BEES:

importance and diversity

Häagen-Dazs®

made like no other®

honey, please don't go

Nature needs honey bees. We all do. After all, they're responsible for pollinating one third of all the foods we eat, like the cherries and pears that make our all-natural ice cream so delicious. But they're disappearing at an alarming rate. Learn how to help at *helpthehoneybees.com*

New Häagen-Dazs® Vanilla Honey Bee Ice Cream

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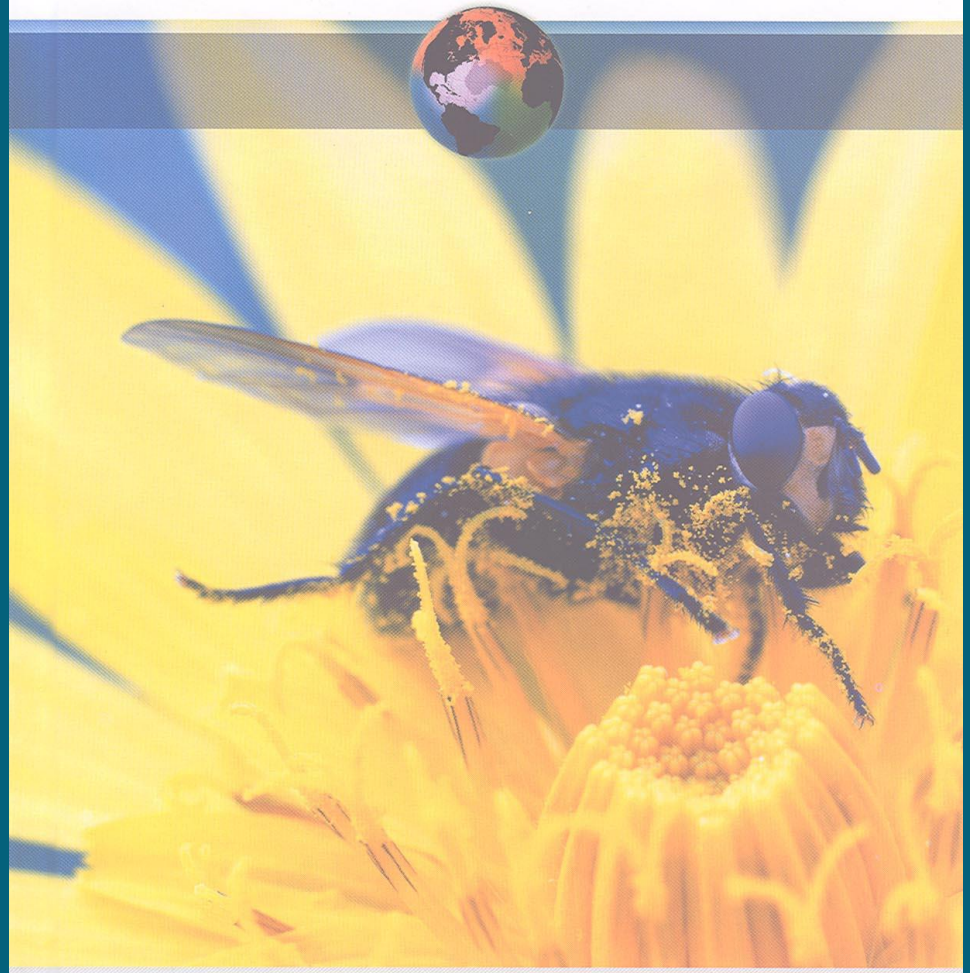
hd hb

Häagen-Dazs loves Honey Bees

BEES
OF THE WORLD

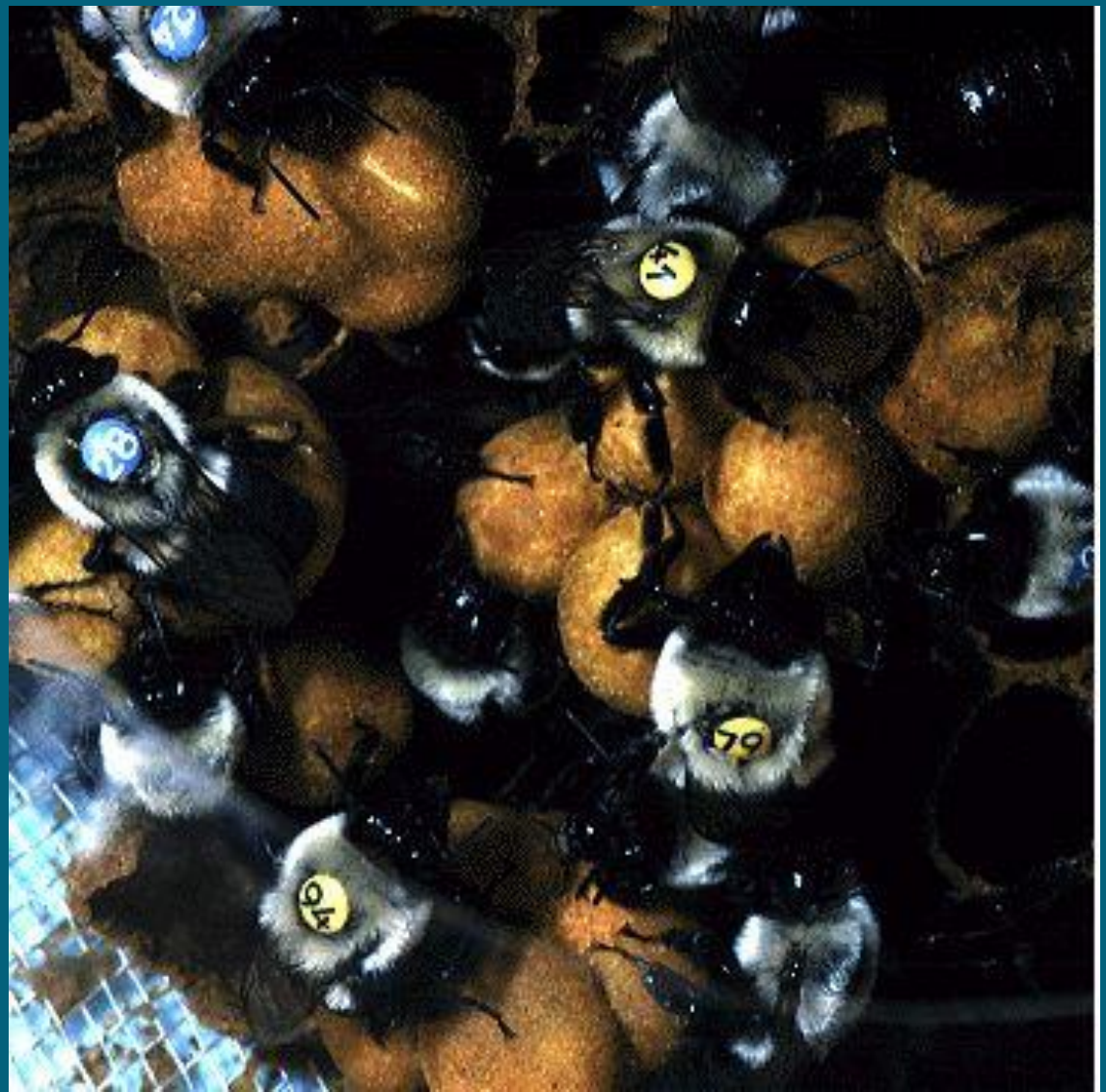


CHRISTOPHER O'TOOLE & ANTHONY RAW

Talk Outline

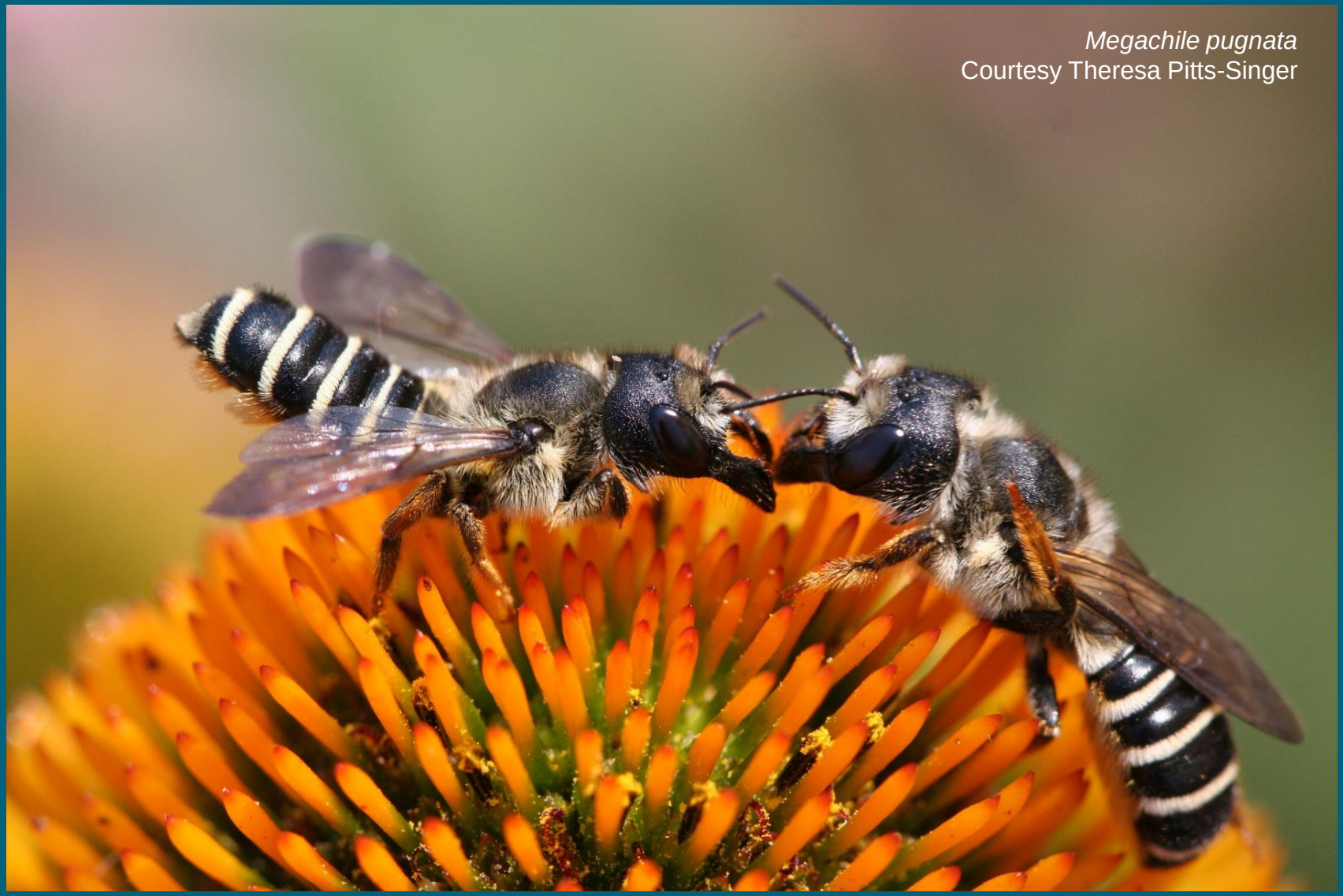
- Misconceptions about bees
- What are bees?
- Bee diversity
- The importance of bees
- An impediment to progress in our use of bees
- Solutions (Canadian-led!)
- What you can do to help the bees.

What do we normally think of when someone says “Bees”?



