EFSA Scientific Workshop, 9 September 2013

Non-*Apis* bees testing and risk assessment

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EFSA GD on risk assessment on bees

- ✓Risk assessment scheme for honey bees
- ✓Risk assessment scheme for bumblebees
- ✓Risk assessment scheme for solitary bees

Same tiered approach for all schemes

Why specific RA schemes for Non-*Apis* bees?

- The group of Apiformes (“Bees”) comprises 7 families and > 16.000 species;
- Differences in life cycle, behavioral, morphological and physiological features;
- Different exposure to pesticides (qualitative and quantitative);
- Differences in pesticides sensitivity.

Level of sociality

Highly eusocial bees
Perennial colonies (>10.000 individuals)

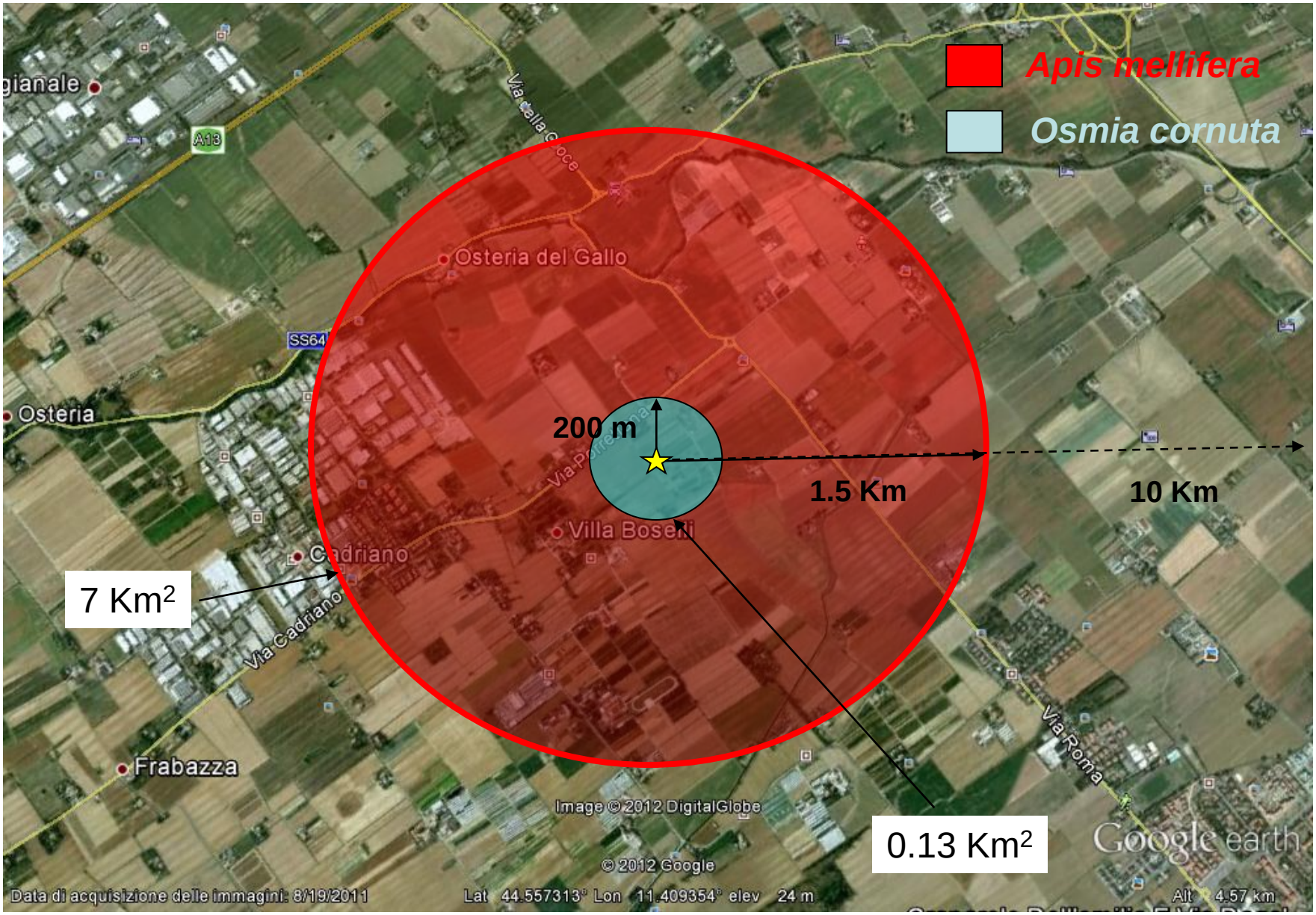
Primitively eusocial bees
Annual colonies (100-400 individuals)

