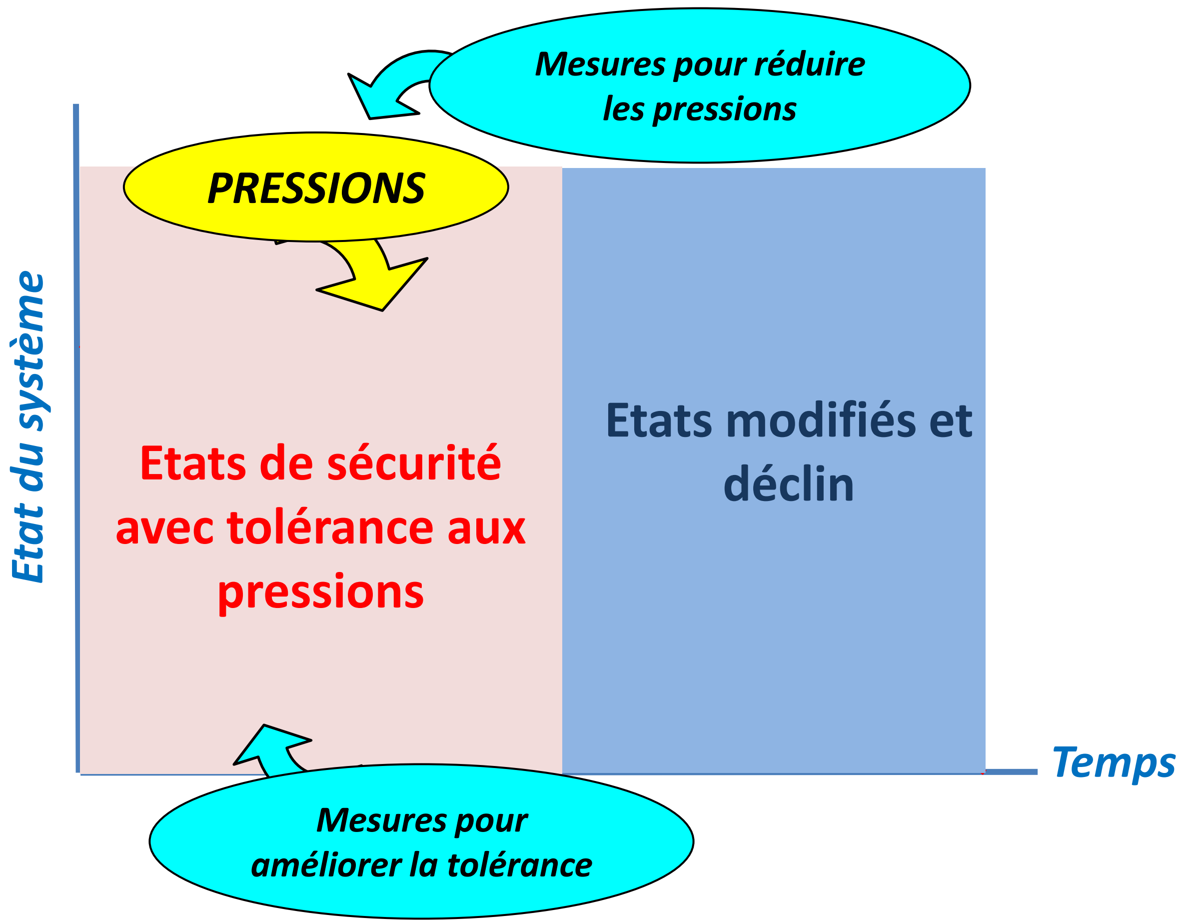
Introduction

The current decline in abundance and diversity of wild bees as well as honeybees has been reported in several regions of the world (Biesmeijer *et al.*, 2006; National Research Council of the National Academies, 2007). The magnitude of this pollinator crisis is believed to not only have a deep impact on agriculture and its related economy (Gallai *et al.*, 2009) but also on plant diversity (Biesmeijer *et al.*, 2006) and landscapes (Ricketts *et al.*, 2008). The most spectacular pollinator decline concerns honeybee colonies, which are disappearing en masse in USA and Europe (Faucon *et al.*, 2002; Higes *et al.*, 2005; Oldroyd, 2007; Stokstad, 2007). Although many stressors have been identified as a potential cause or indicator of colonies losses, including viruses (Cox-Foster *et al.*, 2007), microsporidia pathogens (Higes *et al.*, 2008; 2009) and pesticides (Frazier *et al.*, 2008), a combination of multiple agents is more likely to contribute to honeybee losses. Therefore, investigations have to be carried out on integrative effects of different agents.