Misconception 1 - Honey

Most bees do NOT make honey



Megachile pugnata
Courtesy Theresa Pitts-Singer


Trigona necrophaga
Dr. D.W.Roubik

Image courtesy of Hans Bansinger

Misconception 2 – All Bees Work Hard

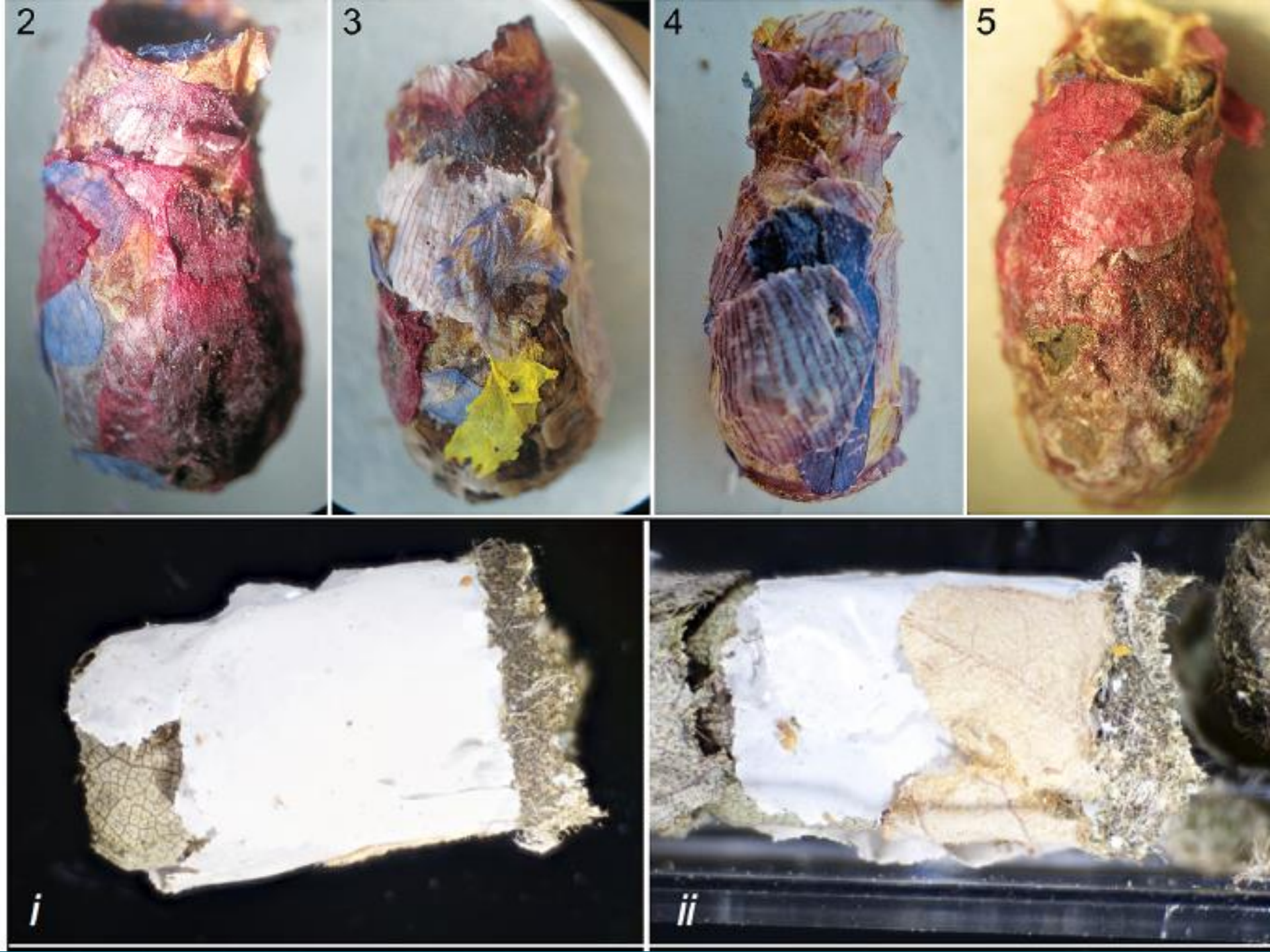
Many bees are cuckoos that do no work, but lay their eggs inside the nests of other bees

Misconception 3 – Hives

Few bees nest in hives

- Most nest in the ground

- Many nest in stems, beetle burrows in wood or other cavities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Misconception 4 – Complex Sociality

- Honey bees, stingless bees, bumble bees and many sweat bees (and a few others) have queens and workers.

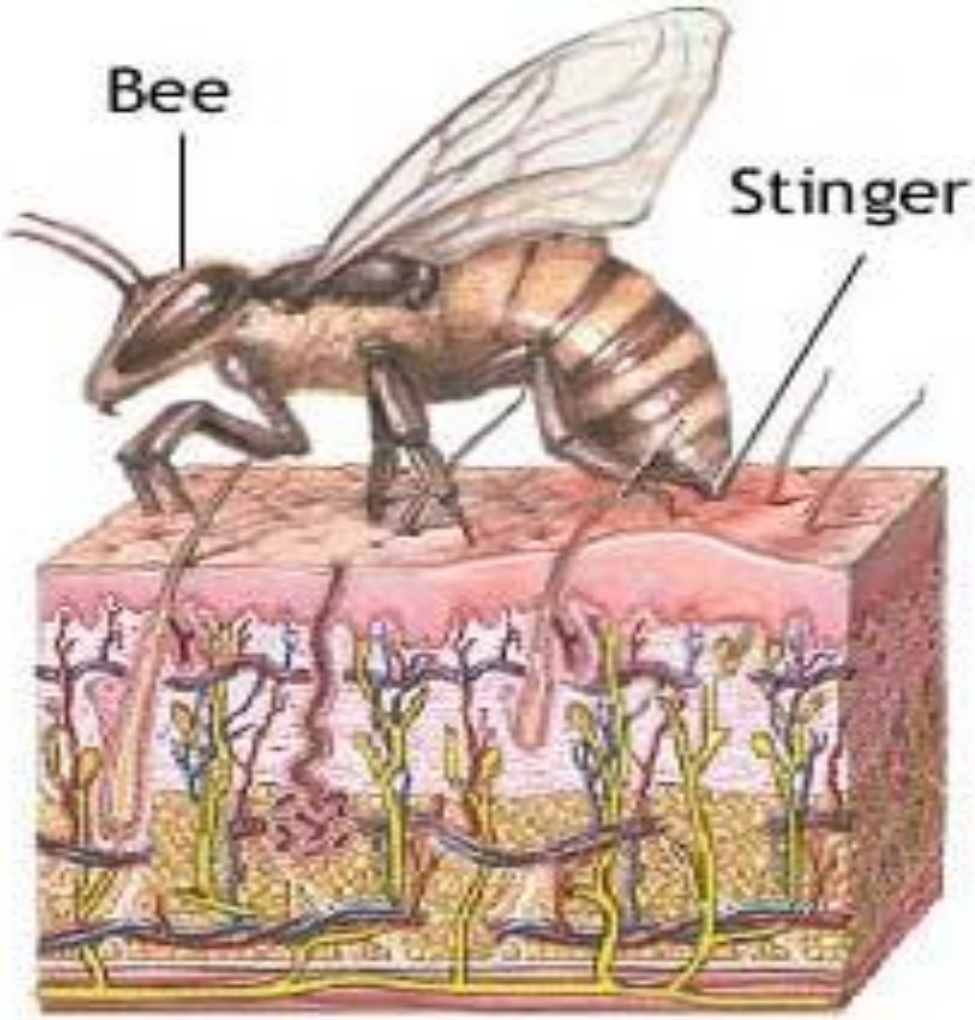
Guards at the entrance of a stingless bee nest in Kenya

Workers of the giant honey bee form the outside layers of the nest

Most bees are solitary

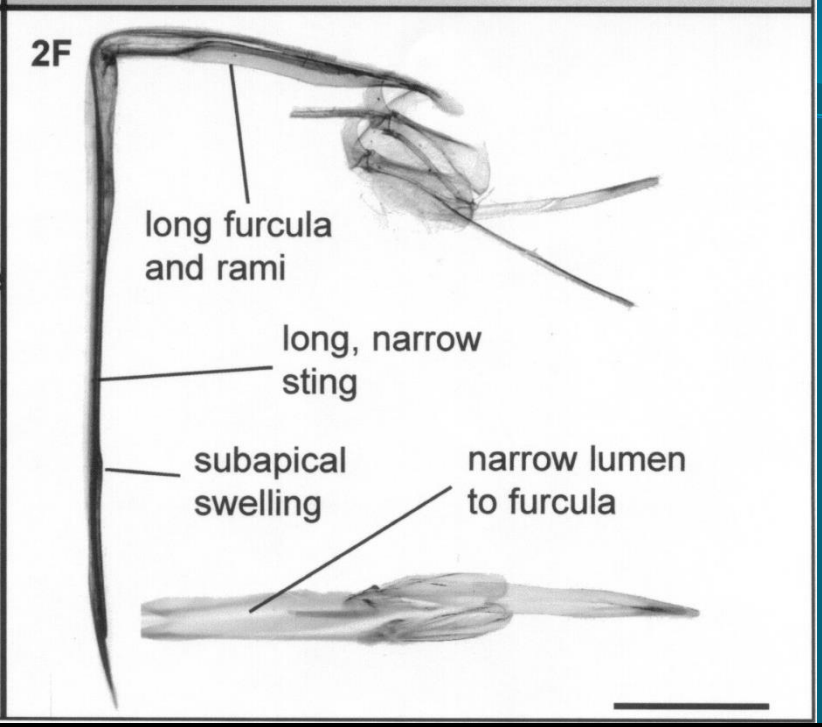

ARKive
© B. Borrell Casals / www.flpa-images.co.uk

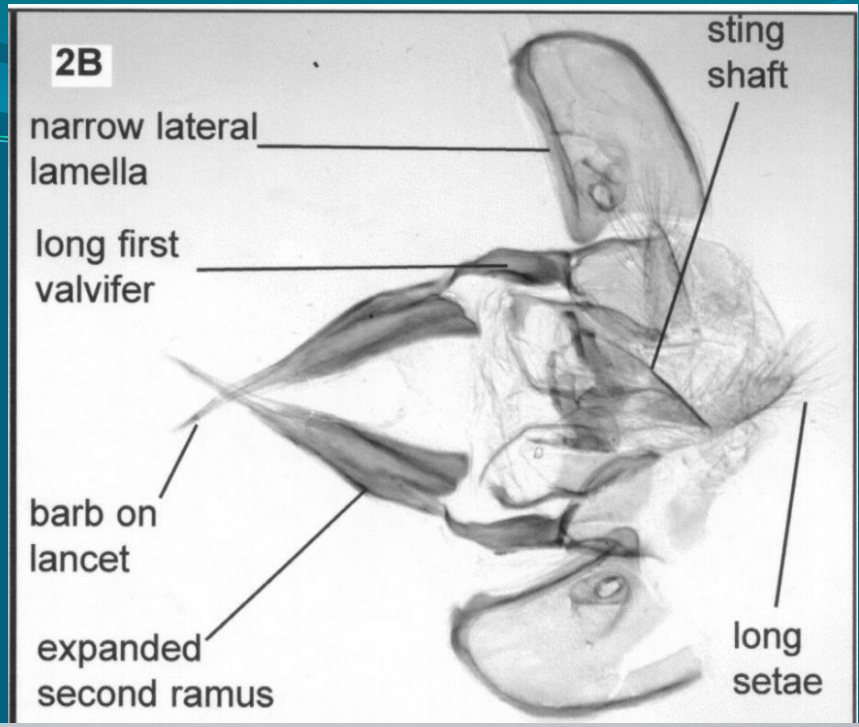
Misconception 5 – All Bees Sting



Immune response causes redness and swelling

A.D.A.M.





Coelioxoides

Orphana

Very few bees make honey: <4%.

A fraction of bee species are social: <8%

Even fewer nest in hives: <2.5%.

15% are cuckoos that lay eggs in the nests of other bees.

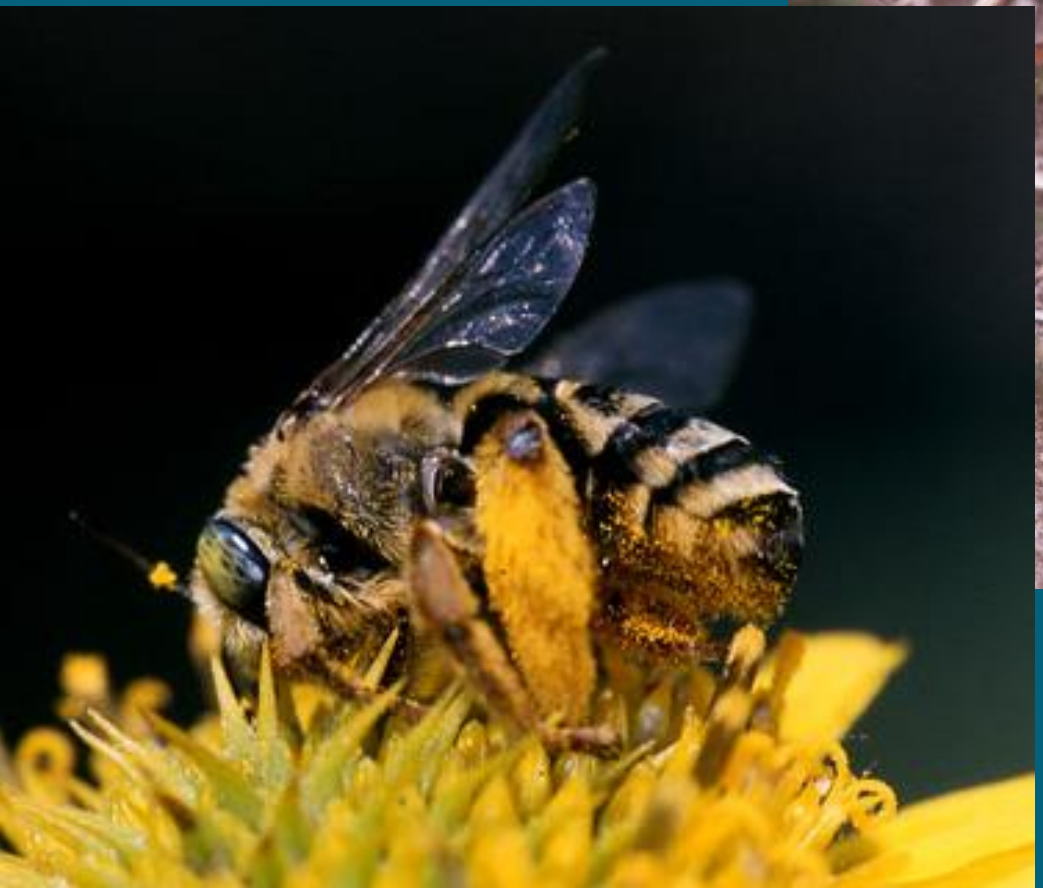
Only females sting and >15% of them cannot sting.