Pre-social bees
Two or more sister adult bees cooperate in the provision of the same nest

Solitary bees
Each female builds and provisions her own nest without assistance from other bees

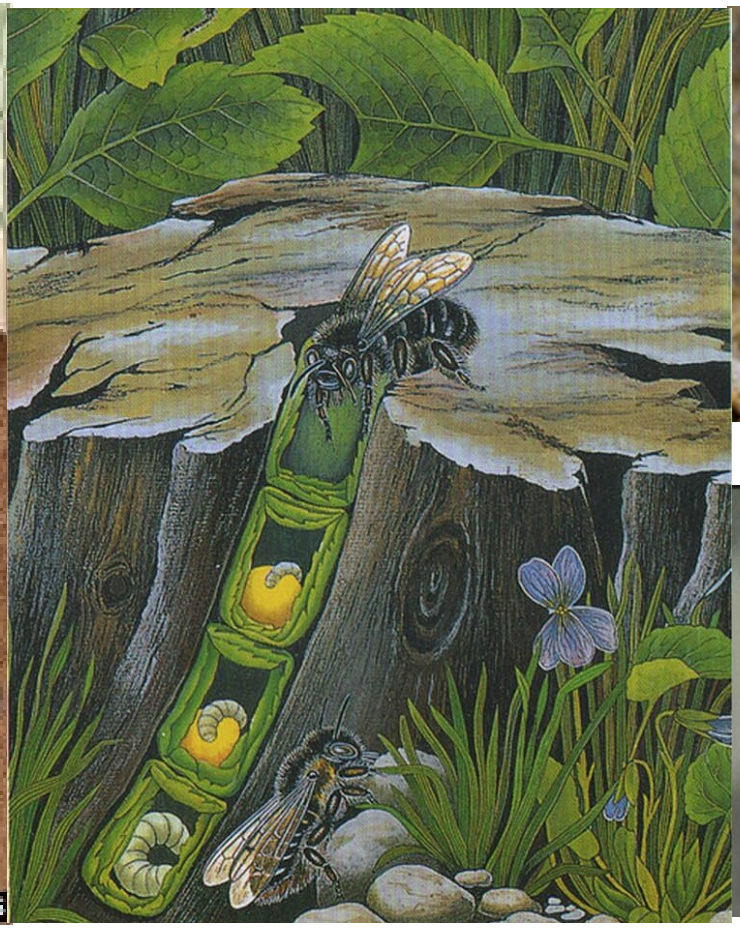
More than 85% of the species of bees are solitary

Foraging range



Nesting site

Nesting structures and materials



Provision with a mix of pollen and nectar

Egg

Mud partition

Larval exposure: unprocessed *vs* processed food

Pollen consumption of *Bombus terrestris* (worker) larvae: 10.3-39.5 mg/day

Pollen consumption of *Osmia cornuta* ( ) larvae: 387 mg in 30 days

Pollen consumption of *Apis mellifera* (worker) larvae: 1.5-2 mg in 5 days

Risk comparison

EFSA Opinion 2012

FACTORS	EXPECTED PESTICIDE IMPACT Expected higher risk in:	Bumblebees *vs* Honey bees	Solitary bees *vs* Honey bees
Body size	Smaller bees (Higher ratio surface/volume)		
Nesting period	Bees with short nesting period		
Foraging range	Bees with short foraging range		
Floral specialization	Oligolectic species		
Nesting location and nest construction	Bees nest or nesting material in or near the area of pesticide application		
Population/colony size	Smaller populations and social species with smaller colonies		
Level of sociality	Non social bees		
Voltinism	Monovoltin species/annual colonies		
Flight season	Bees with long flight season		

