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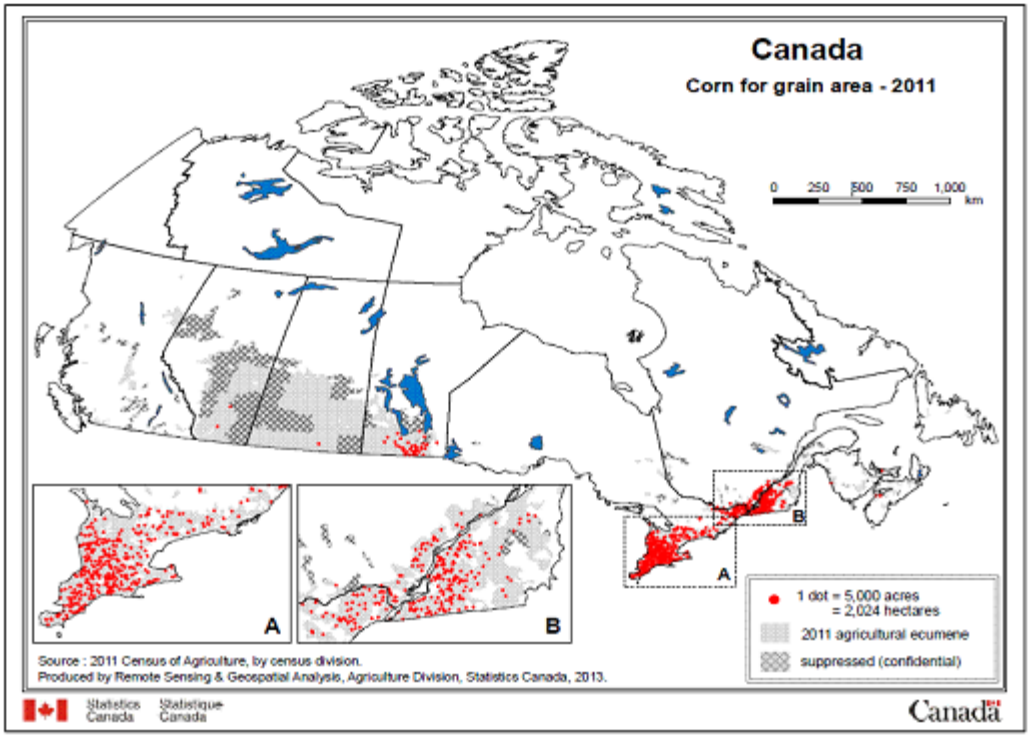
Neonicotinoids and honey bees
Also, Bee 'Omics Update

Nadia Tsvetkov

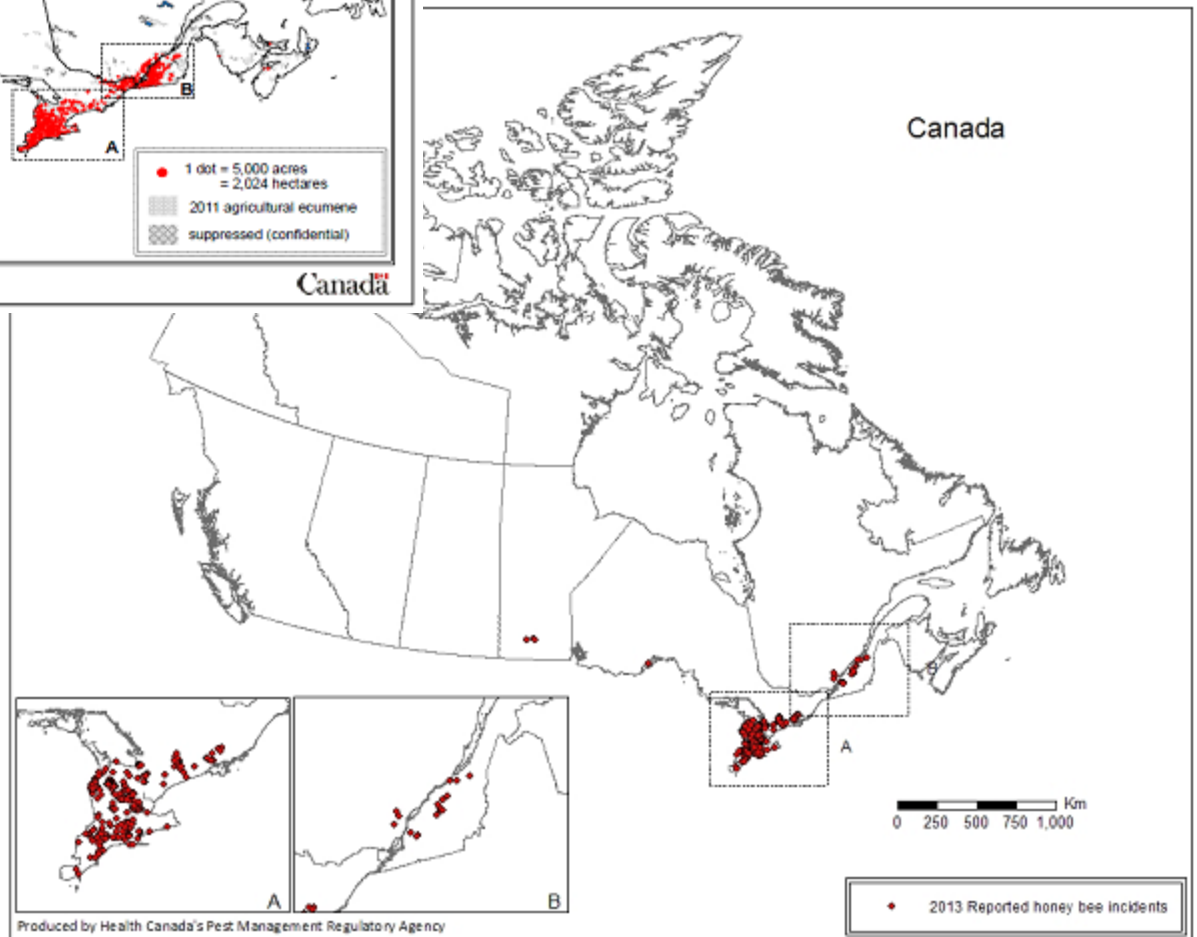
Zayed Lab – York U

Systemic Pesticide

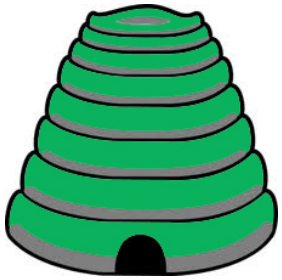
Figure 2 Principal Growing Regions of Corn in Canada, 2011



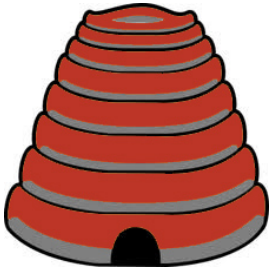
ed Honeybee Incidents Across Canada, 2013



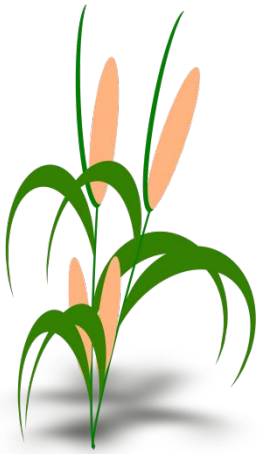
Field Study



Unexposed



Exposed



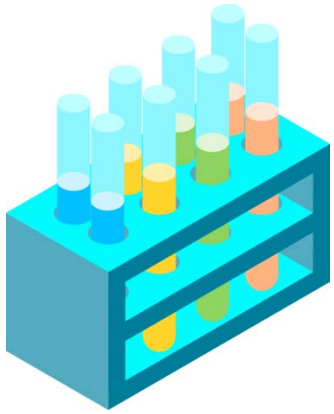
Pesticide Residues

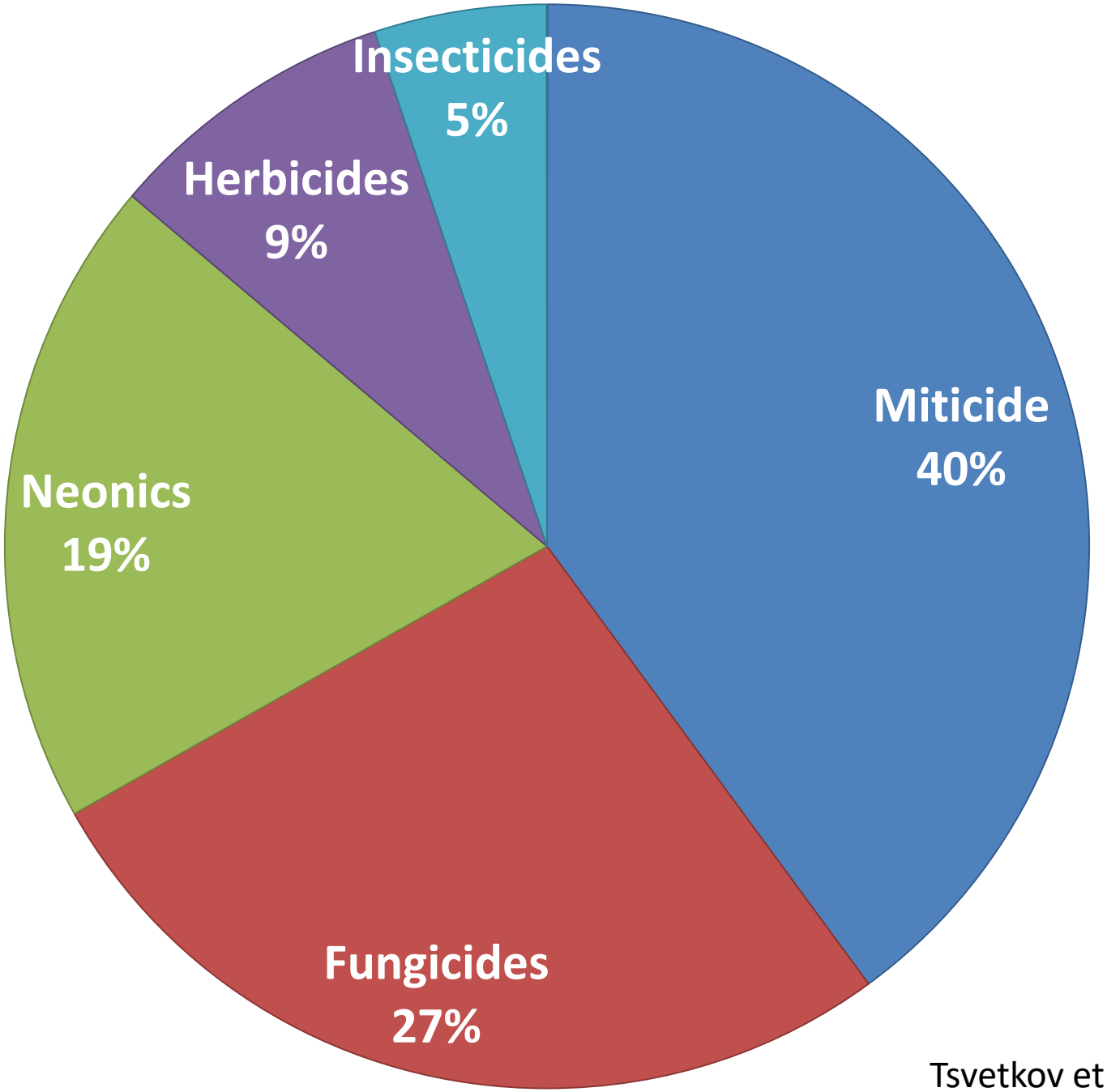
Behaviour

Results – Who?