Why are we confused about bees?

WHAT ARE BEES?

Bees are vegetarian digger wasps.

Melissodes
a long-horned bee



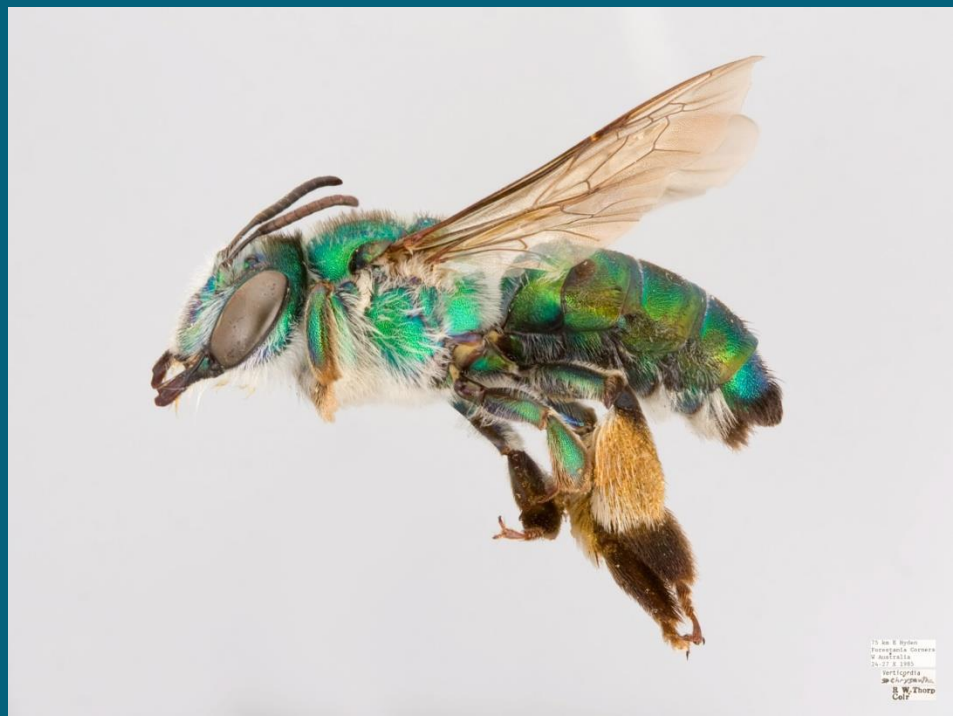
Ammophila
a sand wasp

Photo Steve Buchman

Bee Diversity

Over 20,214 described species (the 20,000th was described by one of my students in 2013)

- 850 in Canada (according to Cory Sheffield, RSM)



Family Stenotritidae:
2 Genera, 21 Species, all Australian

Ctenocolletes smaragdinus

Colletidae: 63 Genera, 2616 species; 2 Genera, >47species in Canada, >28 species in Ontario

Xeromelissa rozeni

***Colletes* sp.**

Photo Steve Buchman

Andrenidae: 47 Genera, 2957 species; 5 Genera, >176 species in Canada, > 83 species in Ontario

Calliopsis anomoptera

***Andrena* sp.**

Photo Steve Buchman

Halictidae: 77 Genera, 4428 species

10 Genera, >188 species in Canada, >108 species in Ontario

Agapostemon splendens

Halictus ligatus

Melittidae: 15 Genera, 201 species: 2 Genera and 3 species in Canada, >1 species in Ontario

Meganomia binghami

Rediviva emdeorum

Megachilidae: 76 Genera 4105 Species
14 Genera >203 species in Canada, >81 species in Ontario

Anthidium manicatum

Megachile sp.

Apidae: 191 Genera, 5811 Species; 21 Genera, >208 Species in Canada, >94 species in Ontario

Triepeolus sp.

Orchid bees attracted to baits

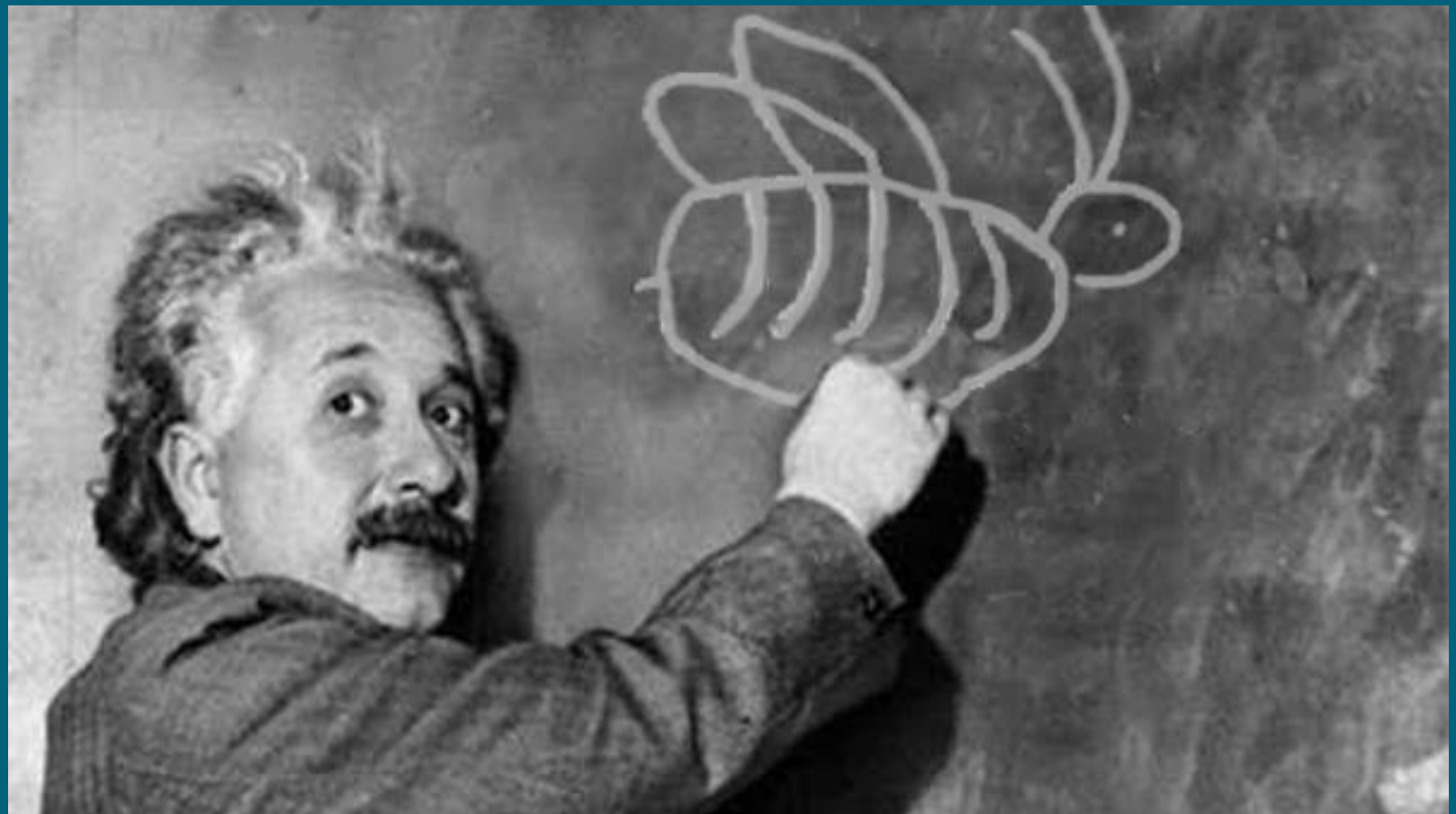
The Importance of Bees

- Pollination of wild flora
- Pollination for our fruits and vegetables
- Pollination Biology
- Environmental Monitoring

Bees and Our Food

- “If the bee disappeared off the surface of the globe man would have only four years of life left”