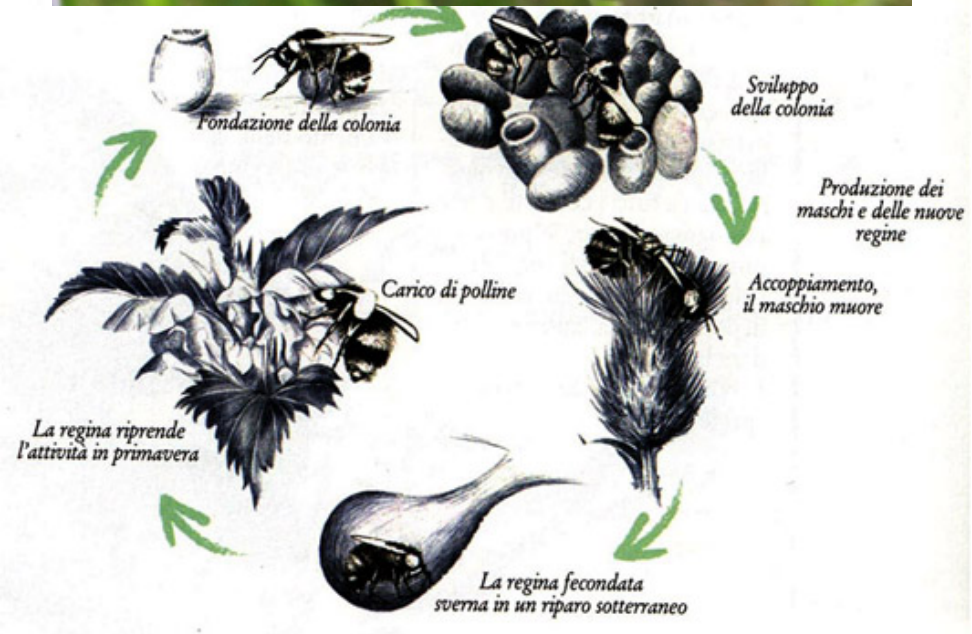
Trigger values

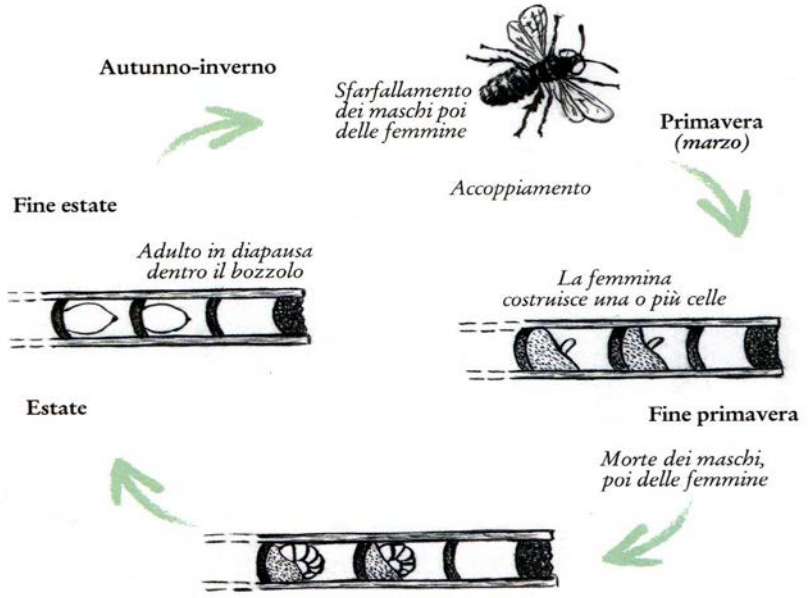
Endpoint	Honey bees	Bumble bees	Solitary bees
Acute contact LD50 downward spray upward/sideward spray	 HQ <42 HQ <85	 HQ <7 HQ <14	 HQ <8 HQ <16
Acute oral LD50	ETR <0.2	ETR <0.036	ETR <0.04
Chronic oral LC50	ETR <0.03	ETR <0.0048	ETR <0.0054
Larval toxicity NOEC	ETR <0.2	ETR <0.2	ETR <0.2
Development hypopharyngeal glands	ETR <1	Not assessed	Not assessed

Non-*Apis* bees are potentially more vulnerable than honey bees (→Assessment factor of 5).