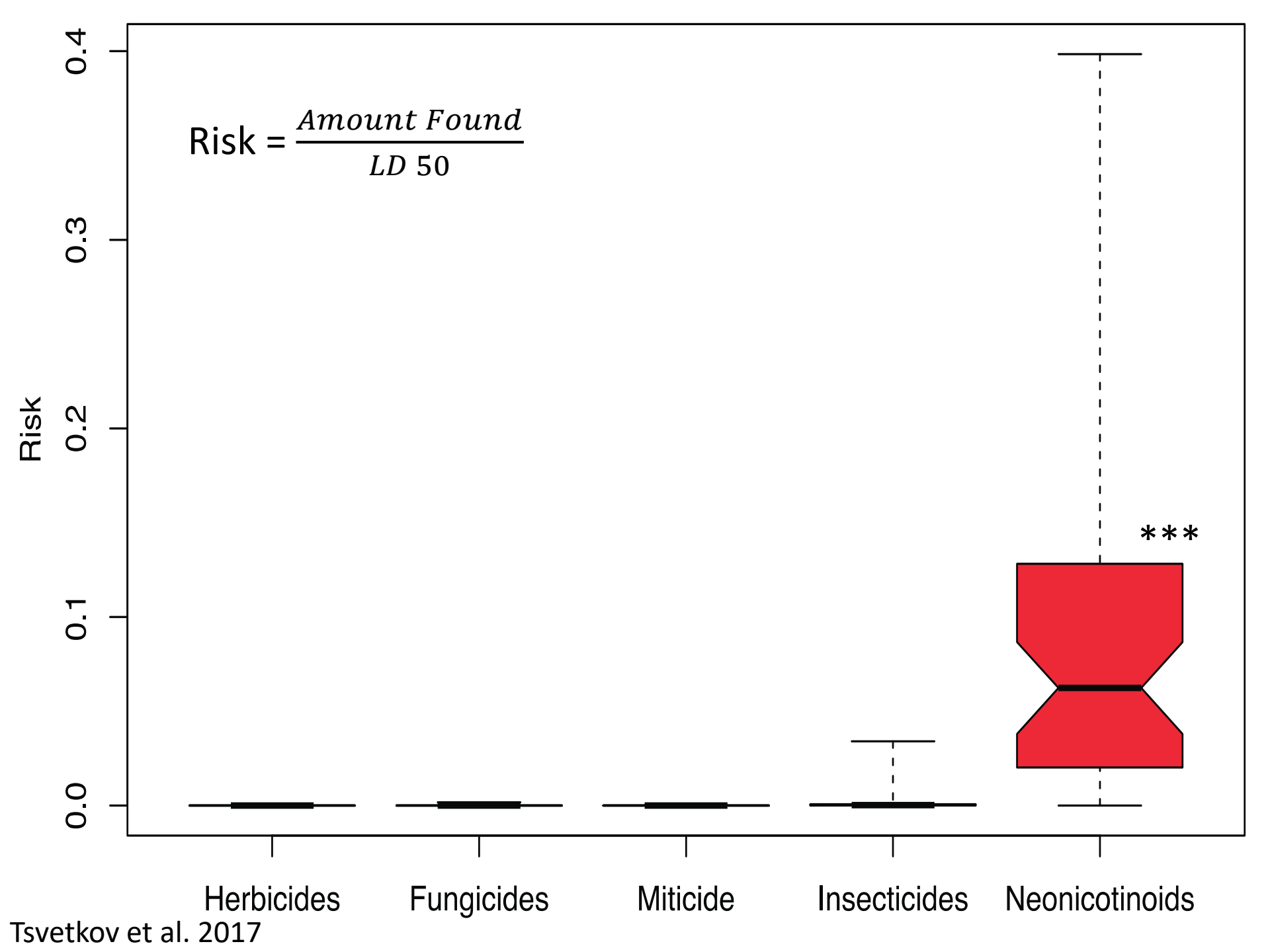
- Tested 231 different agrochemicals

- 26 different agrochemicals



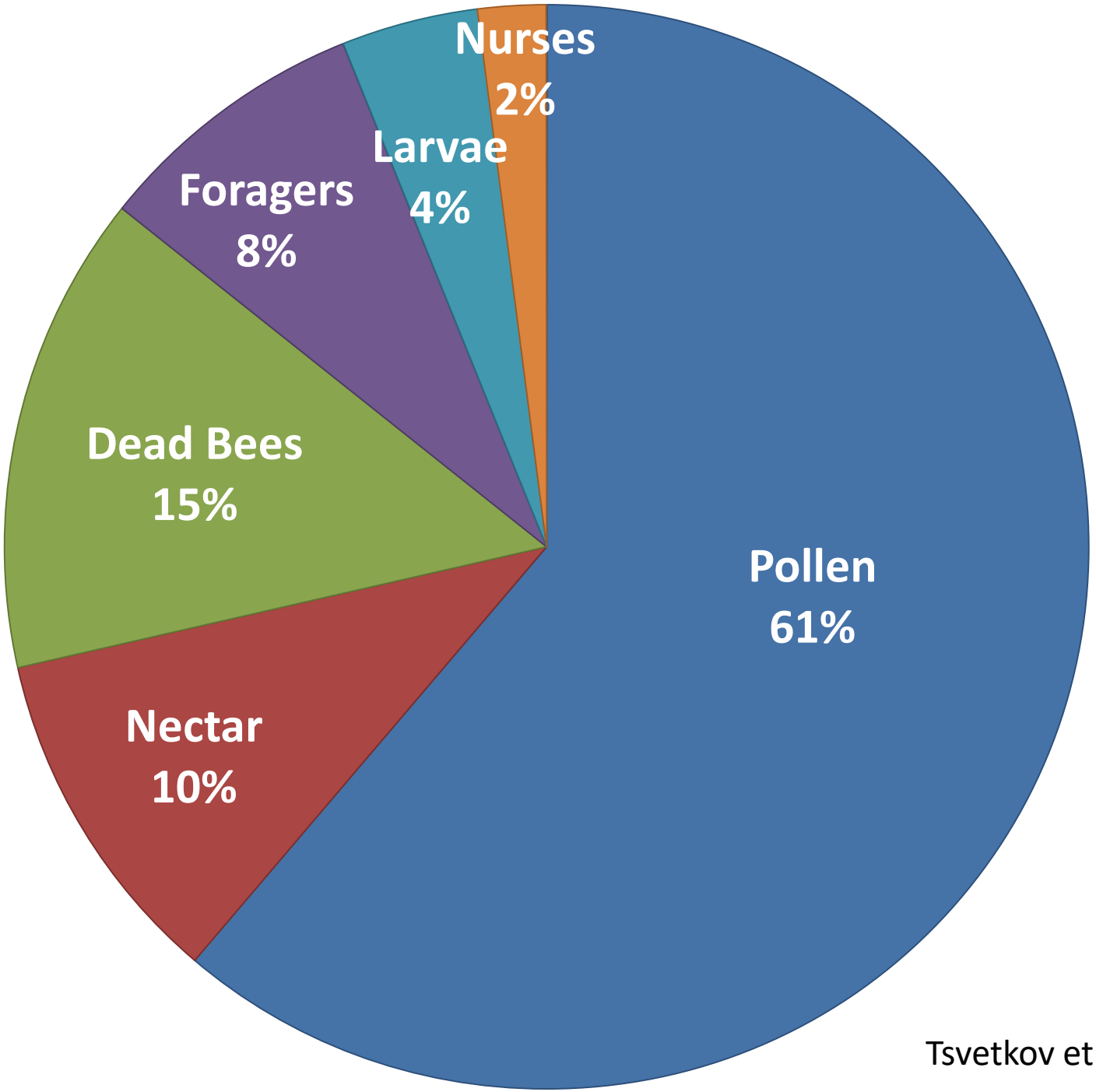


Tsvetkov et al. 2017



Tsvetkov et al. 2017

Results – Where?