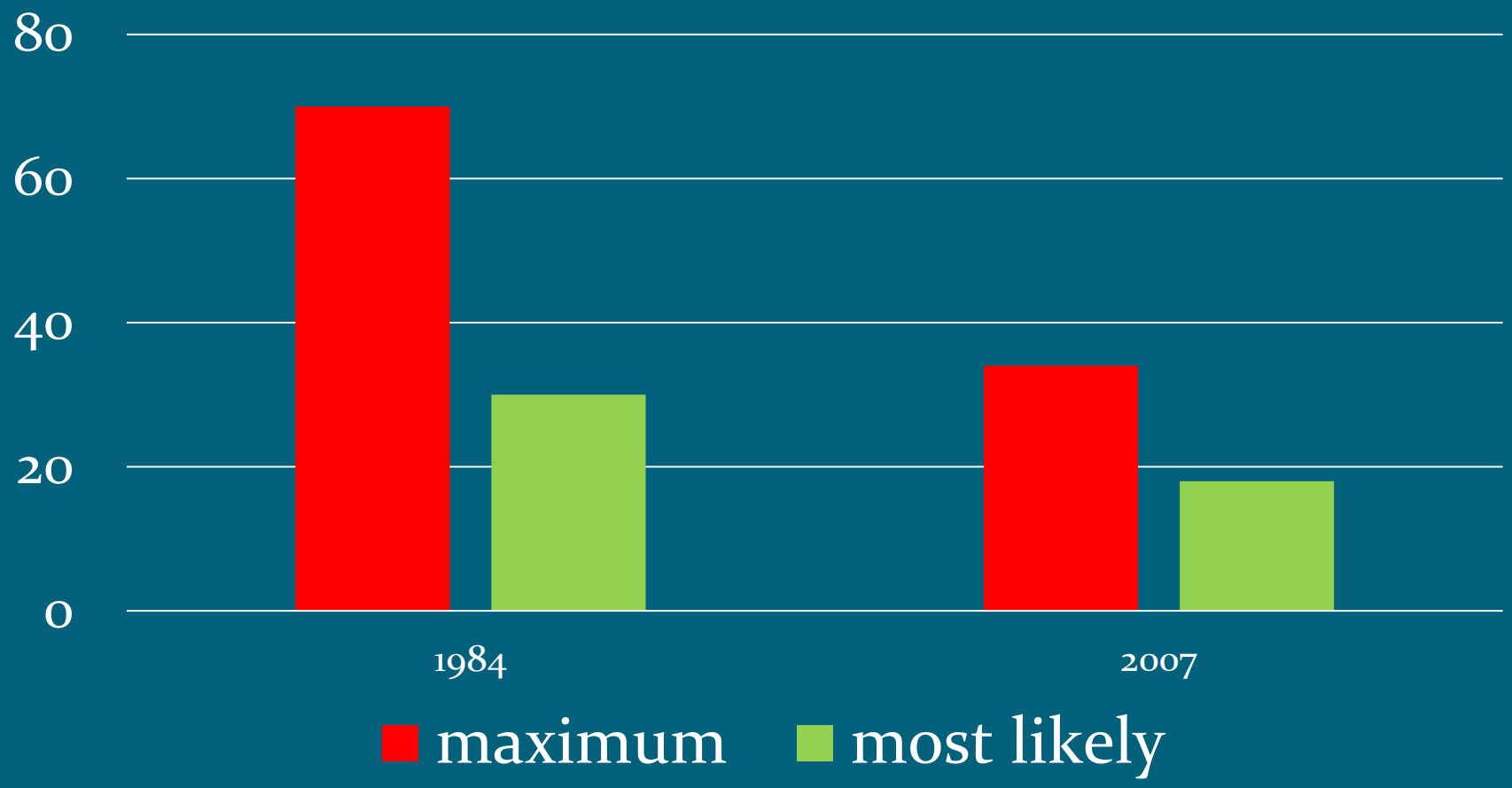
  attributed to Albert Einstein



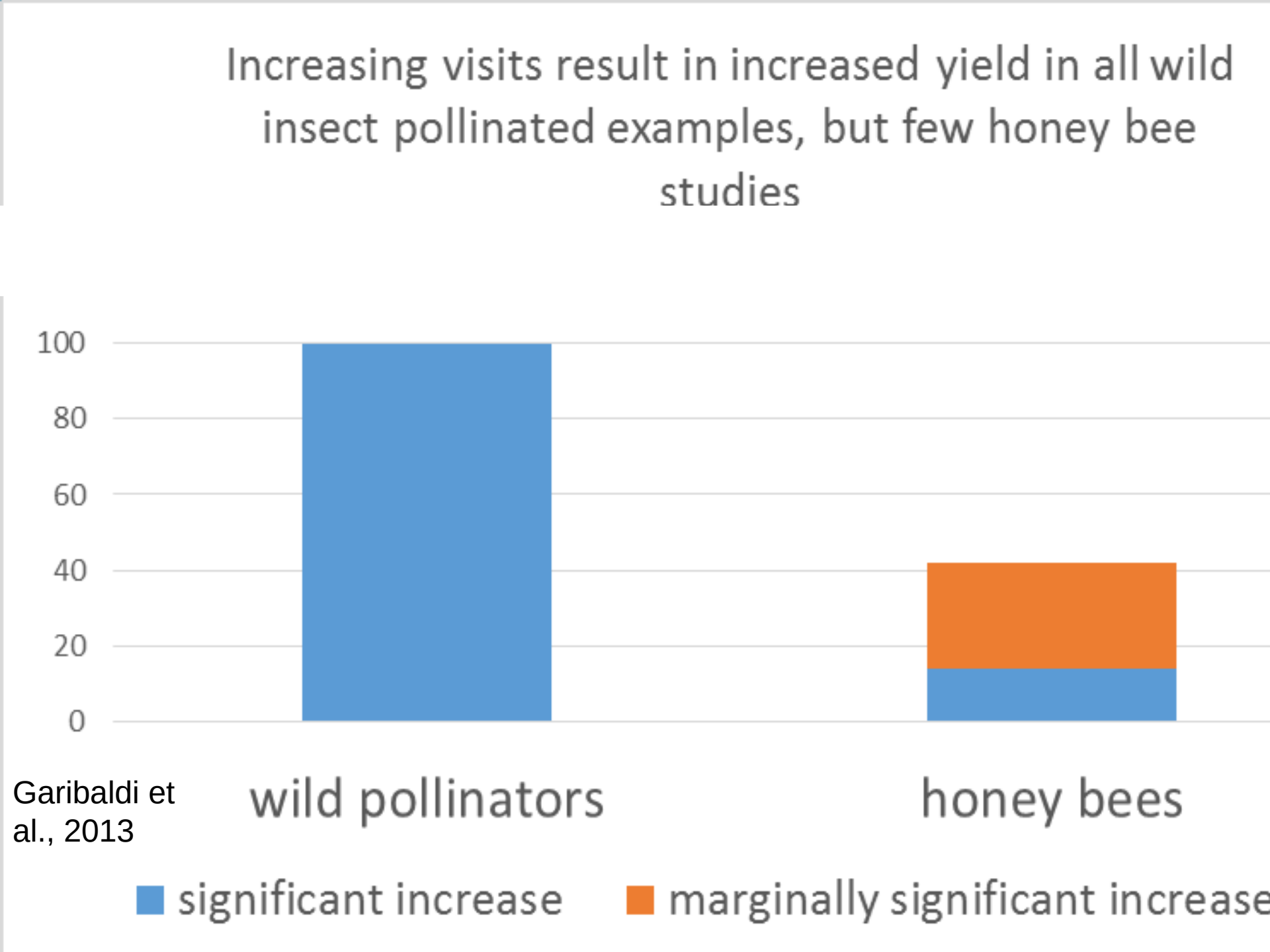
But isn’t that all from honey bees?

- NO!

Percentage of pollinator-dependent agriculture pollinated by honey bees in the UK

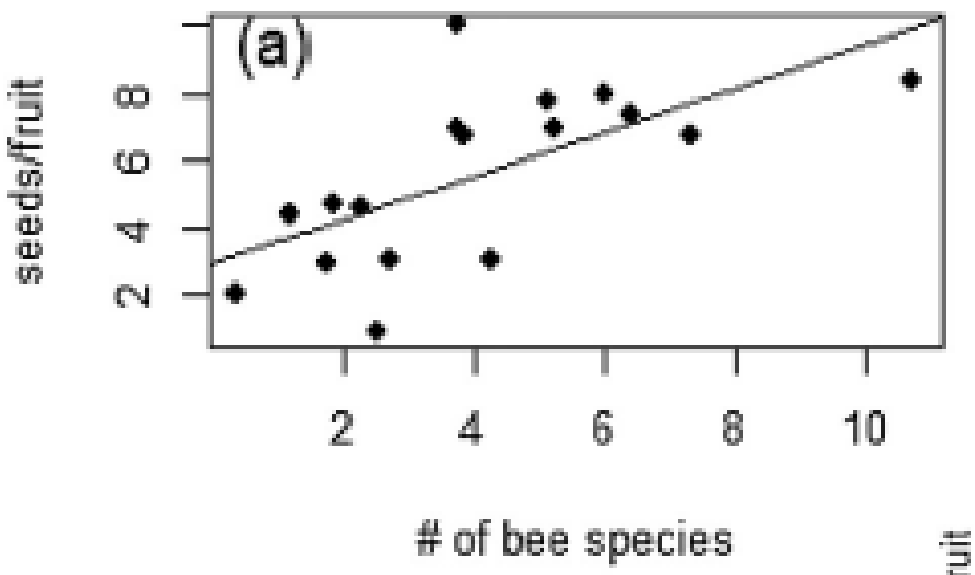


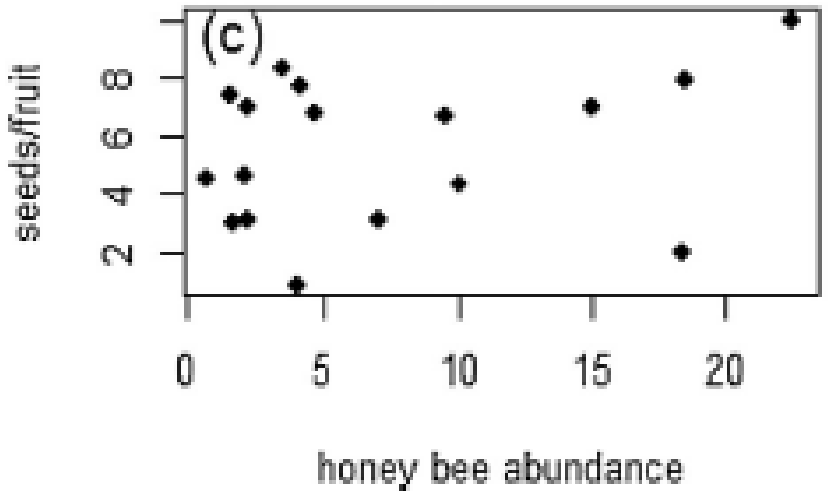
Modified from
Breeze et al., 2011



Garibaldi et al., 2013

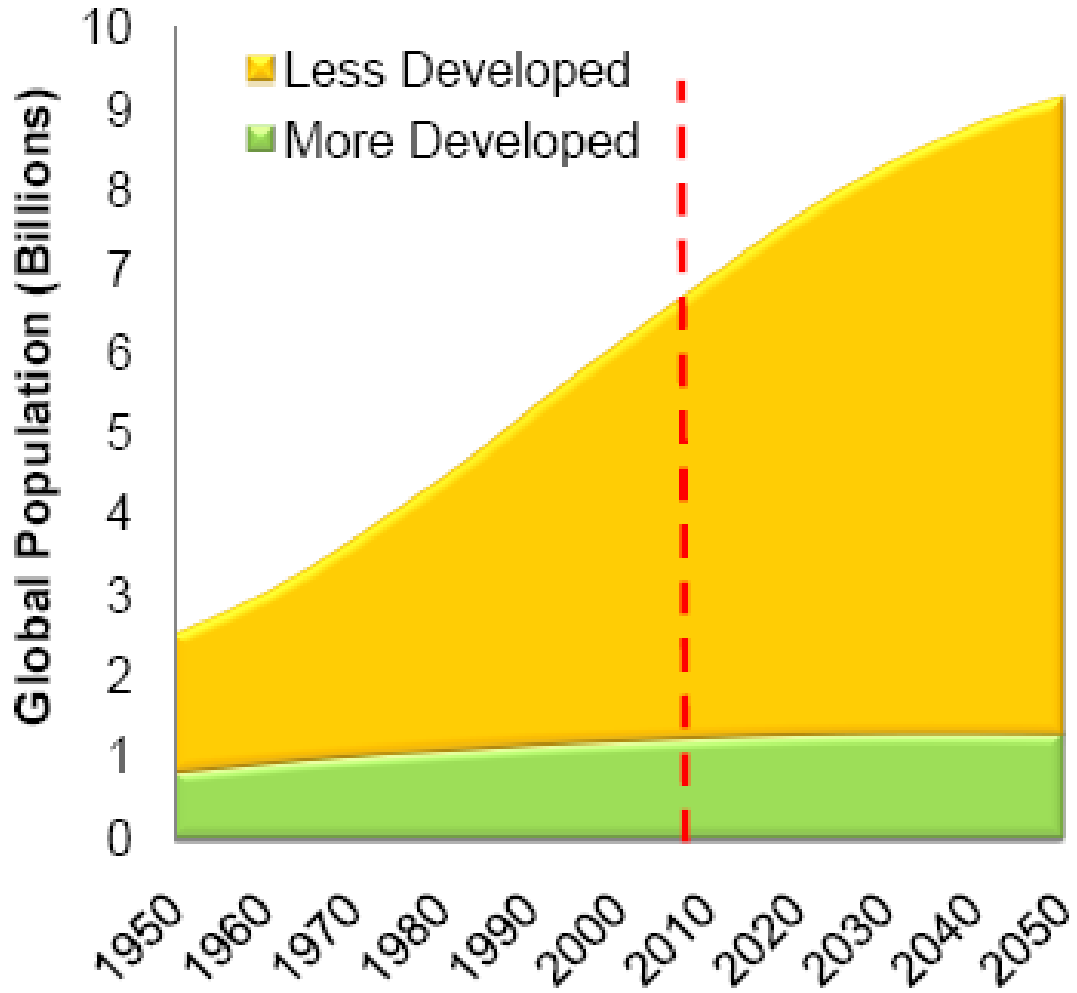
Increases in # of bee species increases apple pollination, increases in honey bee abundance does not