Specific models for bumblebees and solitary bees are needed.

Risk assessment schemes for bumblebees and solitary bees





Why *Bombus terrestris* and *Osmia* spp. as test species?

- It is possible to obtain large populations;
- The biology of these species is well known;
- They are representative of many bee species in the group of bumblebees and solitary bees;
- Several toxicological studies are available in literature.

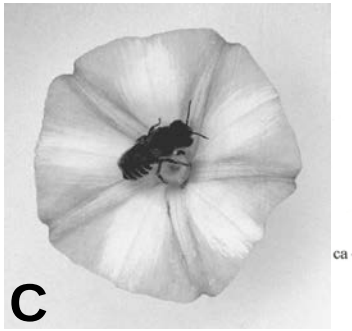
Test protocols for bumblebees and solitary bees

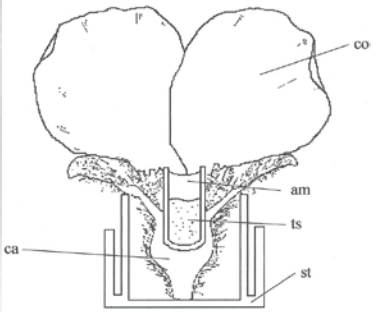
- Lower tier studies:

  Acute oral toxicity test on adults;

  Acute contact toxicity test on adults.

In oral toxicity test, *Apis mellifera* is fed in common feeder because it shows trophallaxis behavior. Group feeding is not applicable for Non-*Apis* bees.





A: Film canister;
B: Glass vial;
C: Method “flower”

Table I. Percent feeding success in *Osmia lignaria* females, *Megachile rotundata* females, and *Apis mellifera* workers offered 10 µL of sugar solution using three individual feeding methods under four light regimes (n = 20 per species/feeding method/light regime).

Bee species	Feeding method	Light regime			
		Natural light	Cool-white light	Gro-Lux light	Darkness
O. lignaria	Film canister	5	0	0	5
	Glass vial	5	0	0	10
	Flower	90	80	75	70
M. rotundata	Film canister	15	25	10	15
	Glass vial	20	60	25	40
	Flower	95	90	100	70
A. mellifera	Film canister	35	50	30	20
	Glass vial	45	50	60	15
	Flower	95	95	80	45

Ladurner et al. (2003) *Apidologie*

Test protocols for bumblebees and solitary bees

Test species	***Apis mellifera***	***Bombus terrestris***	***Osmia cornuta/O. bicornis***
Test conditions	T = 25 °C in darkness	T = 25°C in darkness	T = 22°C; L:D = 12:12
Feeding	group	individual	individual
Reference compound	dimethoate	dimethoate	dimethoate
Test bees	Young worker bees	Worker bees of avarage size and ages from young colonies	Females emerged from cocoons about 24h before the test
Endpoint	LD50 (µg/bee)	LD50 (µg/bee)	LD50 (µg/bee)
N° bees/dose	30	30	30
References	OECD 213 and 214	Van der steen et al. (1996)	Ladurner et al. (2003)