A large spectrum of pesticides is used to manage crop pests. But as an alternative, and to reduce the harmful effects of chemicals on non-pest organisms and human, new eco-friendly strategies for controlling crop pests have been developed. These biological controls include the use of microbial pathogens like viruses, bacteria and fungi. Modern crop management integrates these different techniques in a compatible manner leading to an integrated pest management (IPM) (Maredia *et al.*, 2003). The most extensively used biological agents are fungi, which are often associated with insects [around 750 species are pathogens of insects (Carruthers and Soper, 1987)]. Entomopathogenic fungi and chemical insecticides used together significantly improve the lethality of control agents. Indeed, when fungi are delivered with sub-lethal doses of pesticides, they interact synergistically in killing insects (Purwar and Sachan, 2006). Among the insecticides, the neonicotinoid imidacloprid is one of the most effective in interacting synergistically with fungi. And IPM using the synergy between imidacloprid and fungal spores is commonly used for killing a variety of insect pests, like termites, thrips and leaf-cutter ants

Des analyses globales motivées par des hypothèses





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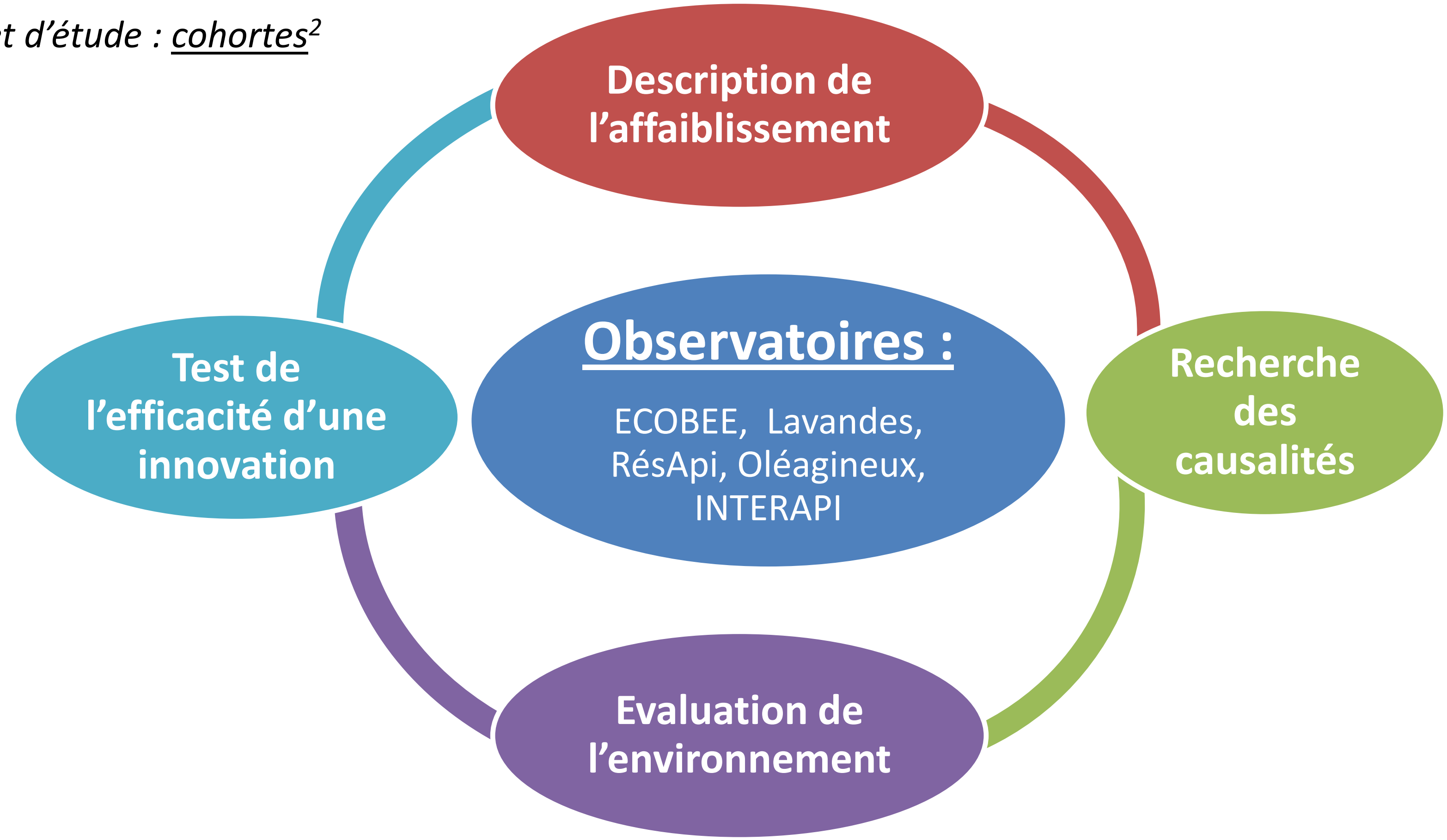
Objectifs des observatoires[1]

1 : Un dispositif mis en œuvre <u>par plusieurs partenaires</u> pour suivre l'évolution d'un ou plusieurs phénomènes, <u>dans l'espace et dans le temps</u> (Moine A., 2007. Le territoire : comment observer un système complexe.)