Blitzer et al., 2016

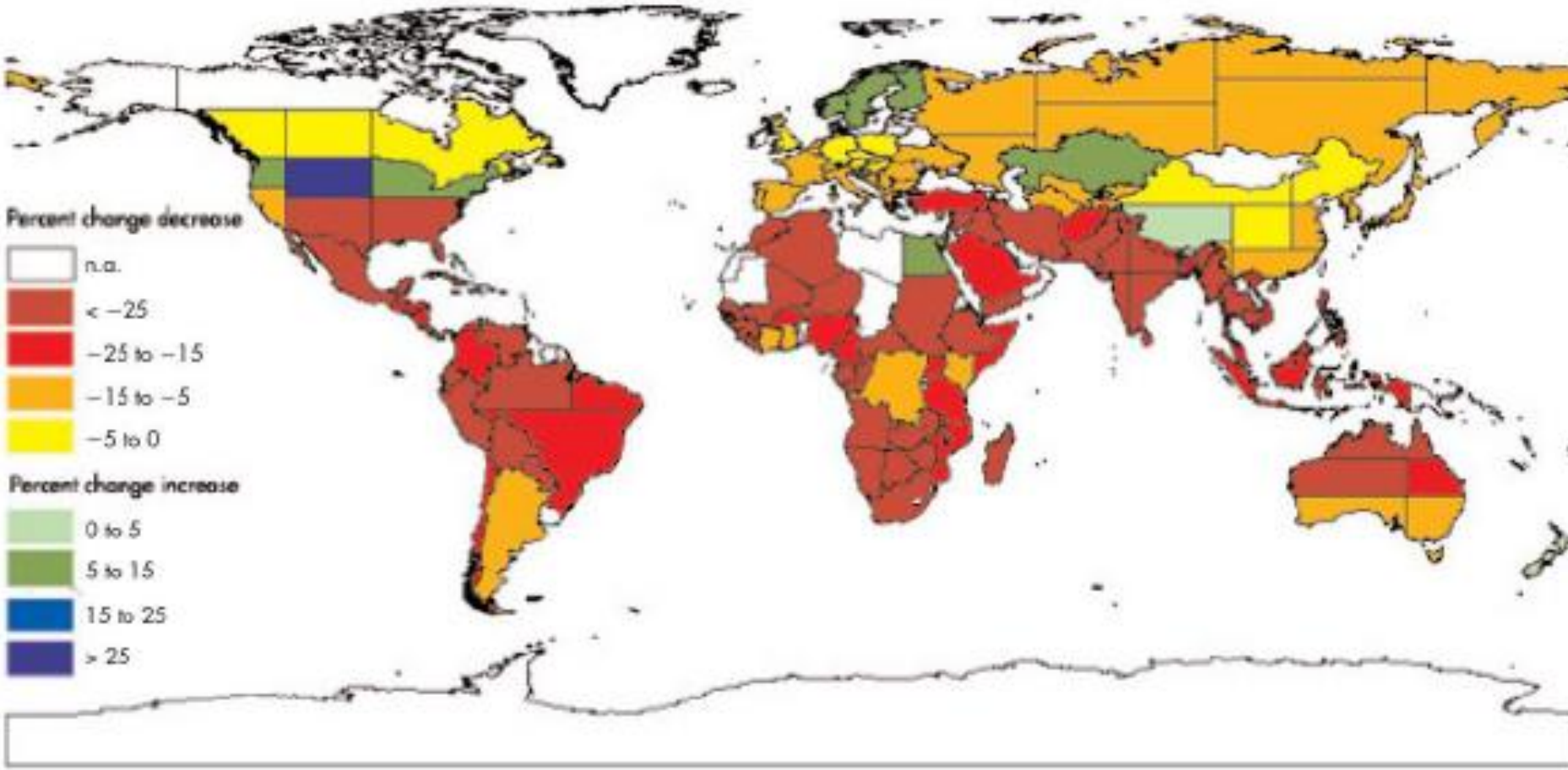
Food security – Population

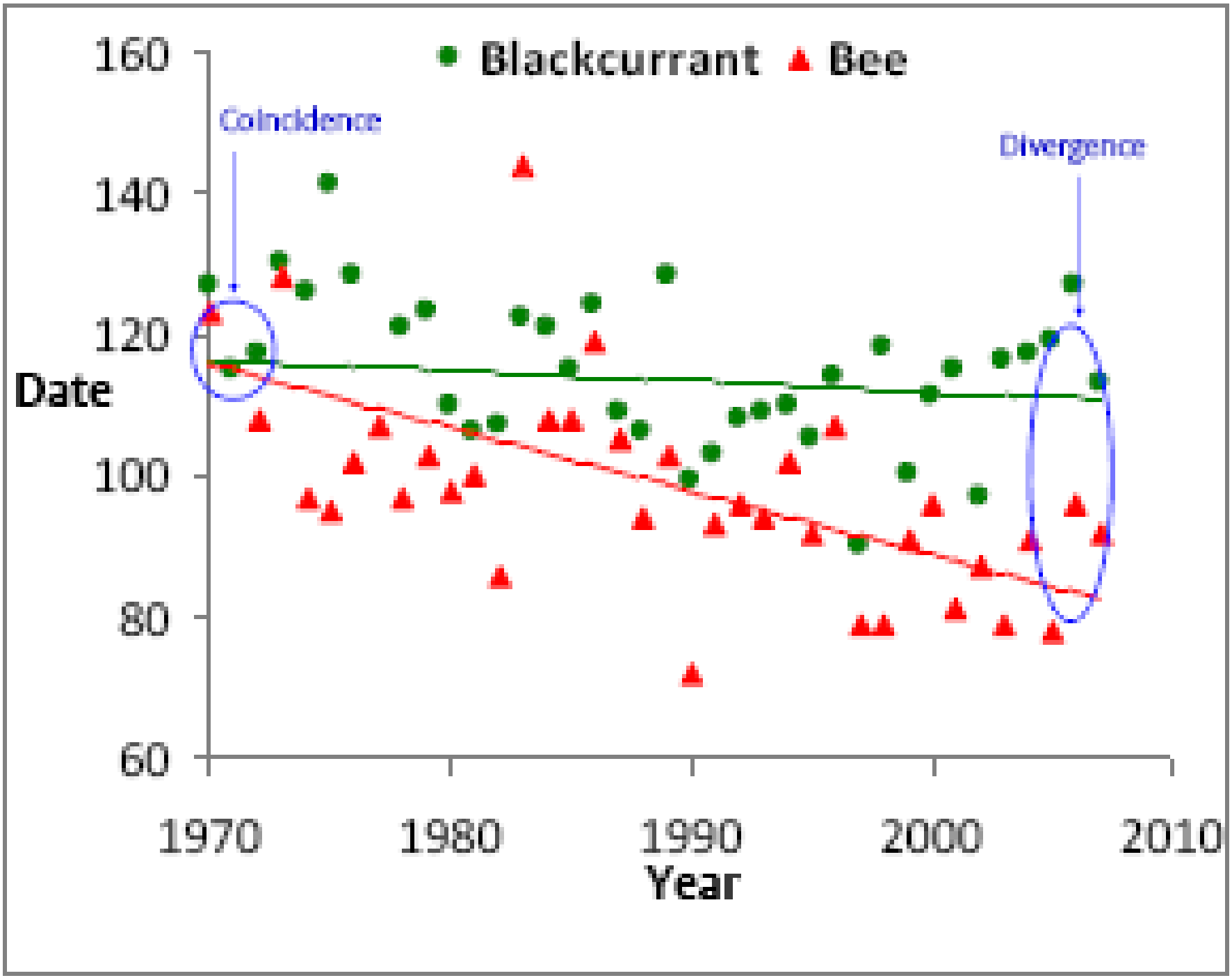


- ~9 billion people to feed by 2050
- Greatest growth in developing countries
- Coincides with areas of decreasing agricultural productivity

Food security - Productivity

- Impacts of Climate Change on agricultural productivity by 2080




Blackcurrant
Bee
Coincidence
Divergence
160
140
120
100
80
60
Date
1970
1980
1990
2000
2010
Year

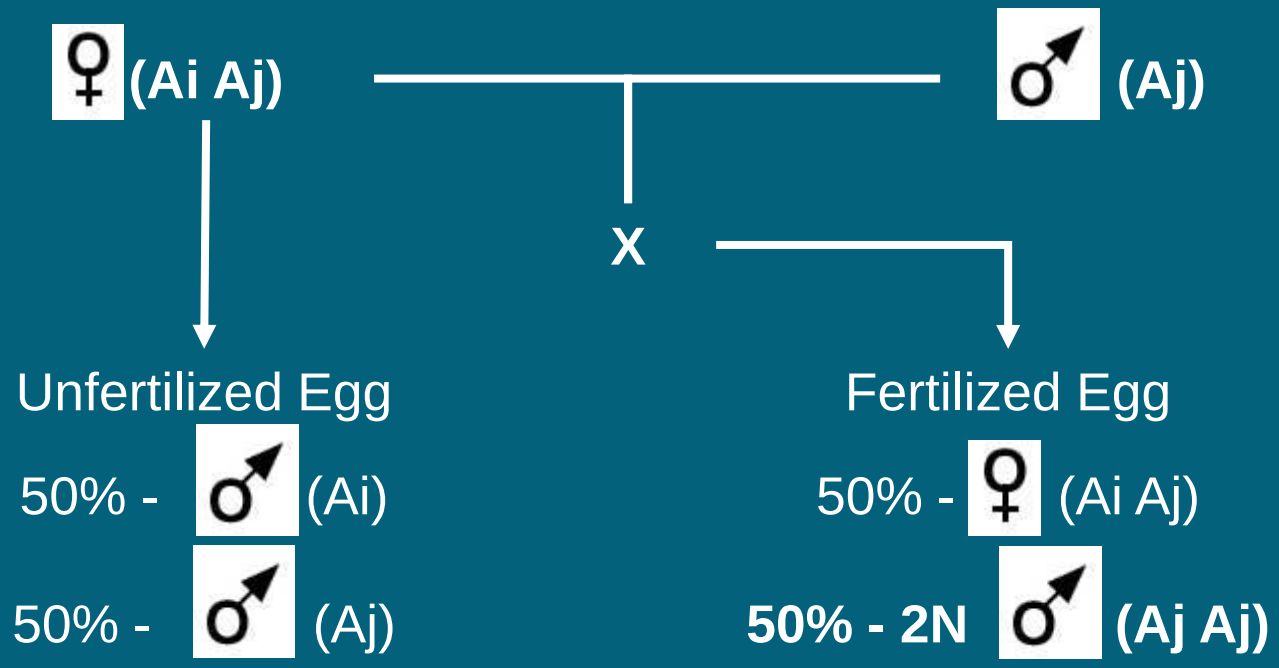
Photos
L. Mandel

Bees as Environmental Monitors

- With >20,130 species there are plenty to use for assessments.
- With diverse ecologies, they should be capable of monitoring many different aspects of the environment.
- But there is another reason why bees should be good for this.


Sex & Death

DIPLOID MALES: result from homozygosity at the sex locus



And are attempts at female production

Diploid Males: two categories

Diploid males

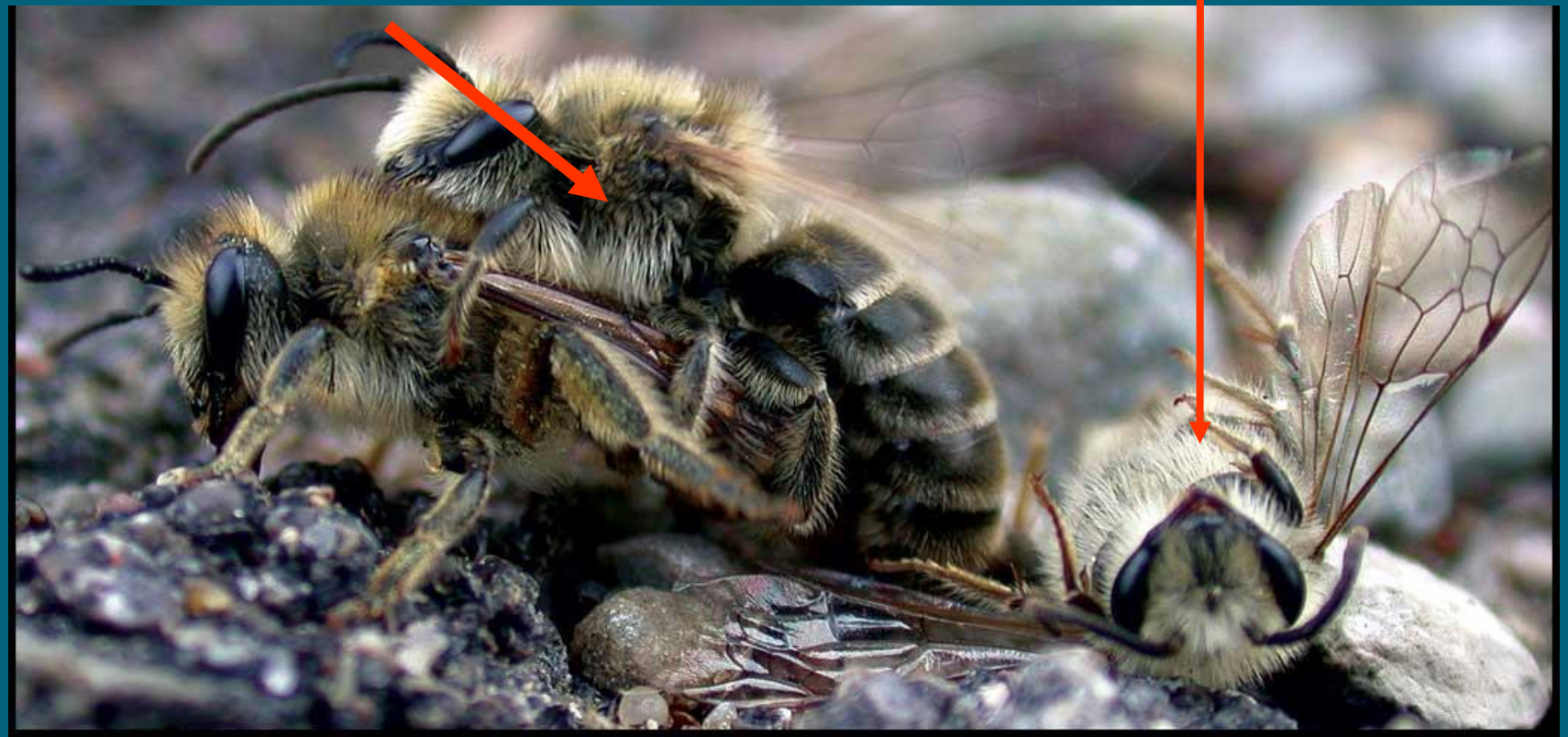
Sterile

1. **Increase female mortality.**
2. **Waste reproductive opportunities of mates**