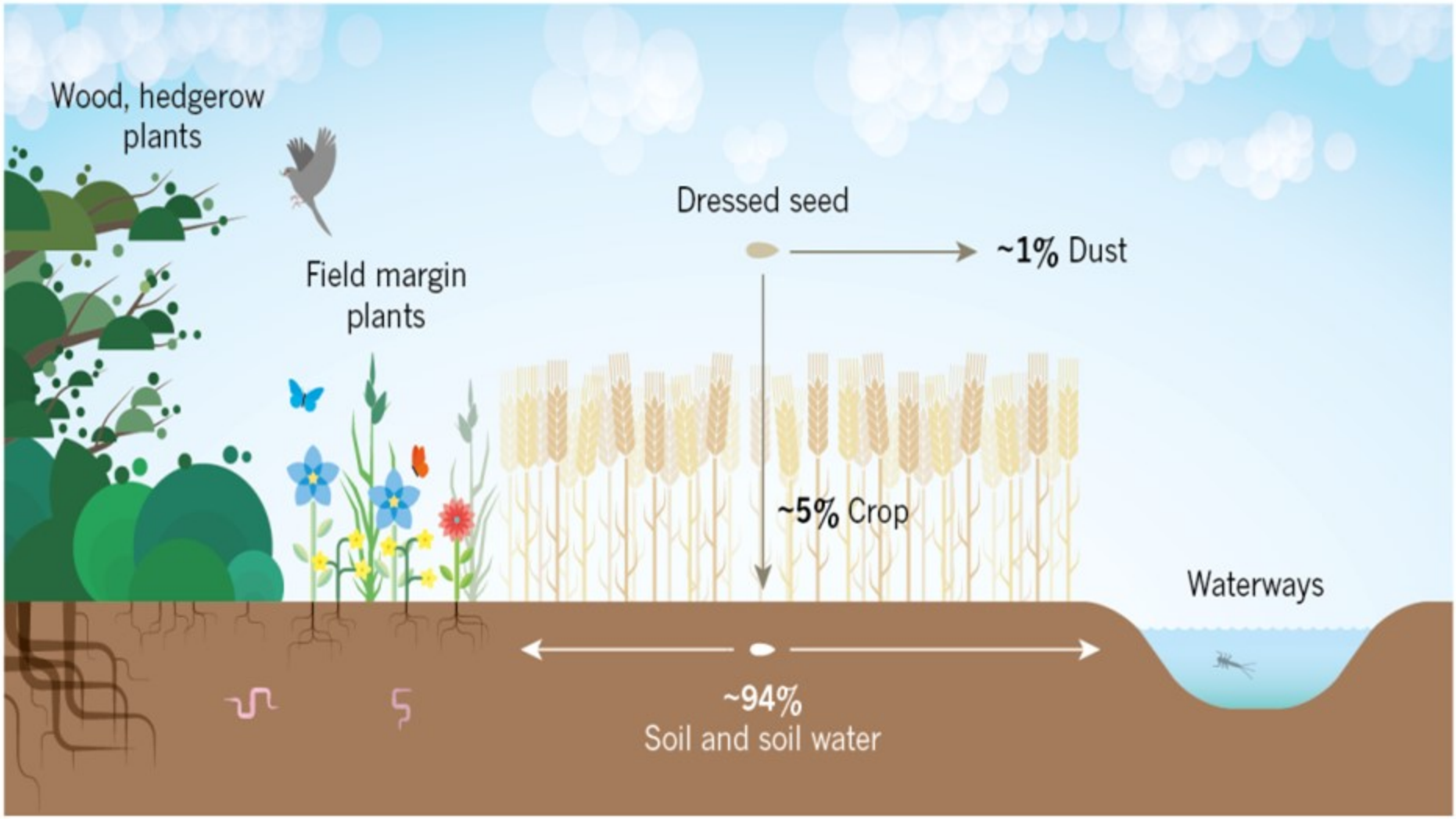


Tsvetkov et al. 2017

Pollen ID

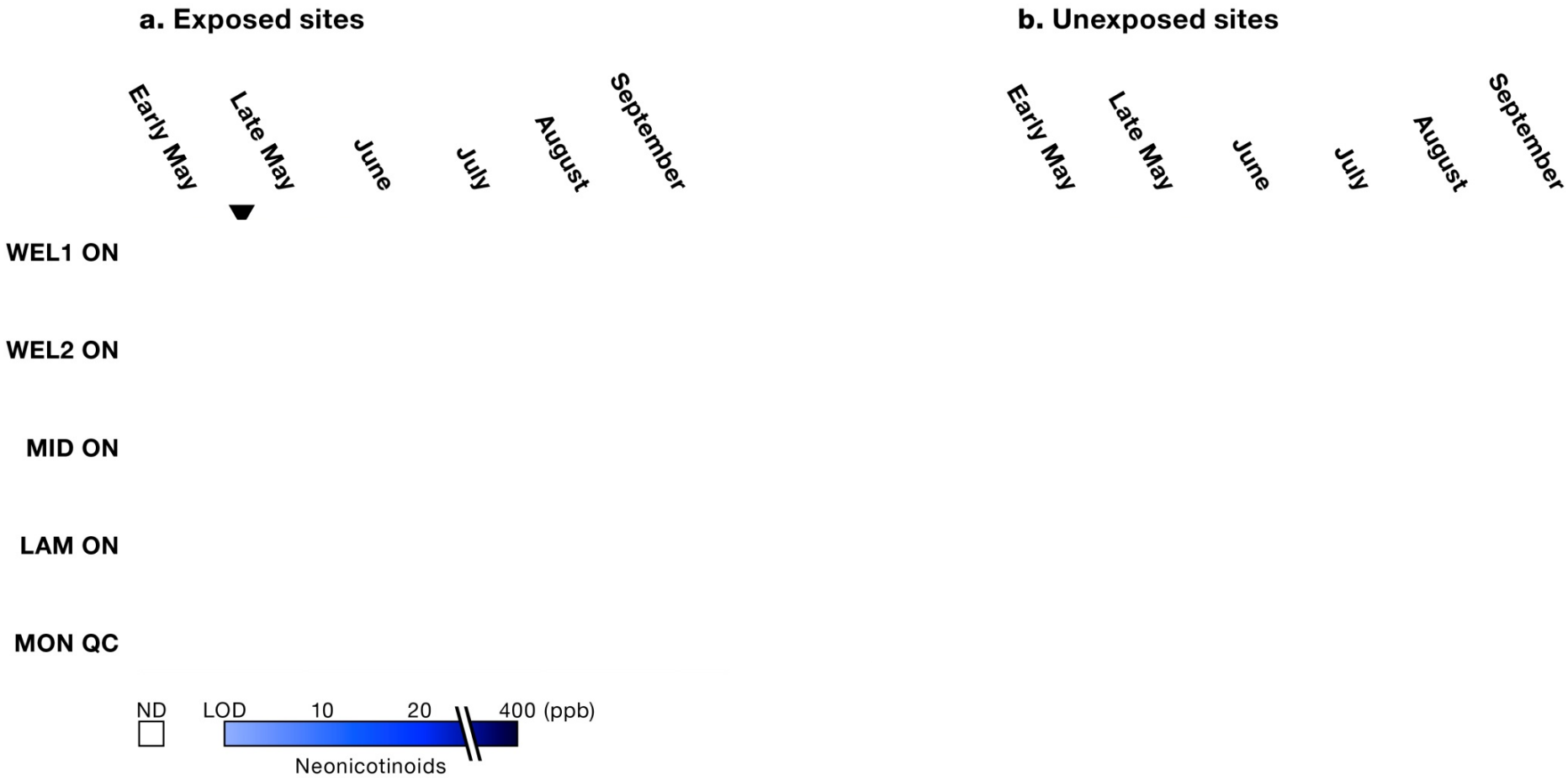
Name	Common Name	NNI Present (%)	NNI Absent (%)
Salix	**Willow**	21.98	8.56
Type Aster/Solidago	**Goldenrod**	0.92	20.31
Type Trifolium Hybridum	**Alsike Clover**	19.05	8.86
Rhamnus Type Cathartica	**Buckthorn**	15.48	2.01
Lotus	**Lotus**	5.43	10.31
Type Melilotus	**Sweet Clover**	0.92	9.67
Acer Type Negundo	**Maple Ash**	1.44	5.85
Type Brassica	**Mustard Vegetables**	5.73	1.77
Rosaceae Fruit Trees Type	**Apple**	5.56	2.29
Acer Type Rubrum	**Red Maple**	0.42	4.30
Liliaceae	**Lily**	2.82	0.36
Type Taraxacum	**Dandelion**	1.28	2.55
Type Trifolium Pratense	**Red Clover**	1.53	2.03
Other	**Other**	<2.00	<2.00

Environmental fate of neonic seed dressings



Goulson, D. 2014. *Nature*, doi:10.1038/nature13642

When?



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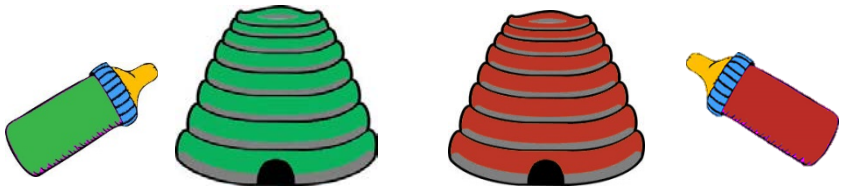
Experimental Work