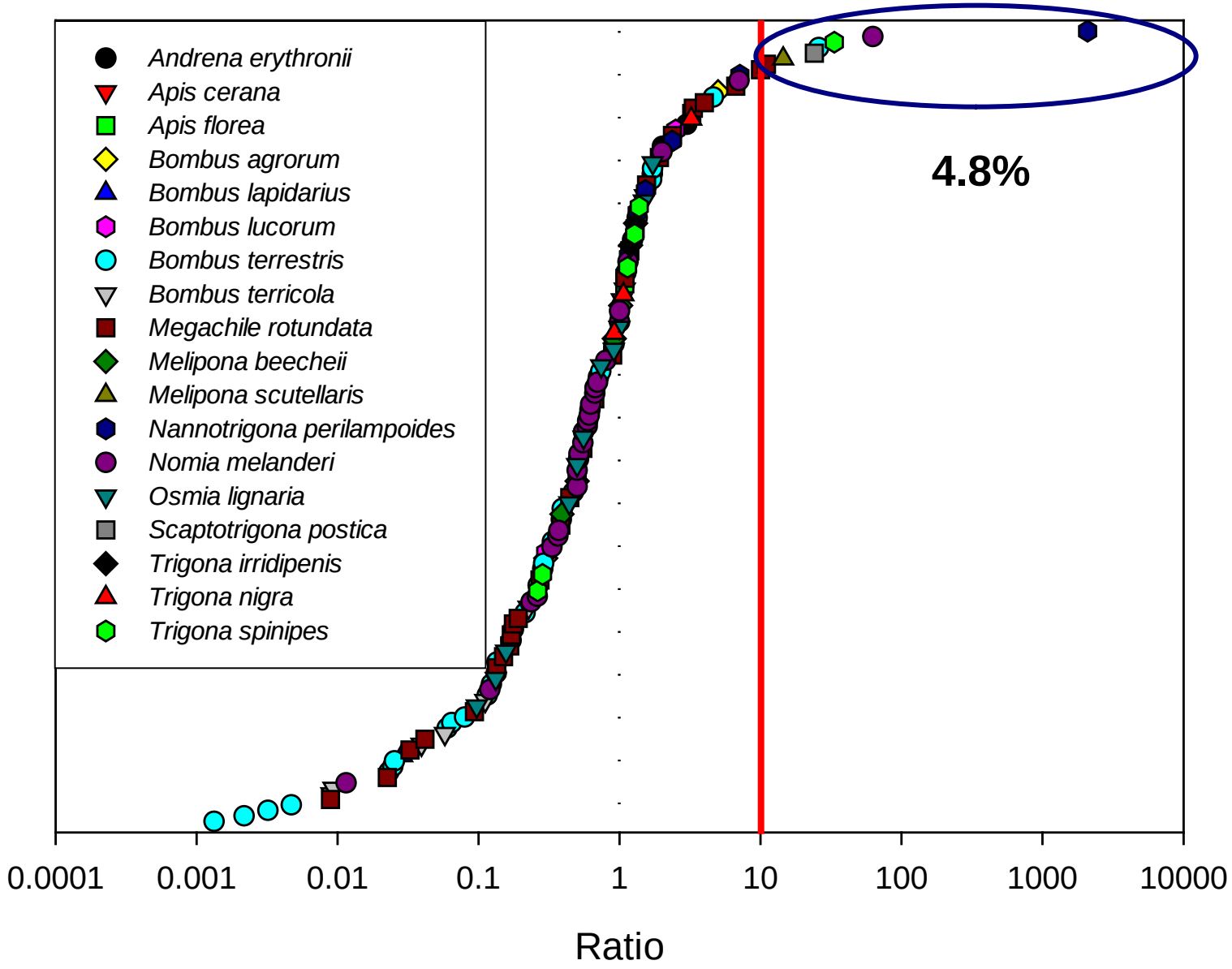
Extrapolation from HB endpoint to BB and SB endpoints

- An assessment factor of 10 is proposed to extrapolate from honey bee endpoint (LD50s) to endpoints for bumblebees and solitary bees;
- In 95% of the cases the difference in sensitivity of bee species is less than a factor 10 (Arena and Sgolastra, *submitted to Ecotoxicology*).

Bee sensitivity

- Systematic review of all the relevant literature followed by a meta-analysis;
- Calculation of the sensitivity ratio (R) comparing the same endpoints (LD50s and LC50) for *Apis mellifera* and for another species of bees;
- 145 case studies including 18 bee species, 49 insecticides and 2 fungicides.