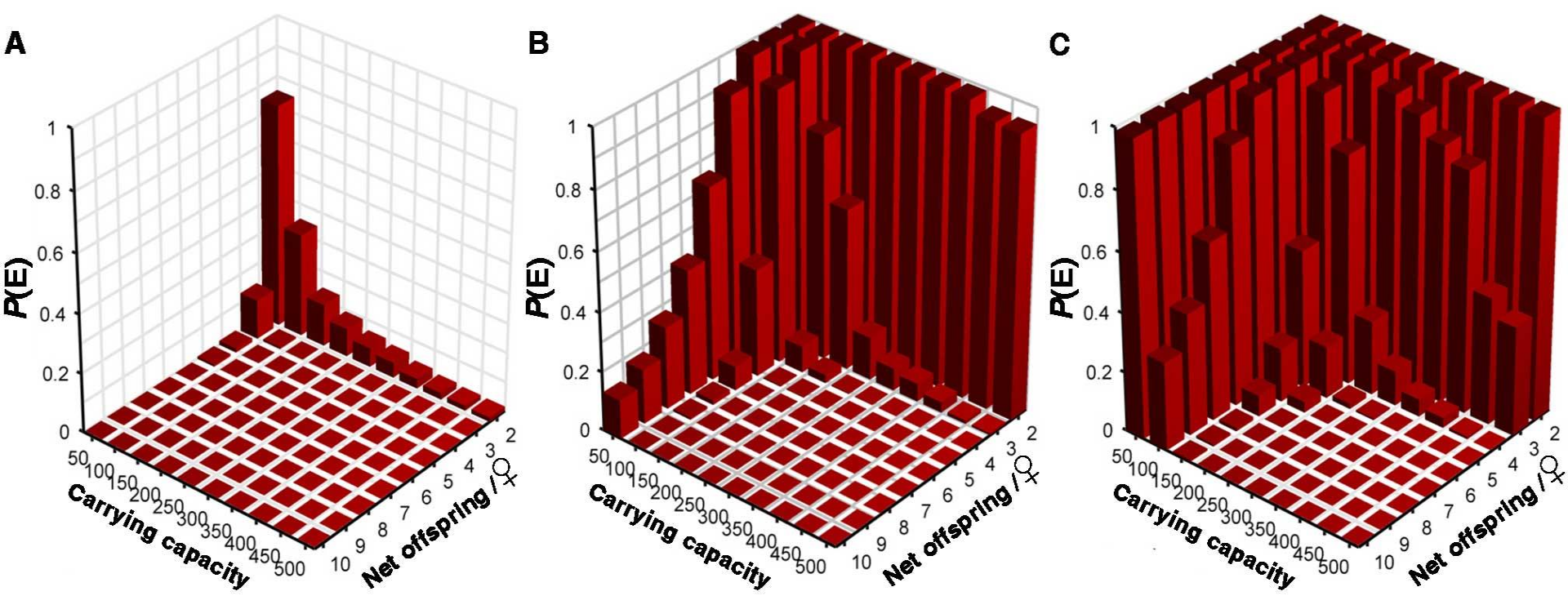
Inviable

1. **Increase female mortality: because fertilized eggs are normally female**

Colletes inaequalis



Probability of extinction in haplodiploid populations with and without DMP



NO DMP

DMP w/ Inviable Diploid Males

DMP w/ Sterile Diploid Males

Zayed and Packer 2005

With all this diversity, are some bees better at assessing the state of the environment than others?

1) Specialist bees: *Lasioglossum oenotherae*

Specialist bees have smaller populations

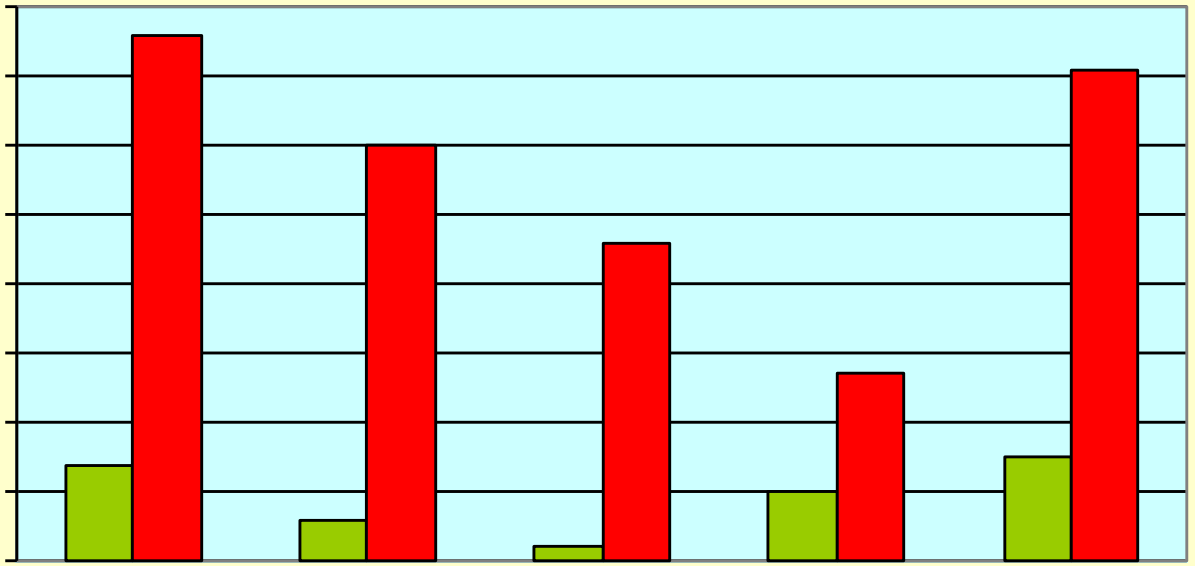
Caupolicana fulvicollis on *Loasa tricolor*

Nolanomelissa toroi on *Nolana*

Centris mixta on *Prosopis tamarugo*

Specialists versus **Generalists**

Packer et al.,2005



2) Cuckoo Bees, especially those that are host specific and have specialist hosts

Colletes latitarsis is a floral specialist on *Physalis* - tomatillo, *Epeolus bilfasciatus* lays eggs only in the nests of this bee host

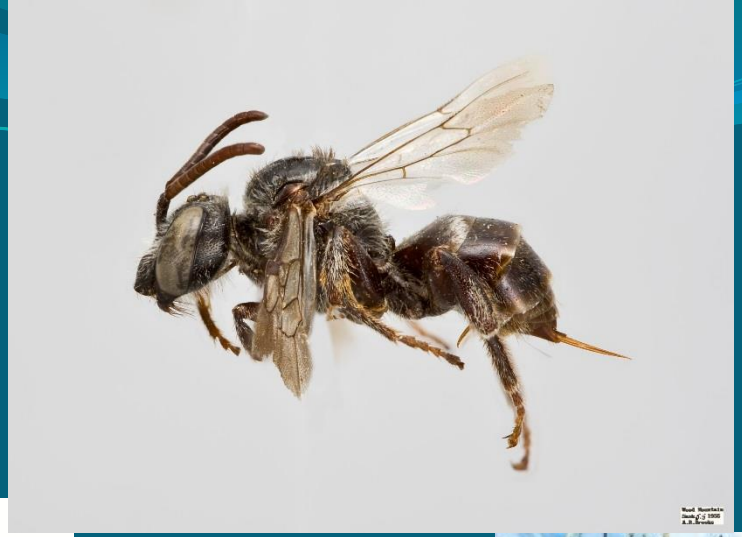
Images by T'ai Roulston

3) Social bees

Bombus affinis

Sheila Colla

Bombus affinis and *Epeoloides pilosulus* have been listed as endangered by COSEWIC



So Why are Bees Not Commonly Used in Environmental Monitoring?

The Taxonomic Impediment

- There are too many species in most parts of the world for anyone to be able to easily recognise all of them to species.
- There are numerous species yet to be discovered.
- There are numerous cryptic species – morphologically apparently identical yet genetically discrete
- There are numerous species known only from one sex.
- This impediment also applies to economically important species.

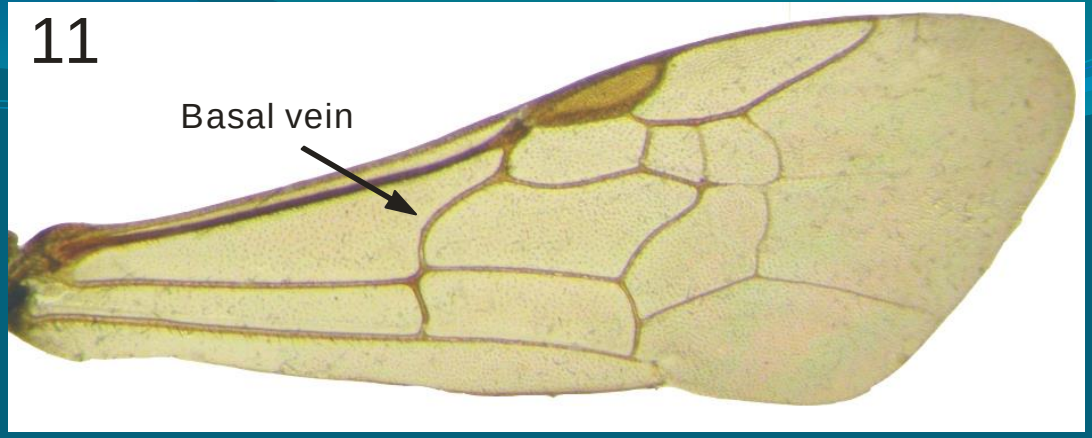

Mukhaya
Pioneer advanced
research on stingle
bees since 19
domestication
Species found in
KaKamega forest
KERGEP
KERGEP
STAR

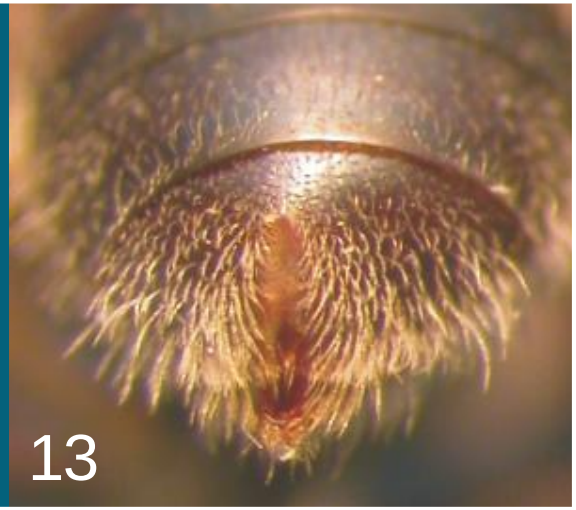
Some Solutions

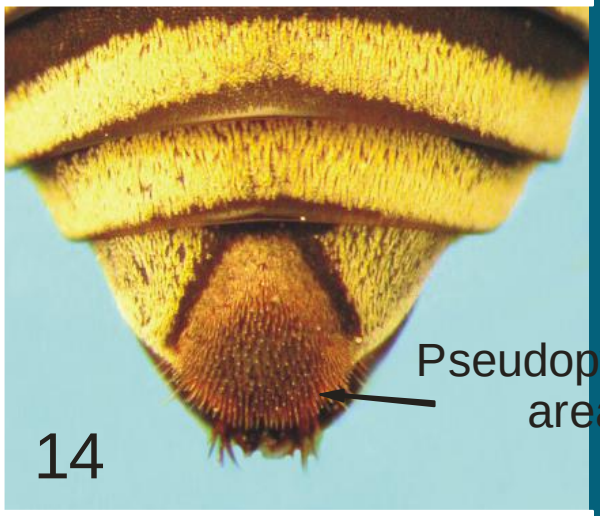
- Increase the background knowledge base
- User-friendly keys
- DNA Barcoding
- Encourage bee-friendly practices

Inform people about wild bees

Examples from "A Key to the Genera of Bees of Eastern Canada" (Packer, Genaro and Sheffield, 2007: CJAI).