Unexposed Exposed

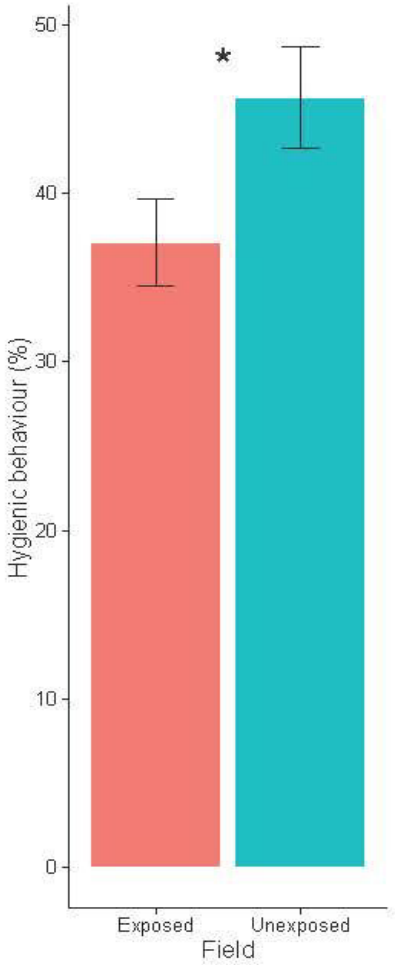
Behaviour

Hygiene

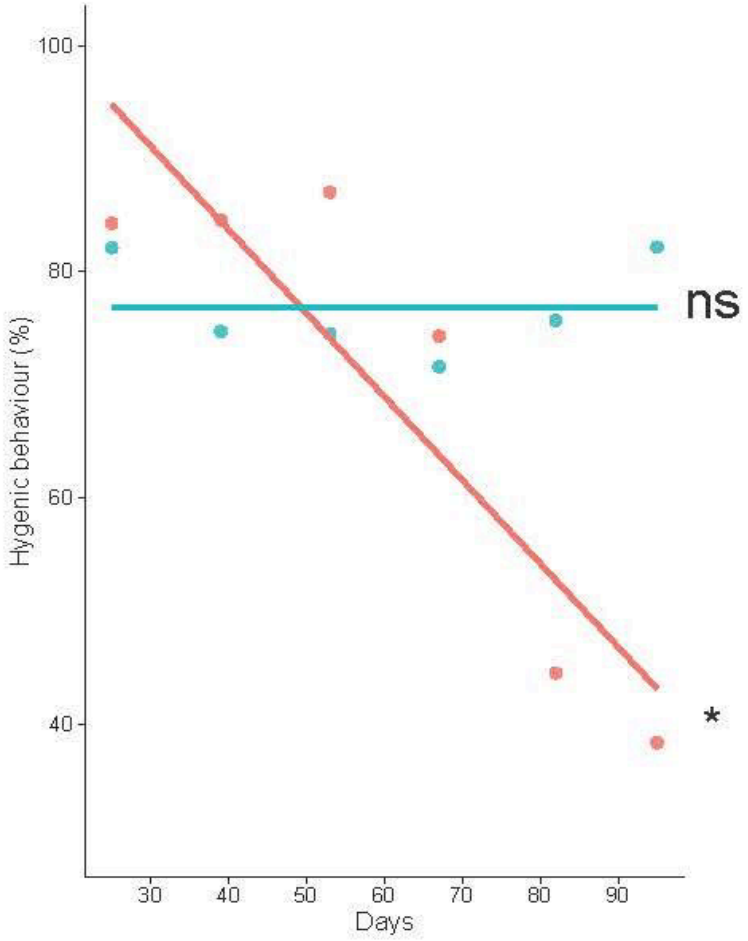
Hygiene

Unexposed
Exposed

2014



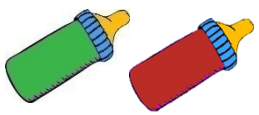
2015



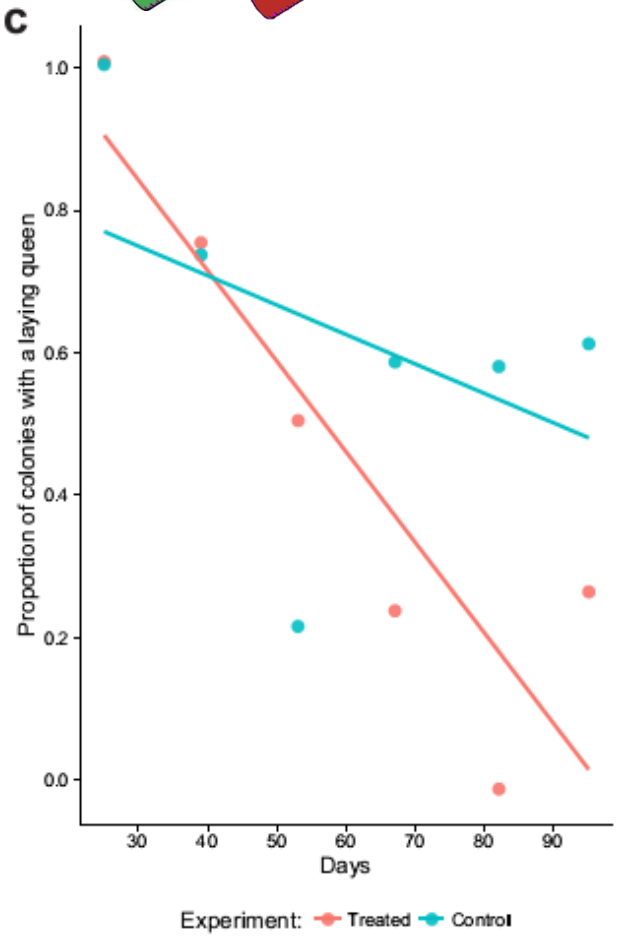
Tsvetkov et al. 2017

Queen

Unexposed
Exposed

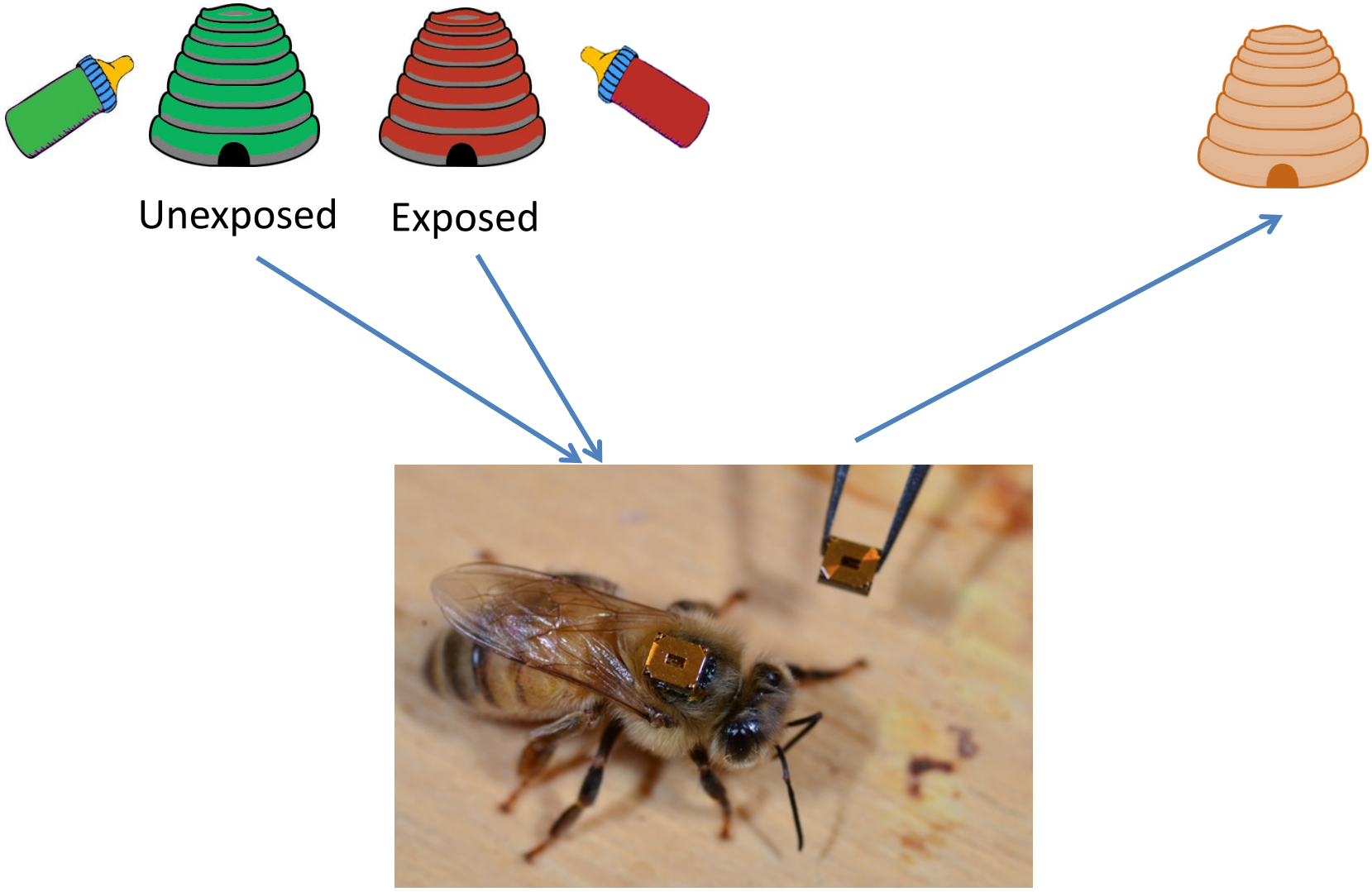


2015



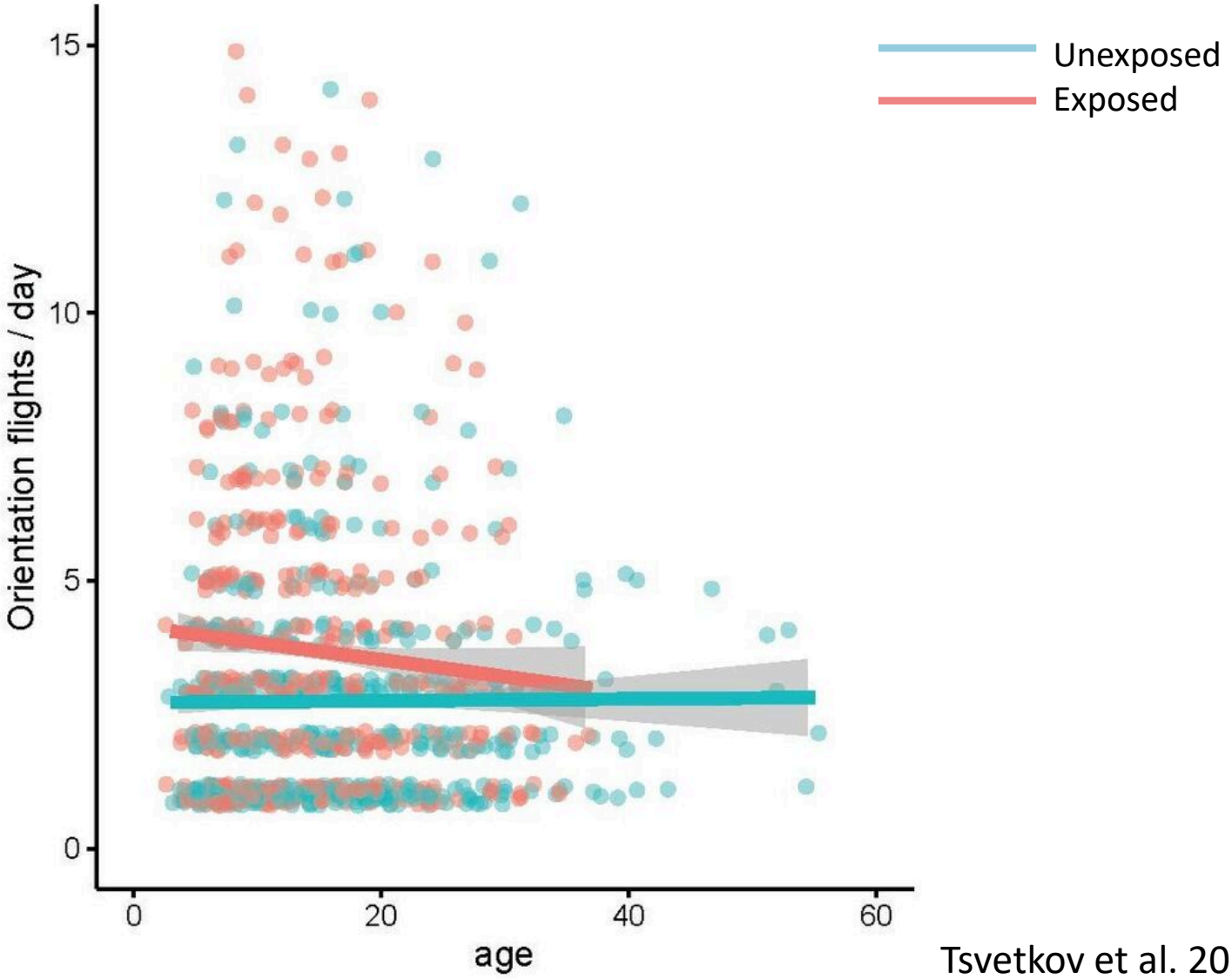
Tsvetkov et al. 2017

RFID



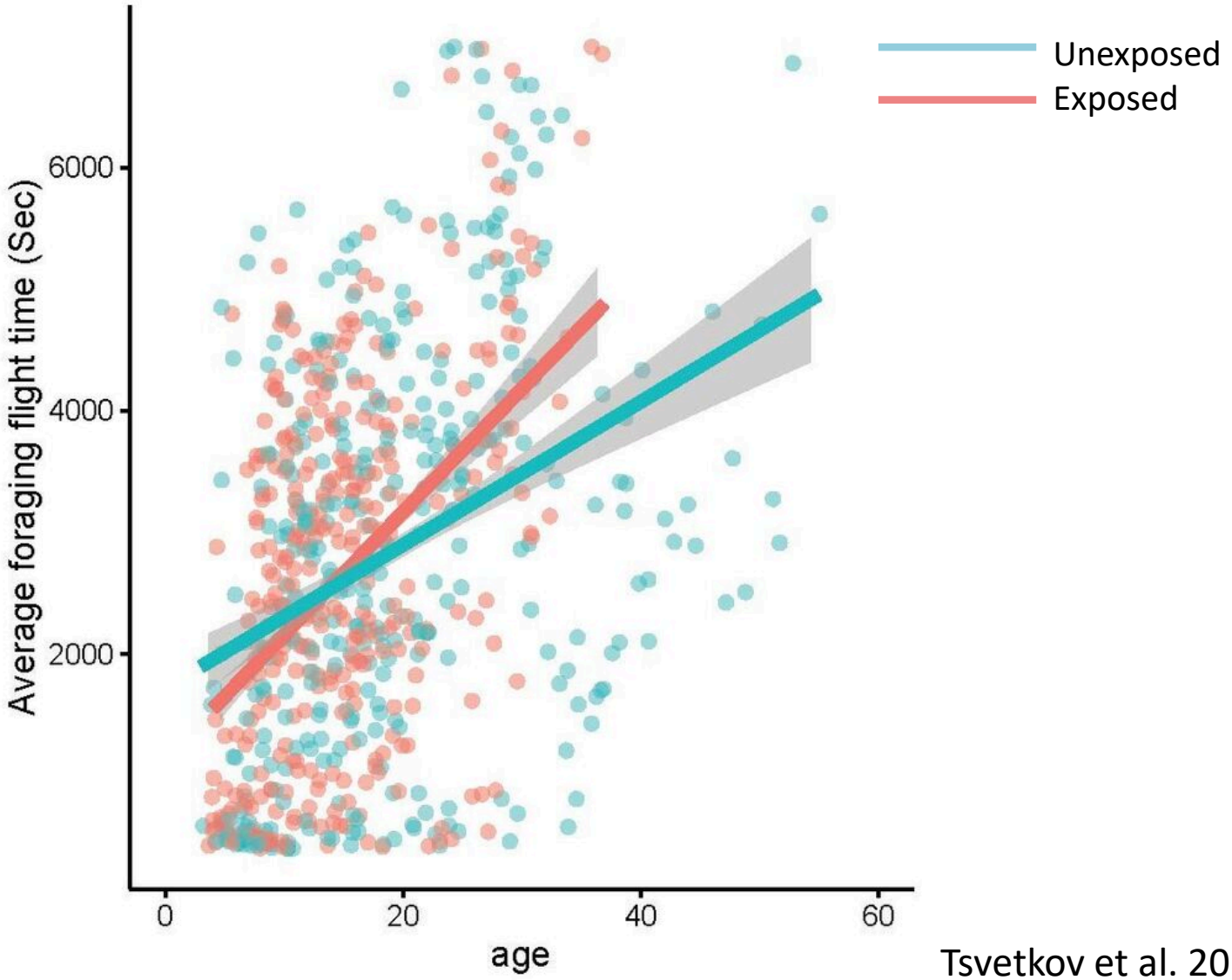
Honey Bee Flights

Orientation Flights



Tsvetkov et al. 2017

Foraging Flights



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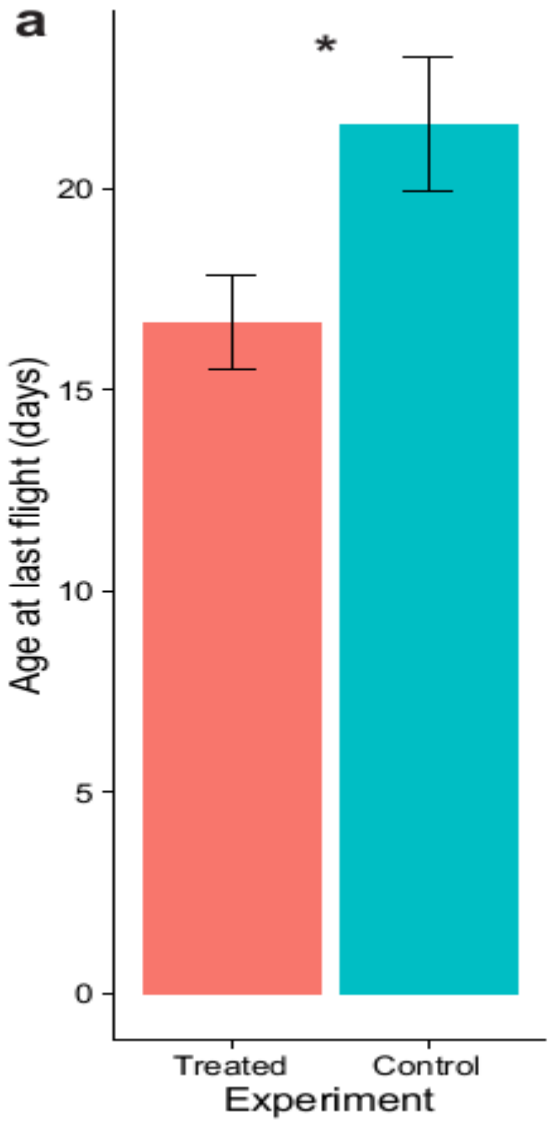
Life Expectancy



Unexposed
Exposed

Tsvetkov et al. 2017

So, What is Field Realistic?