Bee sensitivity



Arena and Sgolastra, *submitted to Ecotoxicology*

Higher tier studies for Non-*Apis* bees

***Bombus* Endpoints**	***Osmia* Endpoints**
Total reproductive output	Cell production rate
Queen vs male production	Offspring production
Queen hibernation survival	Offspring sex ratio
Nest “founding” success the following spring by queens	Progeny survival and post-emergence performances in the next spring

No standardised semi-field and field study designs.

Further researches are needed

Higher tier studies for BB

A

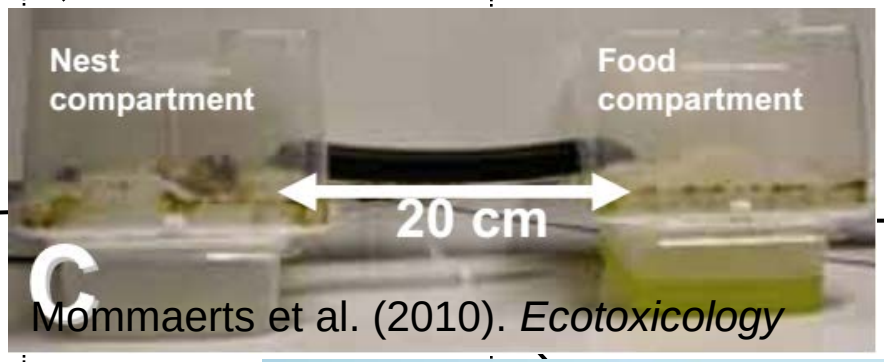
B

C

Short-term effect/exposure on adults

Greenhouse or tunnels study

Long-term effect/exposure on adults



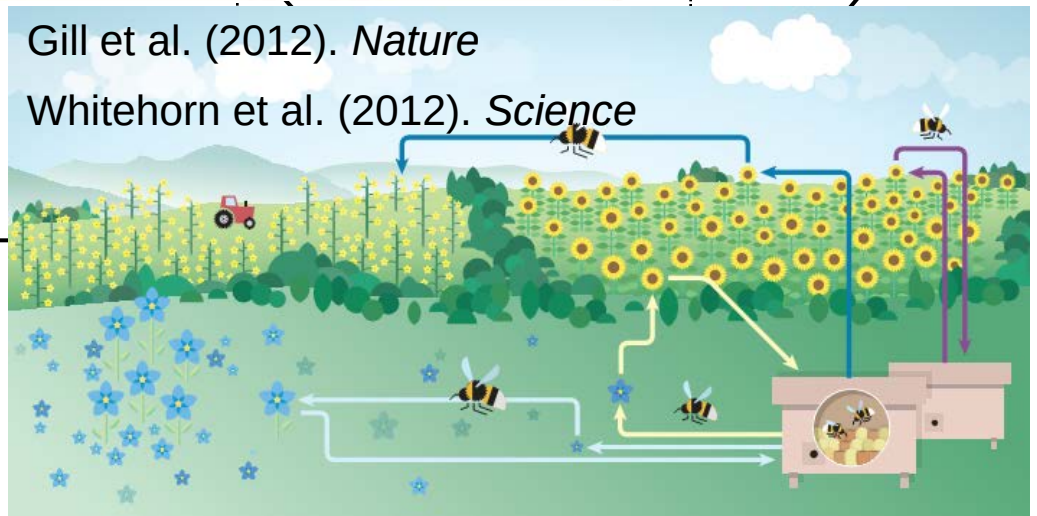
Mommaerts et al. (2010). *Ecotoxicology*

Field study

Effects on larvae

Gill et al. (2012). *Nature*

Whitehorn et al. (2012). *Science*



Higher tier studies for SB

A

B

C

Short-term effect/exposure on adults

Long-term effect/exposure on adults

Effects on larvae

Ladurner et al. (2008). *J. Econ. Entom.*

Konrad et al. (2008). *Plos One;* Sgolastra et al. *in preparation*

Field study

Thank you for your attention