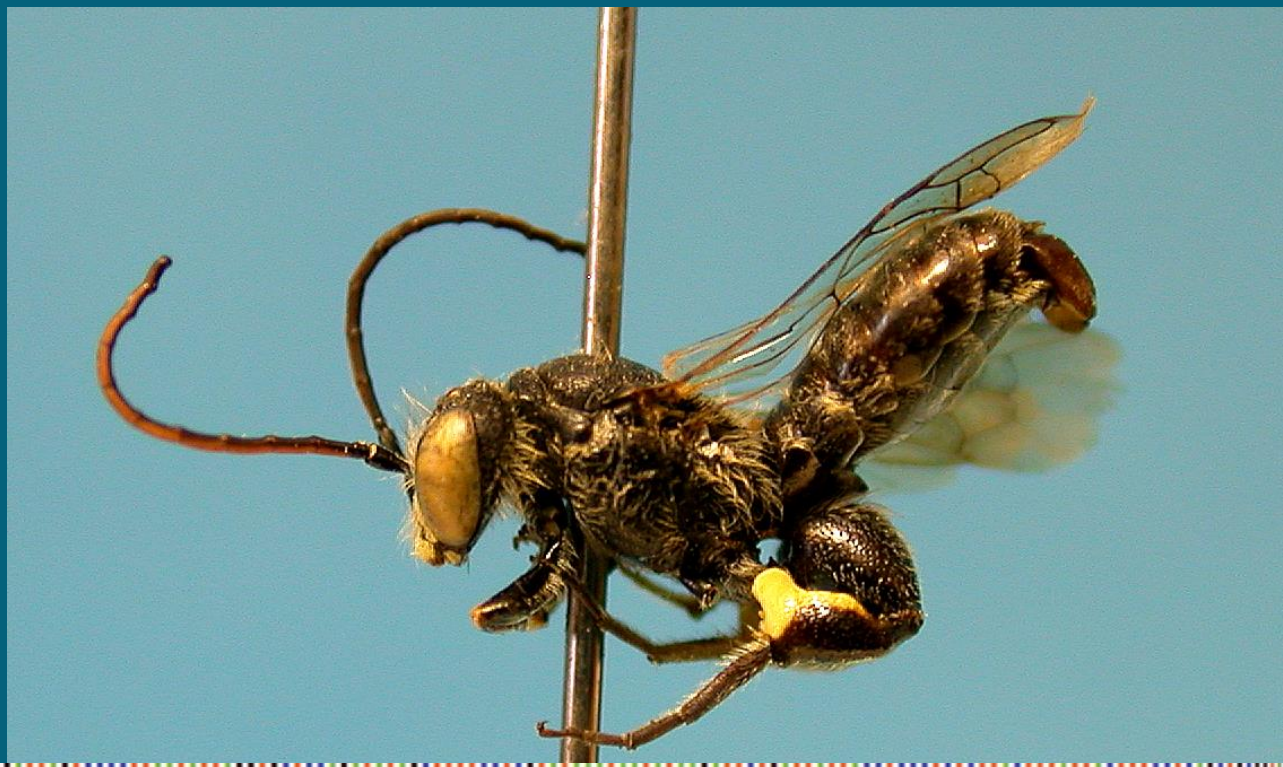




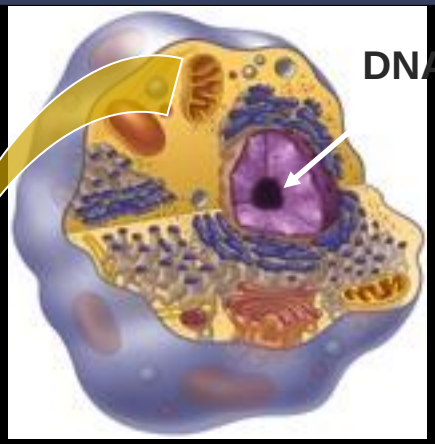
Imaging Facility

DNA Barcoding –

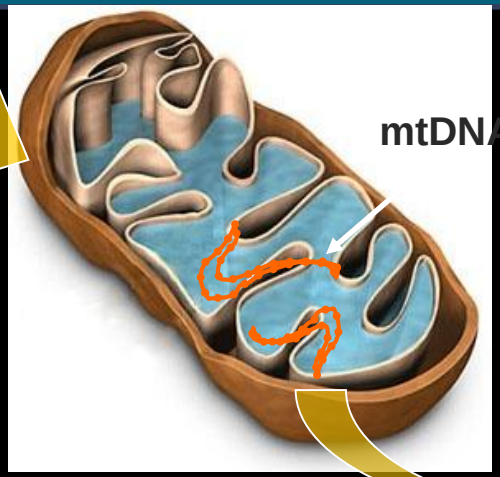
- What is DNA barcoding & how is it done?
- Bee-BOL: the campaign to barcode the bees of the world.