- Exposure through pollen
- Exposure for ~ 3 months
- Exposure to a variety of pesticides at once

Impacts

REPORT

Chronic exposure to neonicotinoids reduces honey bee health near corn crops

N. Tsvetkov[1], O. Samson-Robert[2], K. Sood[1], H. S. Patel[1], D. A. Malena[1], P. H. Gajiwala[1], P. Maciukiewicz[1], V. Fournier[2], A. Z…
+ See all authors and affiliations

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Peer Reviewed
← see details

Thank you

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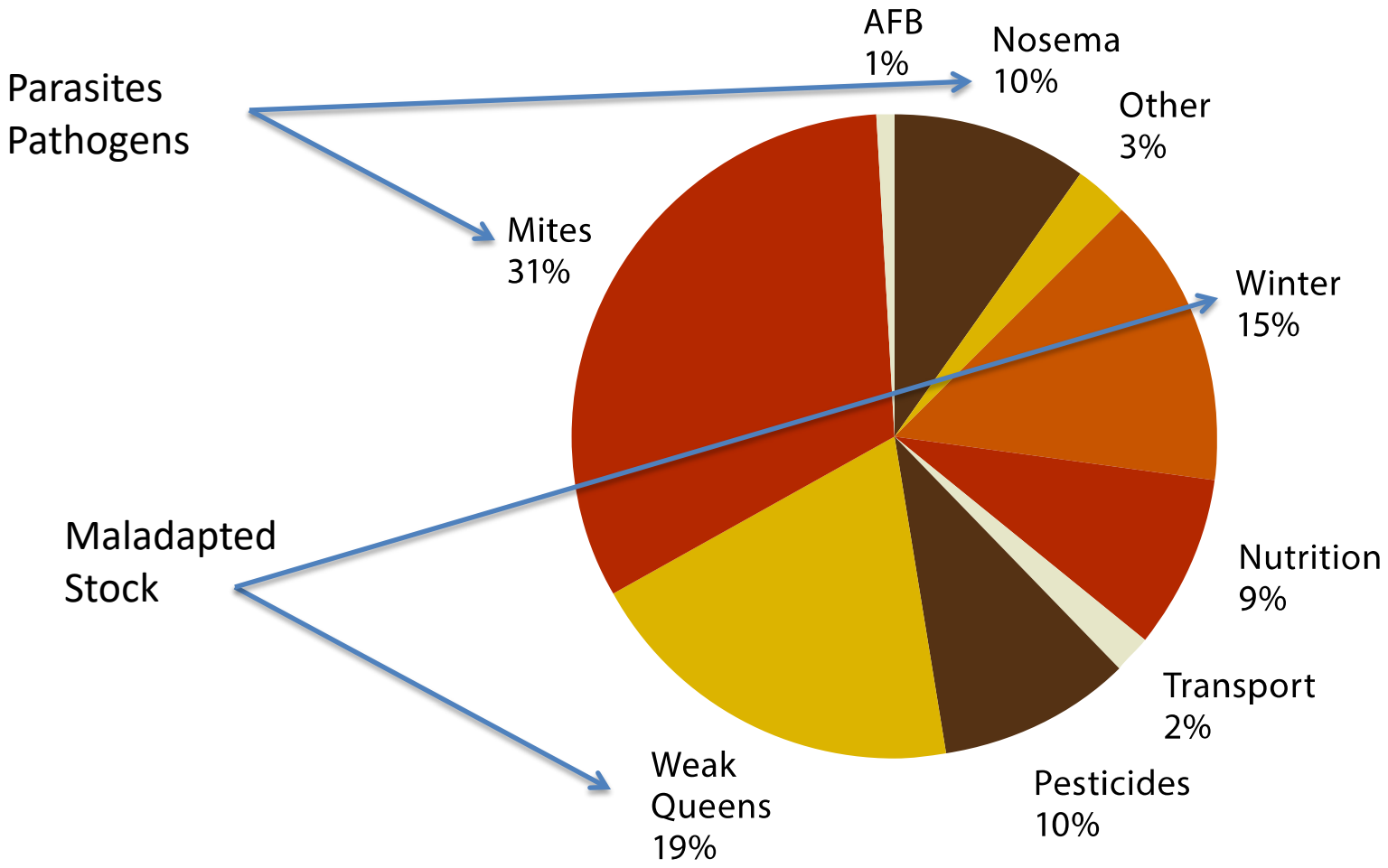
Pratik Gajiwala

Bee Genomics and Health

Amro Zayed
York University



The causes of bee declines in Canada in 2011 as reported by beekeepers.

Leonard Foster, UBC
+ Many colleagues

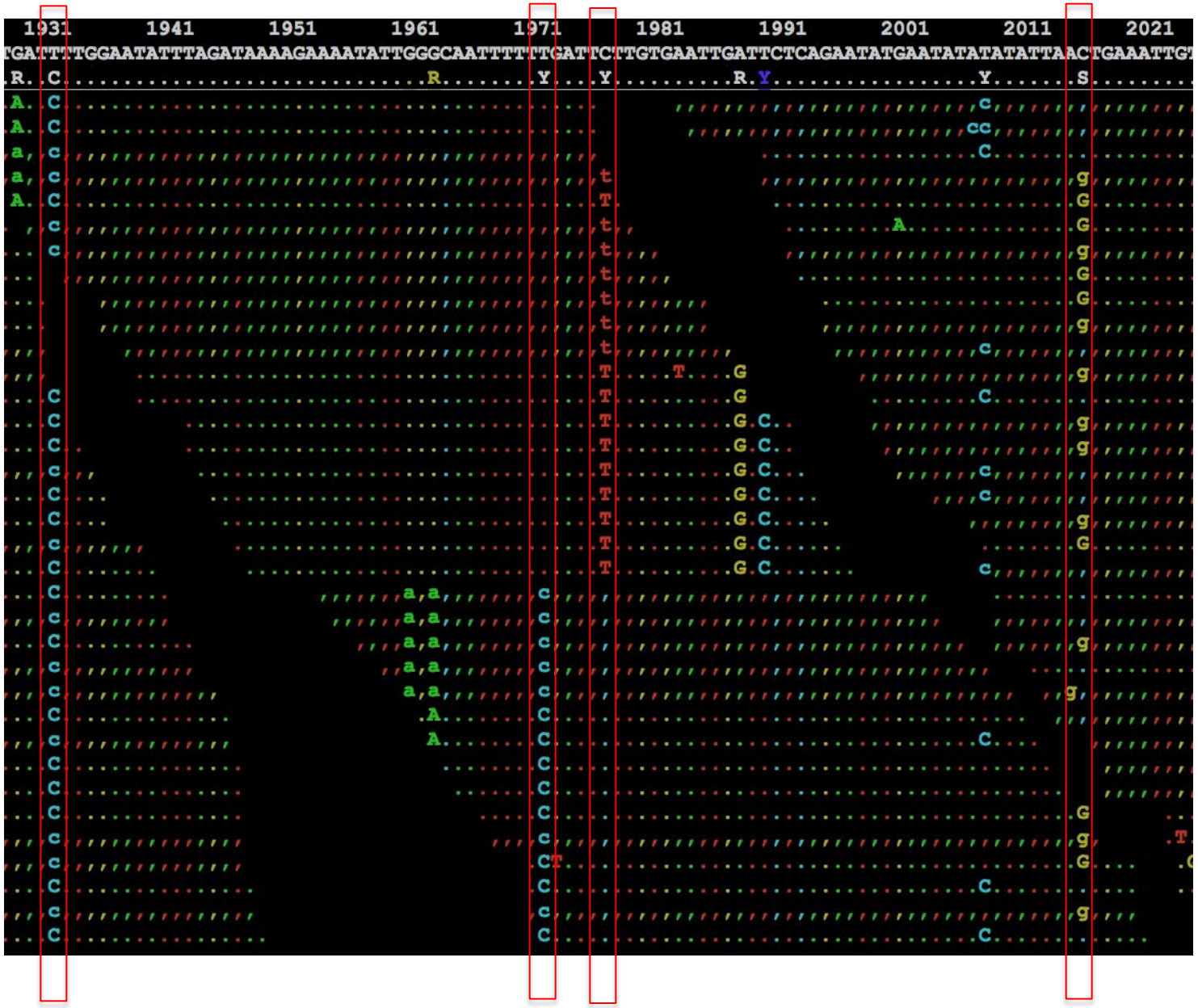
‘omic solutions to bee health

- ***IF*** we can identify the genetics of colony level traits, we can implement marker-assisted breeding programs to improve bee health

To Boldly Go!

To Boldly go!

- Lab was the first to sequence individual honey bee genomes
- 40 genomes in 2014
- Now 2,000+ individual bee genomes