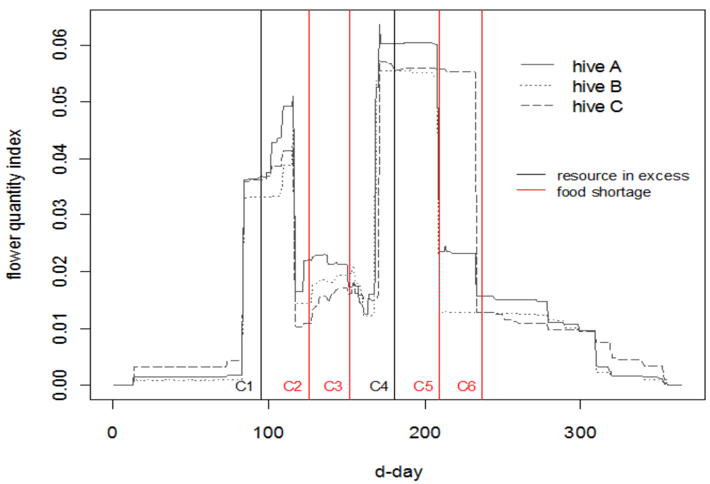
Objet d'étude : <u>cohortes</u>[2]

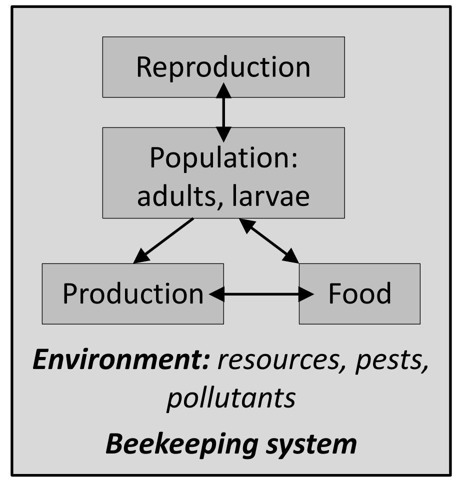


2 : Une cohorte désigne un <u>ensemble d'individus</u> ayant vécu un même événement au cours d'une même période (Wikipedia).

Exemples d'observatoires actuels de ruchers en agrosystèmes : cohortes définies ***a posteriori***

Situation :	**Grandes cultures - POLINOV (ACTA)**	**Lavandes (INRA/ADAPI)**	**Oléagineux (CETIOM/ITSAP+ADA)**
Contexte :	Irrégularité spatio-temporelle des ressources trophiques	Instabilité de la production	Suspicions d'intoxication





Question :	**Quelle influence sur les traits de vie ?**	**Quels profils à risque ?**	**Quels sont les symptômes rencontrés ?**
Echelles :	**d'avril à octobre (pas ITK api pro)** **250 ruches (5/an x 10 sites x 5 ans)**	**miellée (ITK api pro)** **336 ruches/an (14/rucher, 24 ruchers)**	**d'avril à octobre (ITK api pro)** **72 ruches/an (12 x 6 sites)**

Variables étudiées : **Traits populationnels (survie, croissance, santé, capacité de récolte)**

+ traits de vie individuels (sorties, longévité)	+ biomarqueurs physiologiques	+ comportement sur planche d'envol

(suite) Exemples d'observatoires actuels de ruchers : cohortes définies *a priori*

	Parcours de professionnels – RésApi (ACTA/ITSAP+ADA)	Grandes cultures – InterApi (ITSAP)
Situation :	**Parcours de professionnels – RésApi (ACTA/ITSAP+ADA)**	**Grandes cultures – InterApi (ITSAP)**
Contexte :	Pertes hivernales	Manque de ressources en pré-hivernage
Question :	**Quelles sont les causes des pertes ?**	**Est-ce que les cultures intermédiaires mellifères sont une mesure compensatoire?**
Cohortes :	**Parcours à risque *versus* parcours à moindre risque (?)**	**Environnement aménagé *versus* environnement non aménagé**
Echelles :	**de mars à mars (ITK api pro)** **432 ruches/an (24 x 2 parcours/api x 9 api)**	**de septembre à avril (ITK api pro)** **240 ruches/an (30 x 8 sites)**
Fonctions étudiées :	**Traits populationnels (survie, croissance, santé, capacité de récolte)** + biomarqueurs physiologiques, analyses pathologiques et des résidus	**Traits populationnels (survie, croissance, santé, capacité de récolte)** + biomarqueurs physiologiques, analyses des résidus

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Les points essentiels

- Poser des hypothèses
- Définir « le acquis / le non acquis », « le champ / le hors champ »
- Utiliser des indicateurs validés (publiés, appliqués *in situ*)
- Anticiper les phases de centralisation, de structuration et d'analyses des données
- Rechercher la pluridisciplinarité (réellement !)
- Chercher le compromis entre le plan d'échantillonnage (échelle, représentativité) & degré de précisions des indicateurs -> Et la science participative en apiculture ??
- Assurer un retour vers les observateurs

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Merci