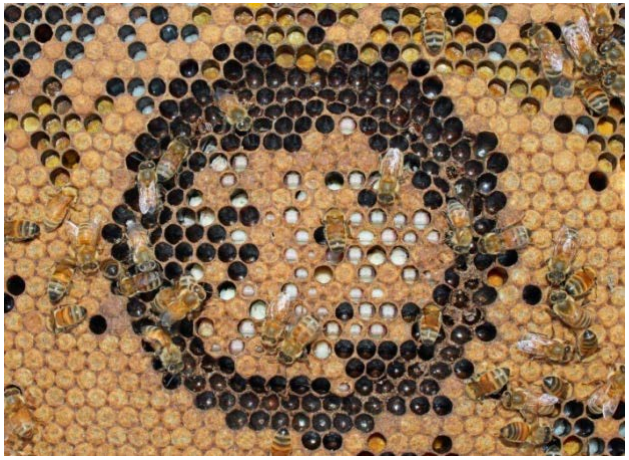

1931
1941
1951
1961
1971
1981
1991
2001
2011
2021

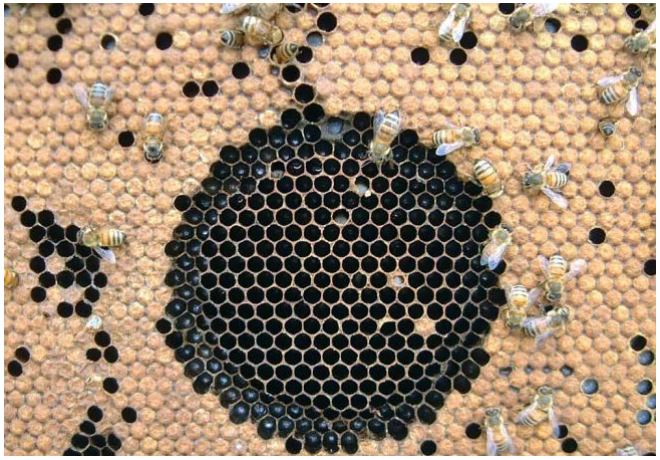
This is a healthy winter hardy bee

Social immunity Pilot

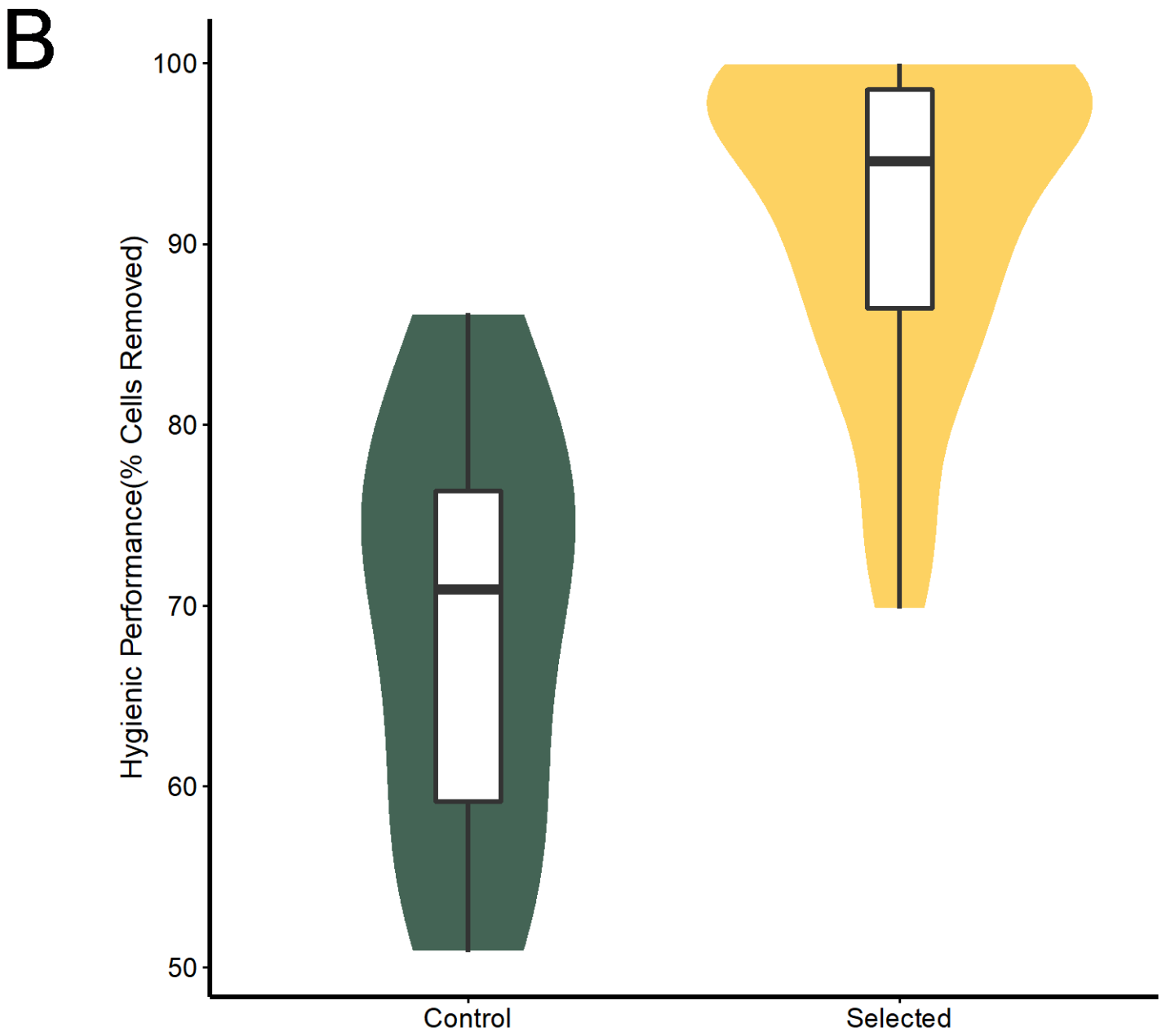
Baseline
No selection

3 generations of
artificial selection



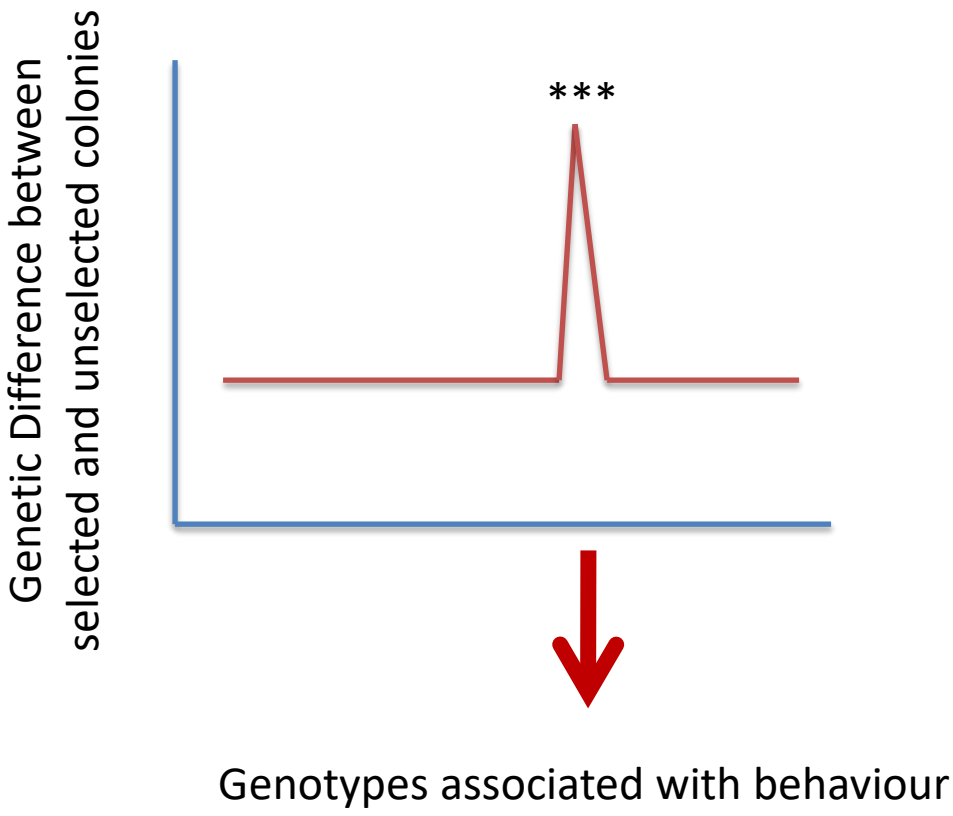


Leonard Foster, Steve Pernal, Rob Currie, Shelly Hoover, Marta Guarna,

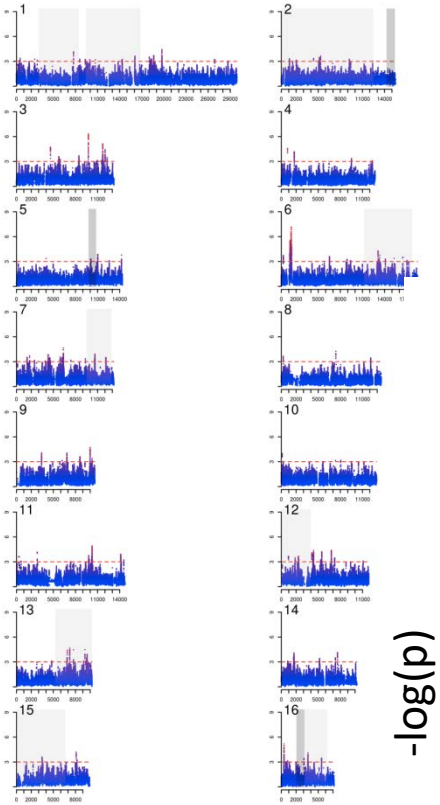


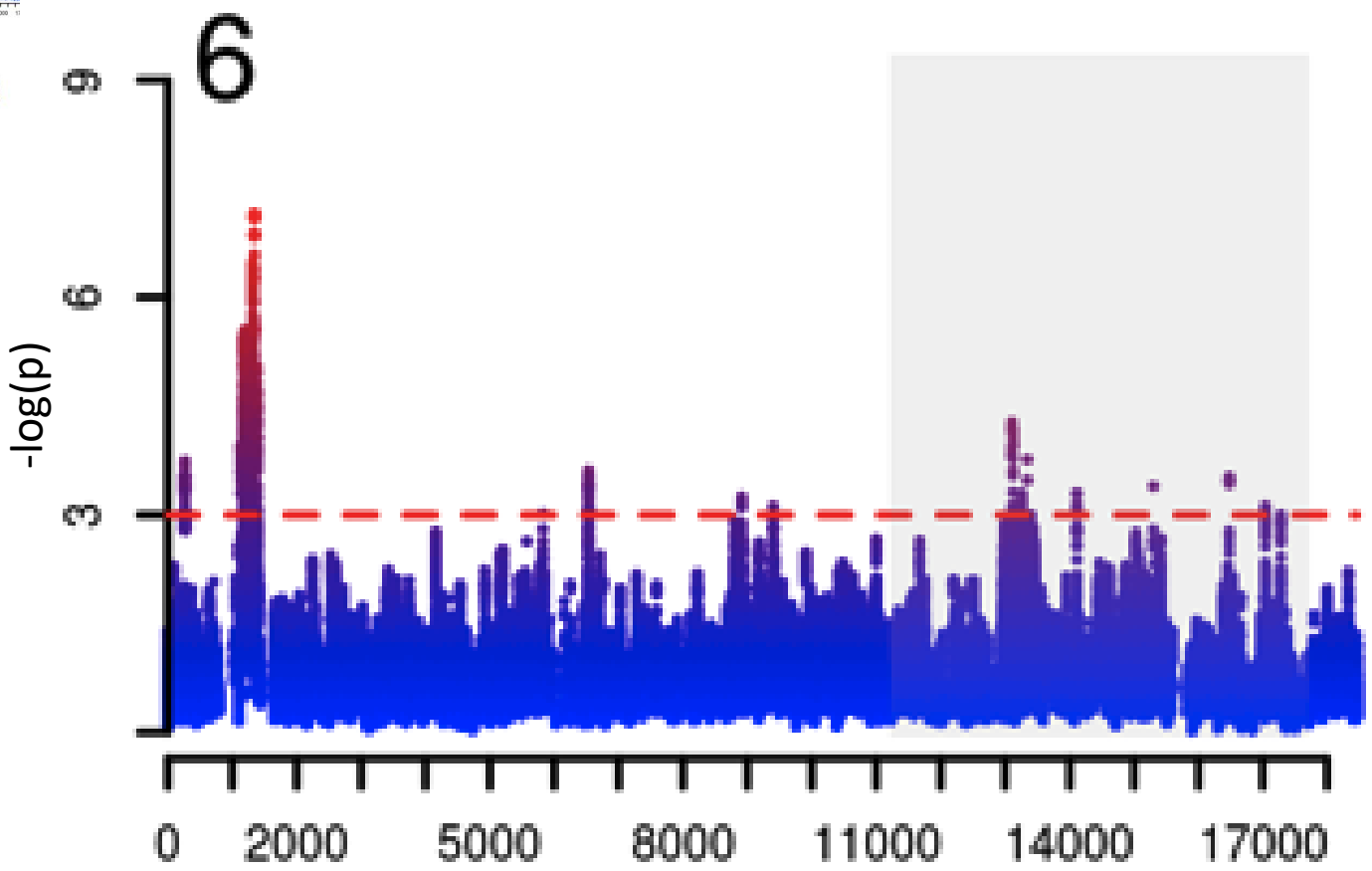
Harpur et al, GBE 2019

Artificial selection



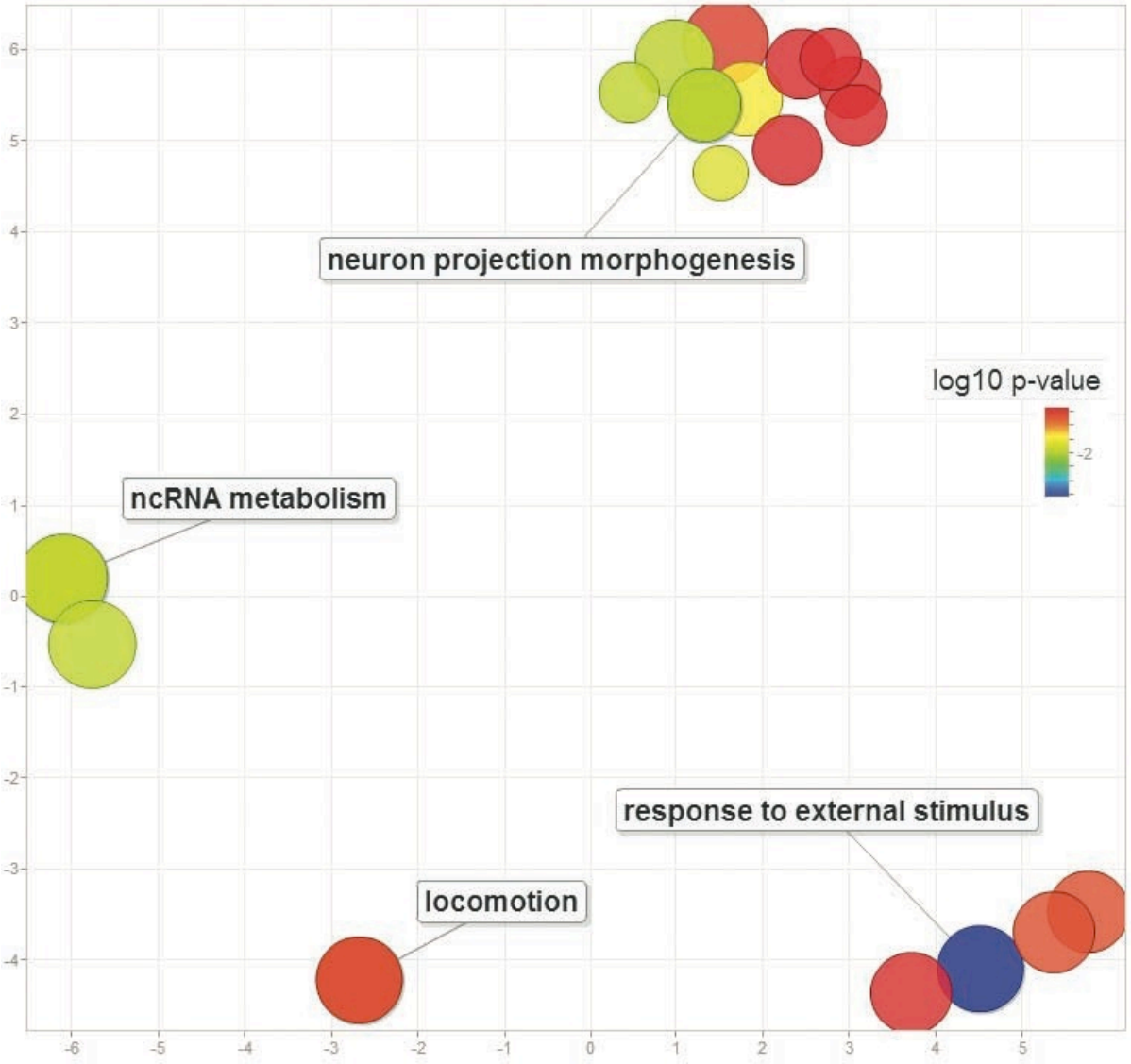
Artificial selection



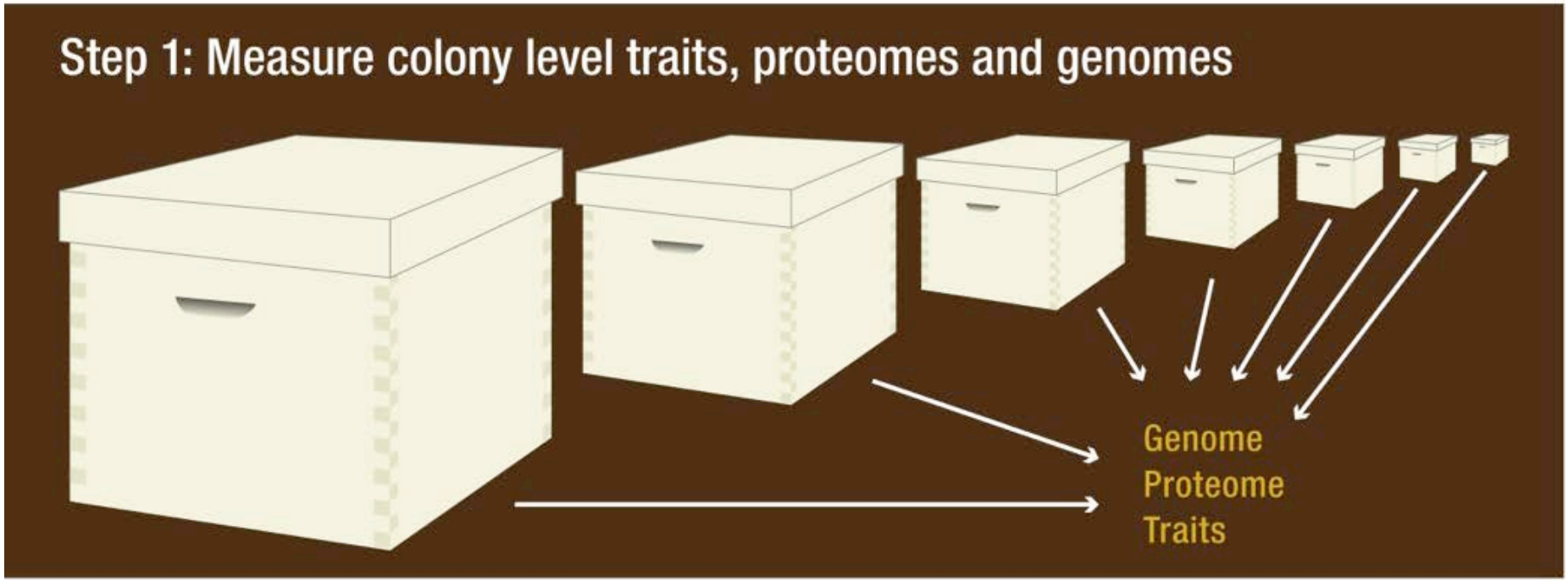


Harpur et al, GBE 2019

Hygienic behavior – a state of mind!



Harpur et al, GBE 2019



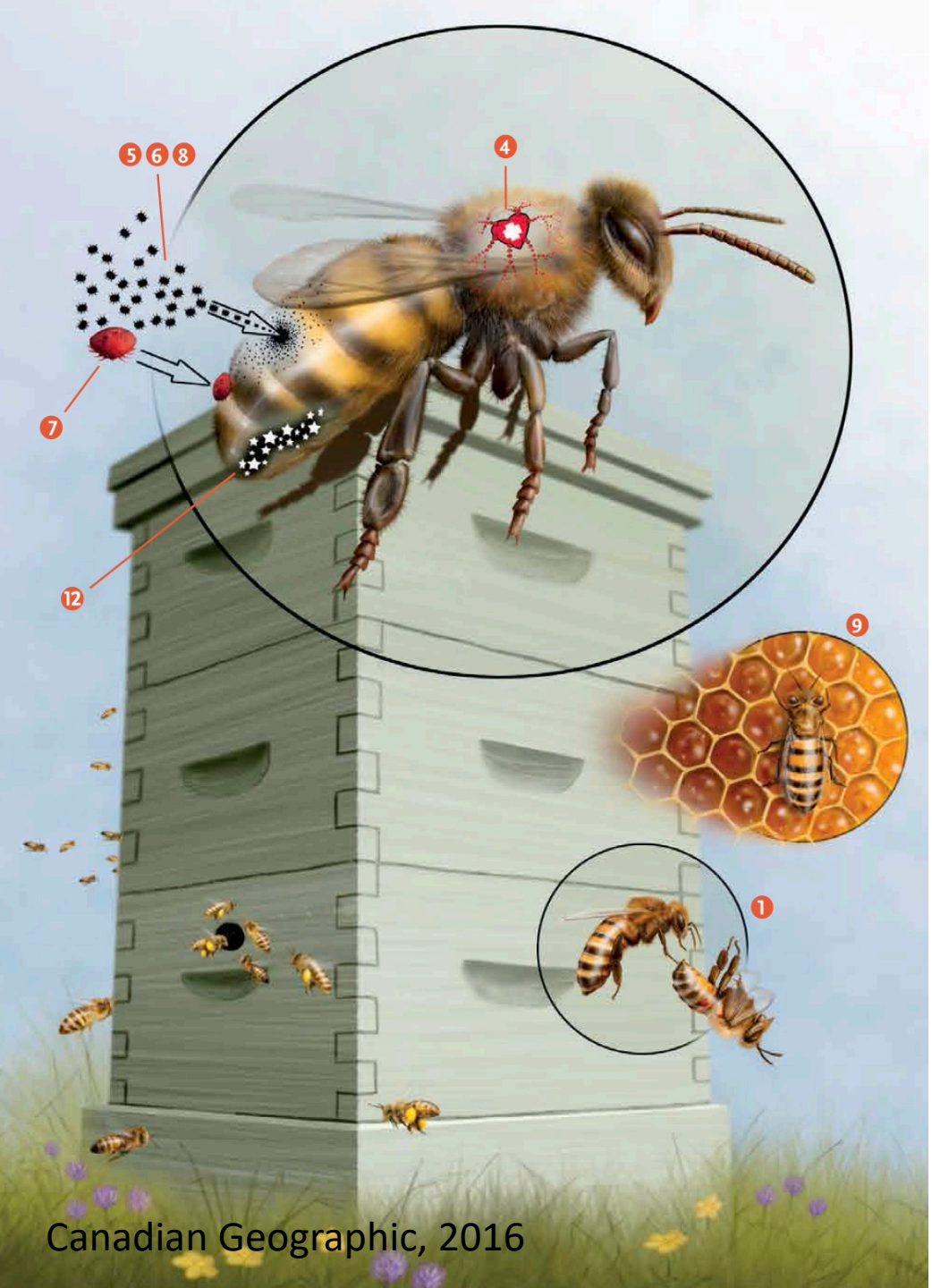
N= 1000 colonies

Traits include

Social immunity (hygiene behavior, Varroa-sensitive hygiene, grooming)

Innate immunity (expression of antimicrobials), **gut microfauna**

Honey production / Aggression / Overwintering mortality



Canadian Geographic, 2016

Traits include
Social immunity (hygiene behavior, grooming)
Innate immunity (expression of antimicrobials),

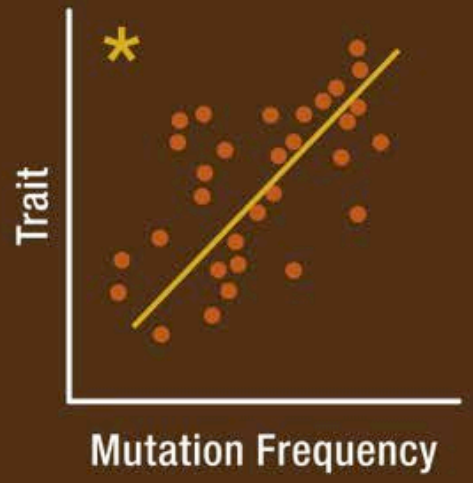
gut microfauna

Honey production / Aggression /

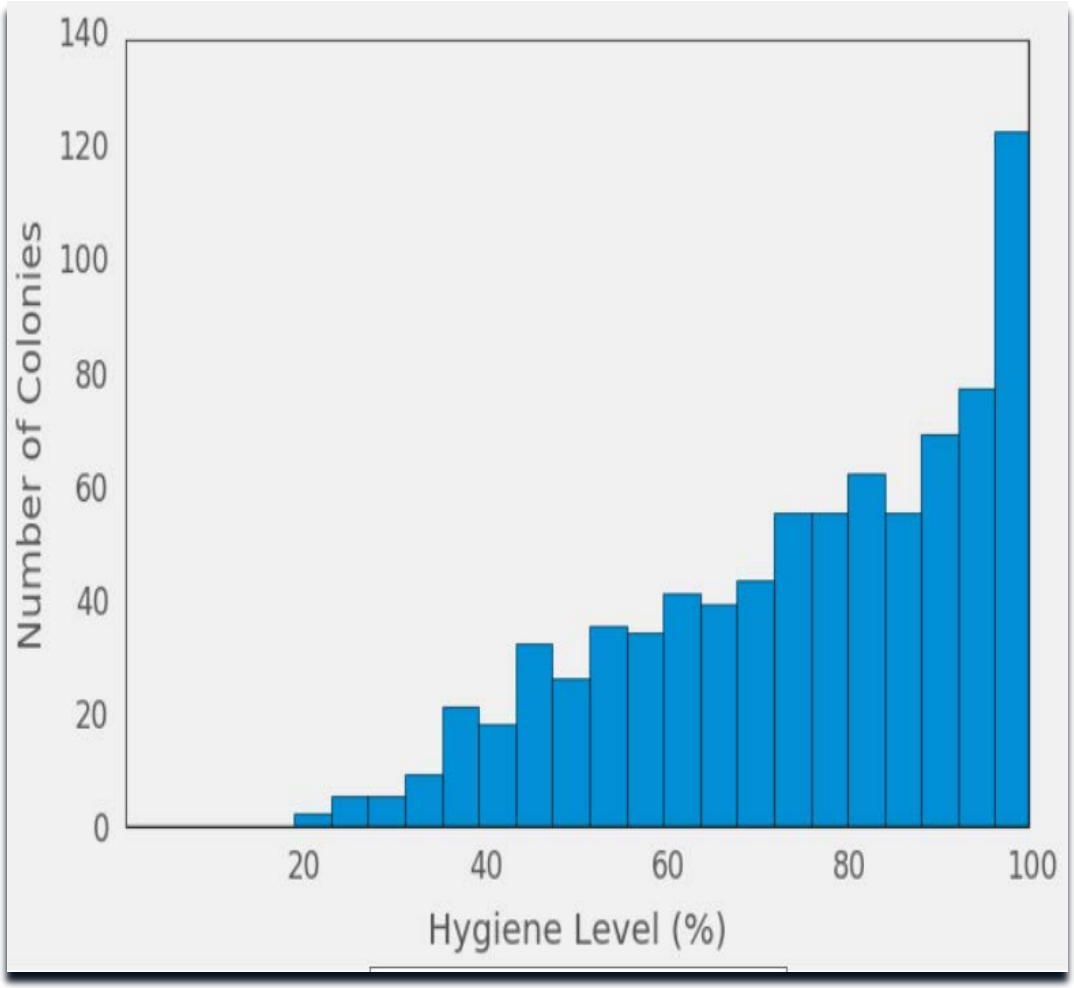
Overwintering mortality

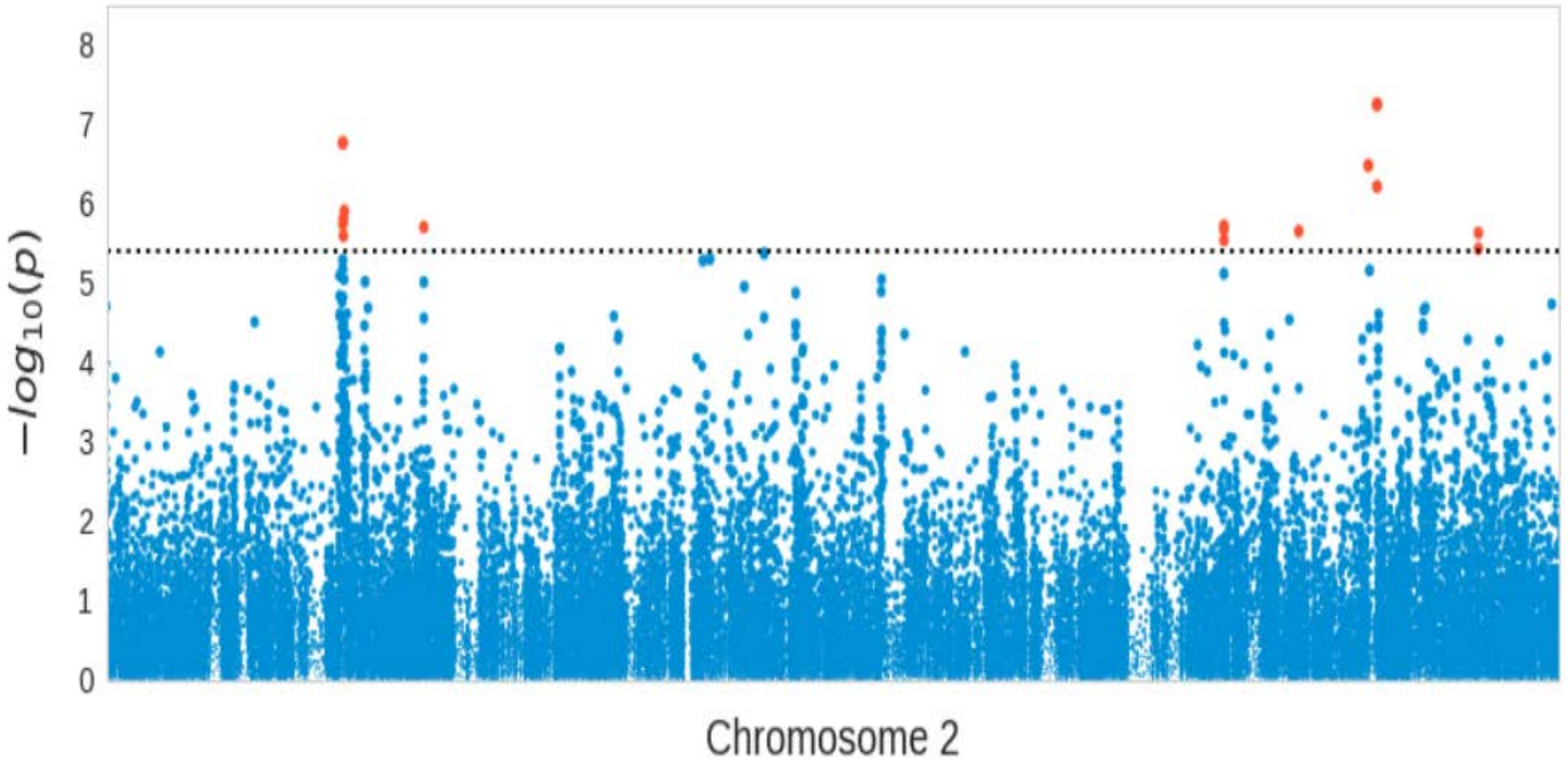
Also…
Expression of thousands of proteins in the brain ☺

Step 2: Identify markers associated with economically desirable traits

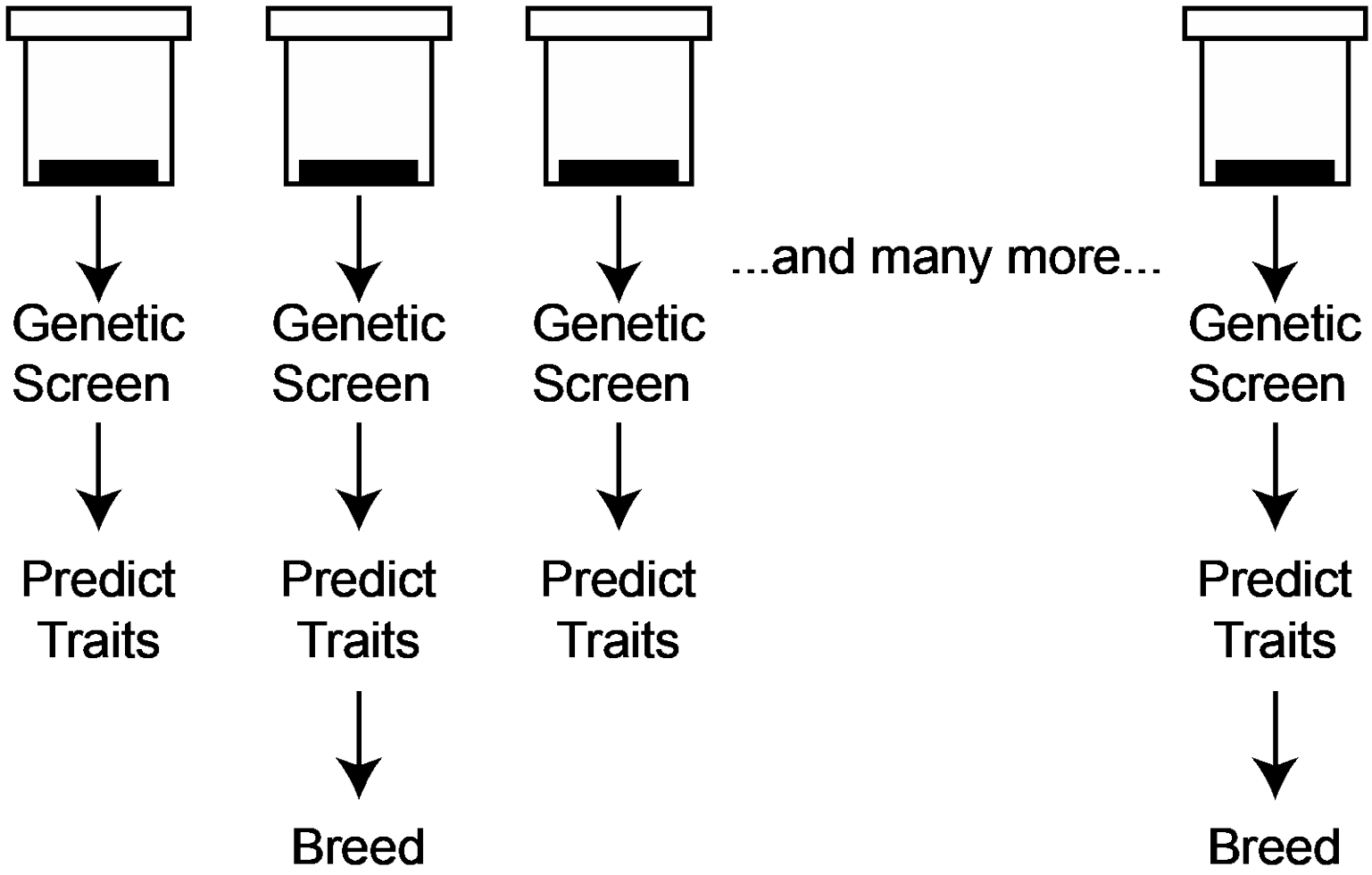


Early days… Hygienic behaviour




8
7
6
5
4
3
2
1
0
$-log_{10}(p)$
Chromosome 2

In 2 years….


Genetic Screen
Predict Traits
Breed
Genetic Screen
Predict Traits
Genetic Screen
Predict Traits
...and many more...
Genetic Screen
Predict Traits
Breed

Thank you!

ONTARIO BEEKEEPERS' ASSOCIATION

GenomeQuébec

GenomeCanada

Genome BritishColumbia

OntarioGenomicsInstitute

BC Honey Producers Association

Promoting and Encouraging Beekeeping in British Columbia Since 1920