DNA Barcoding – Animal target gene

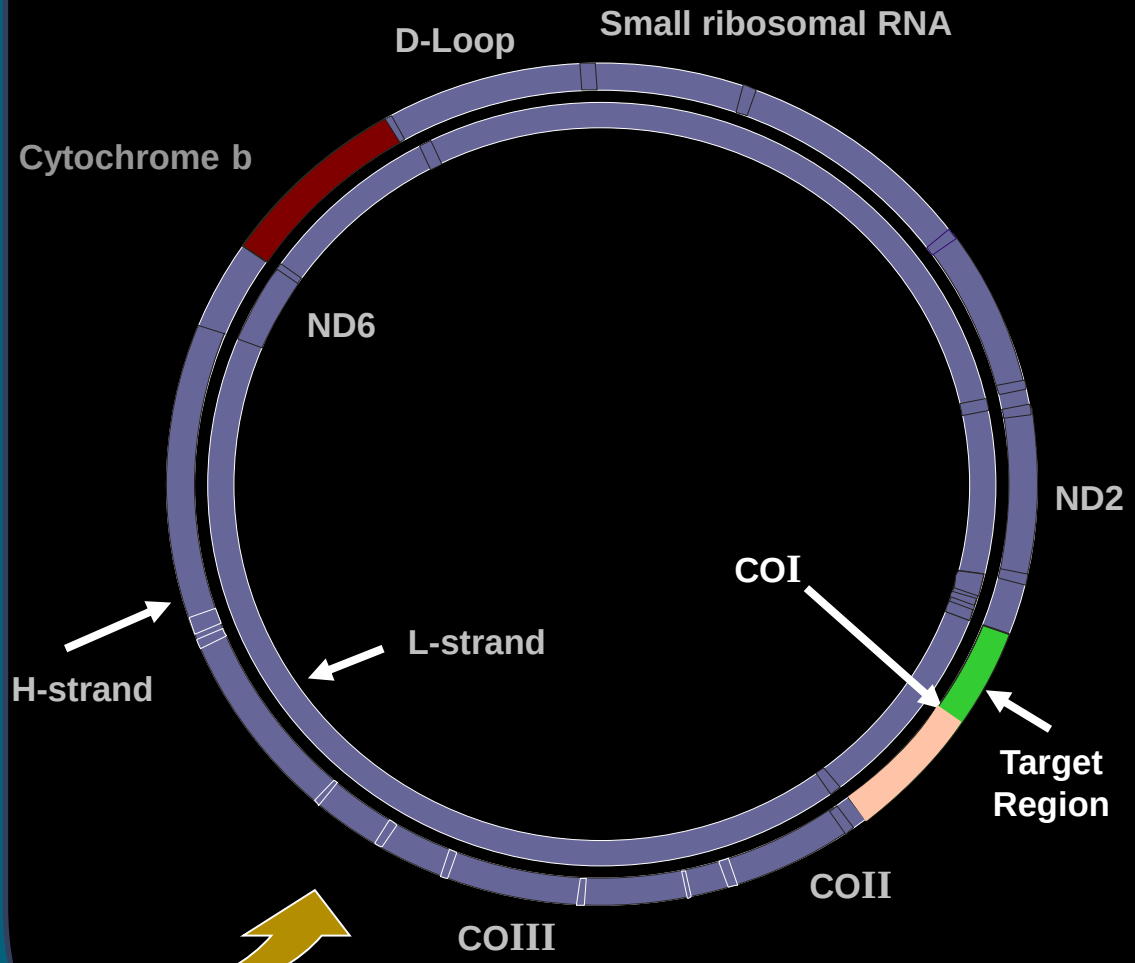


Typical Animal Cell

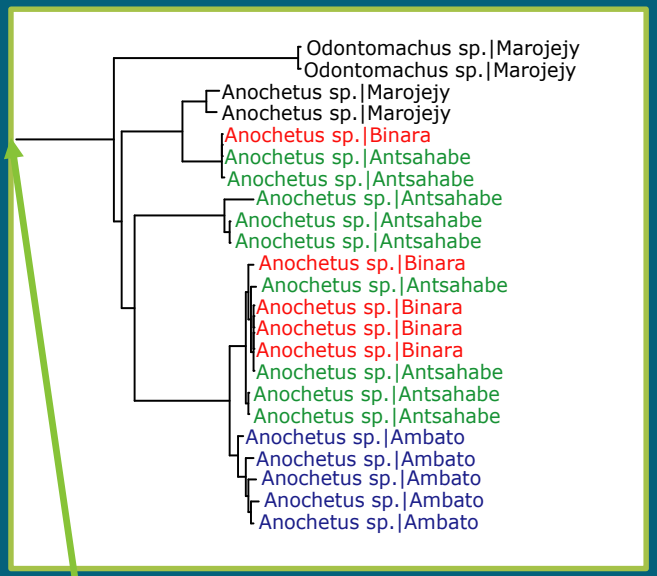


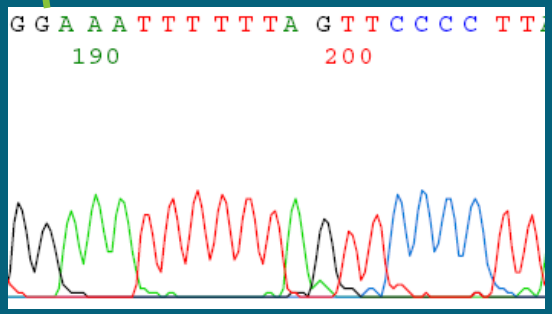
Mitochondrion

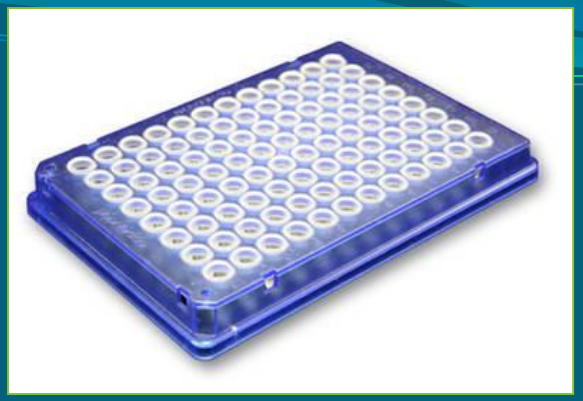
The Mitochondrial Genome



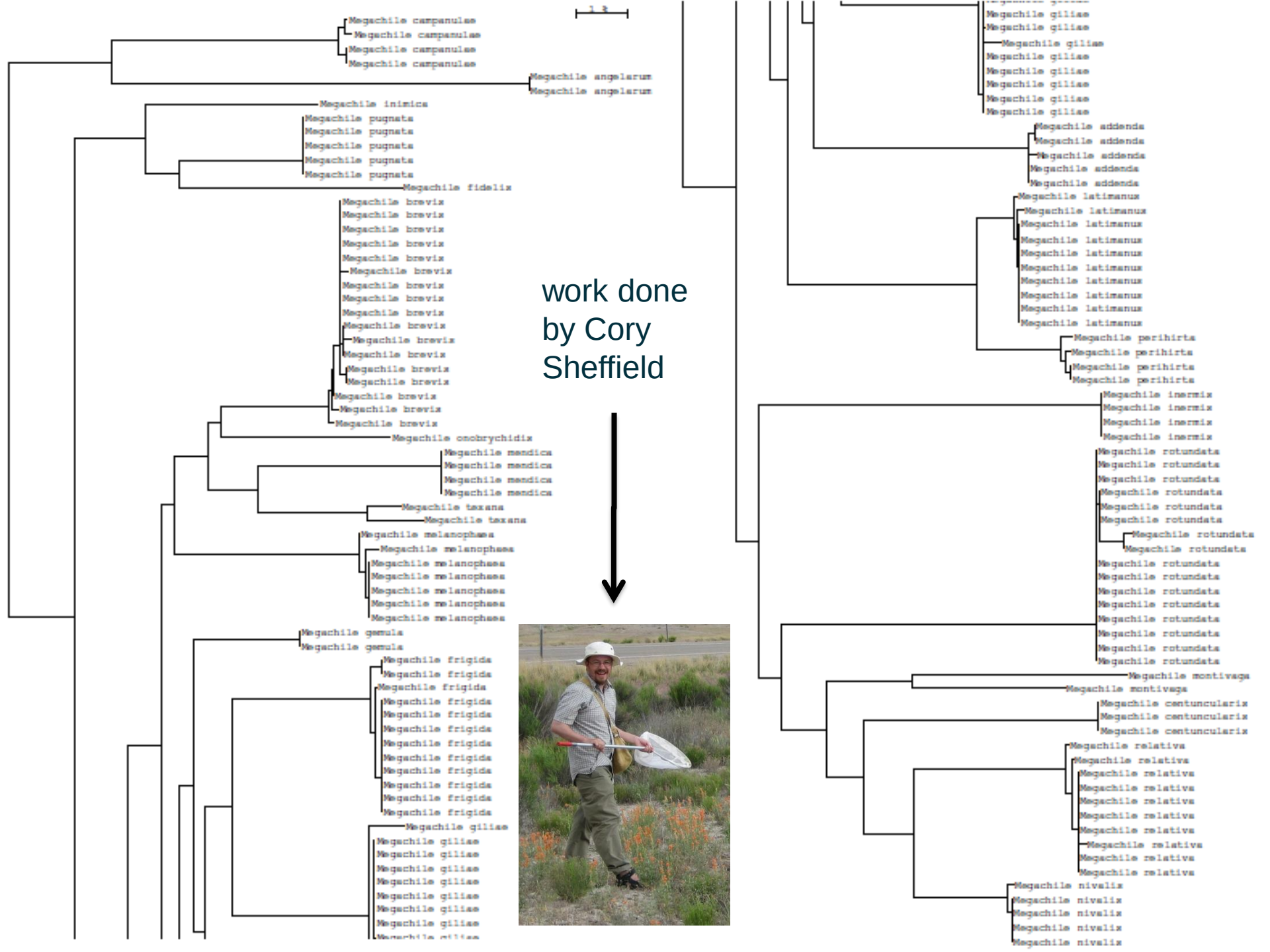
Methods







Bee legs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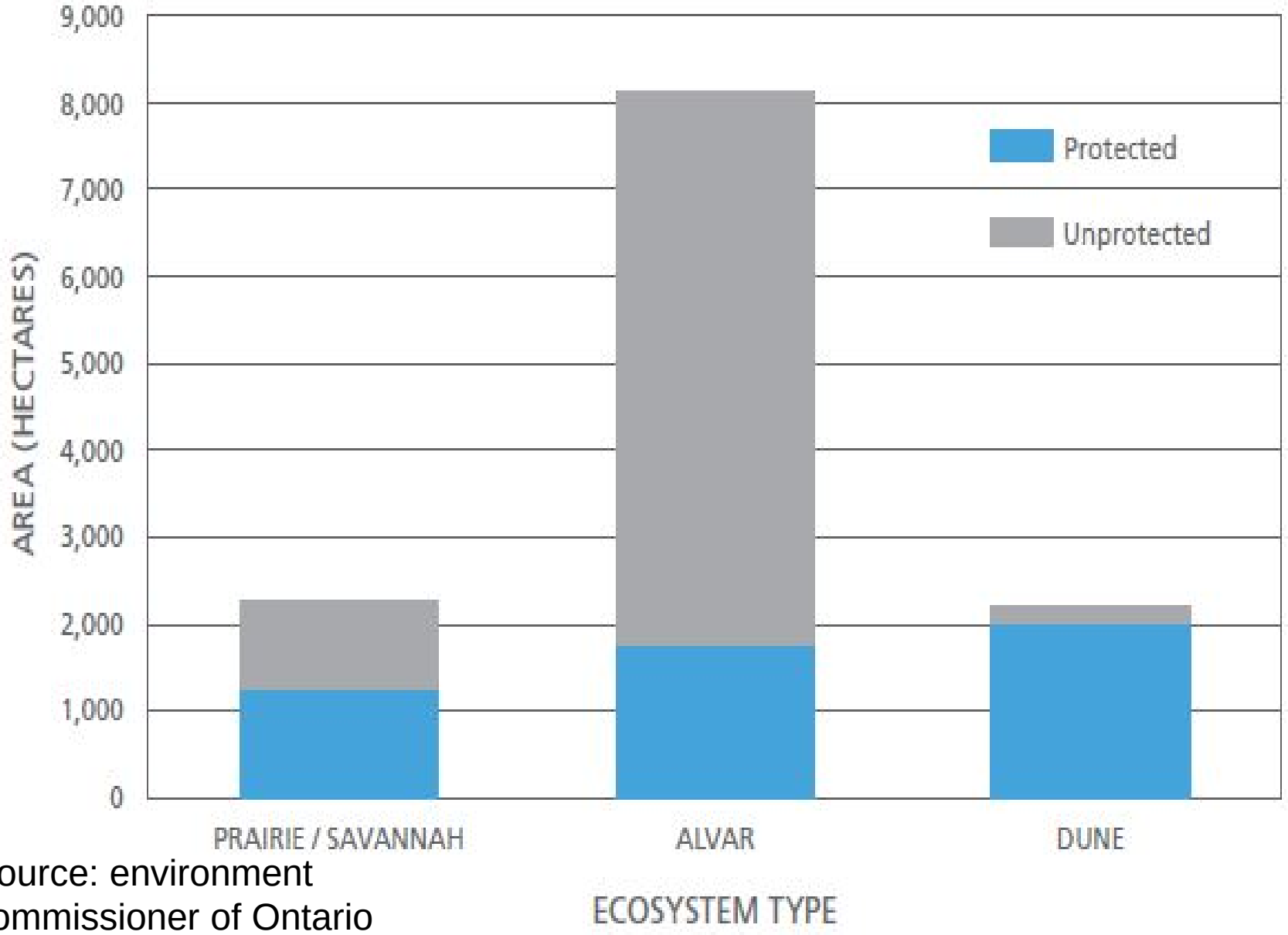
Megachile nivalis
Megachile nivalis
work done by Cory Sheffield

HELP THE BEES

- Protect bee hotspots
- No insecticides – buy organic
- Native plants and/or fewer complex or unrewarding flowers in the garden
- Diversify habitats
- Bare soil patches
- Leave some old, dead, stems around
- Minimal mulching

Protect bee hotspots



Source: environment commissioner of Ontario

Maintain hotspot habitats

Alana Pindar:
PhD thesis

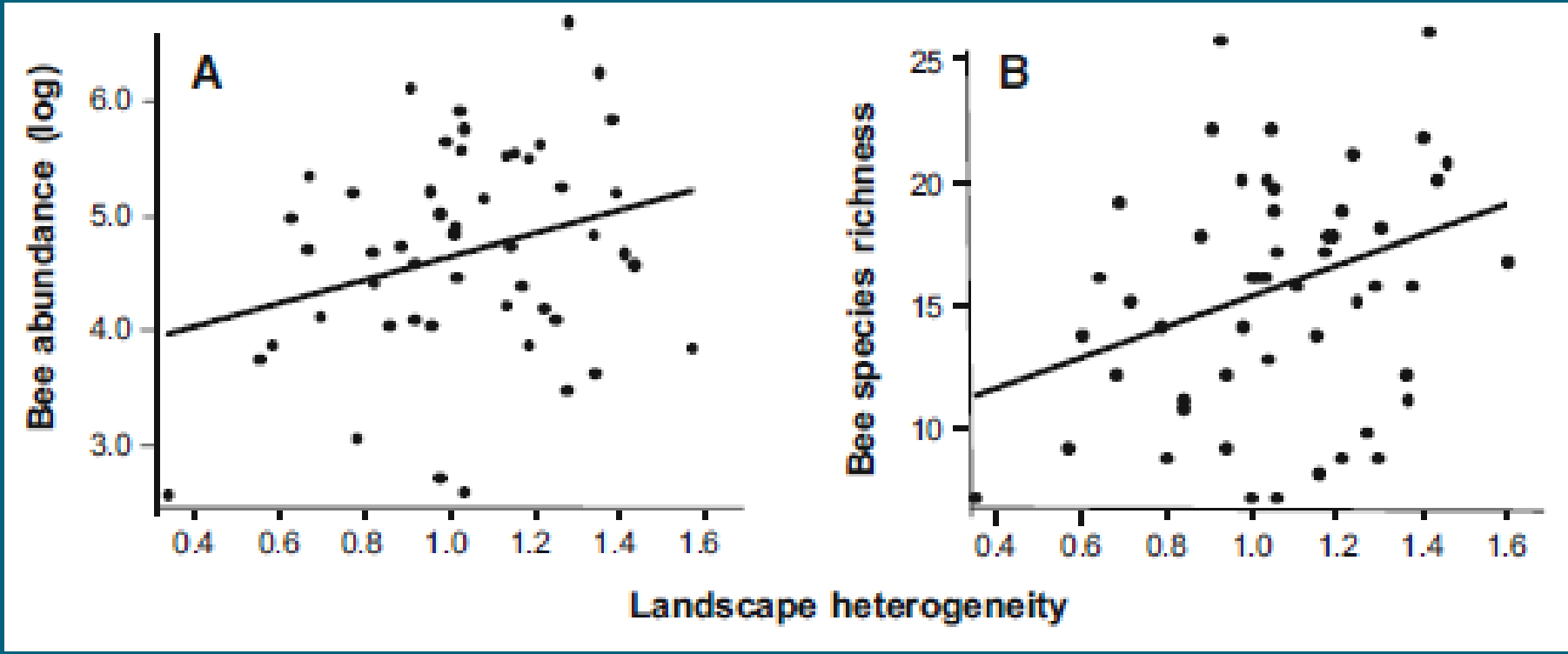
No fly zones – >2km around sensitive areas

No pesticide zones – several km around sensitive areas to avoid pesticide drift

Plant bee-friendly flowers

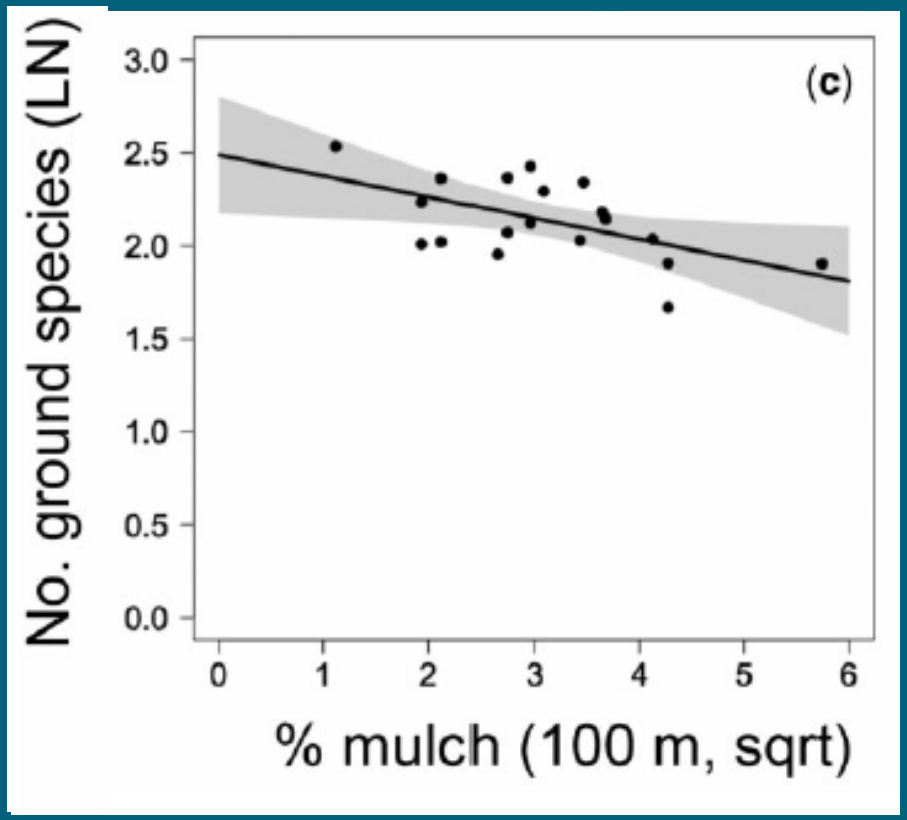
Diversify the habitats: both bee abundance and species richness increases in more heterogeneous landscapes

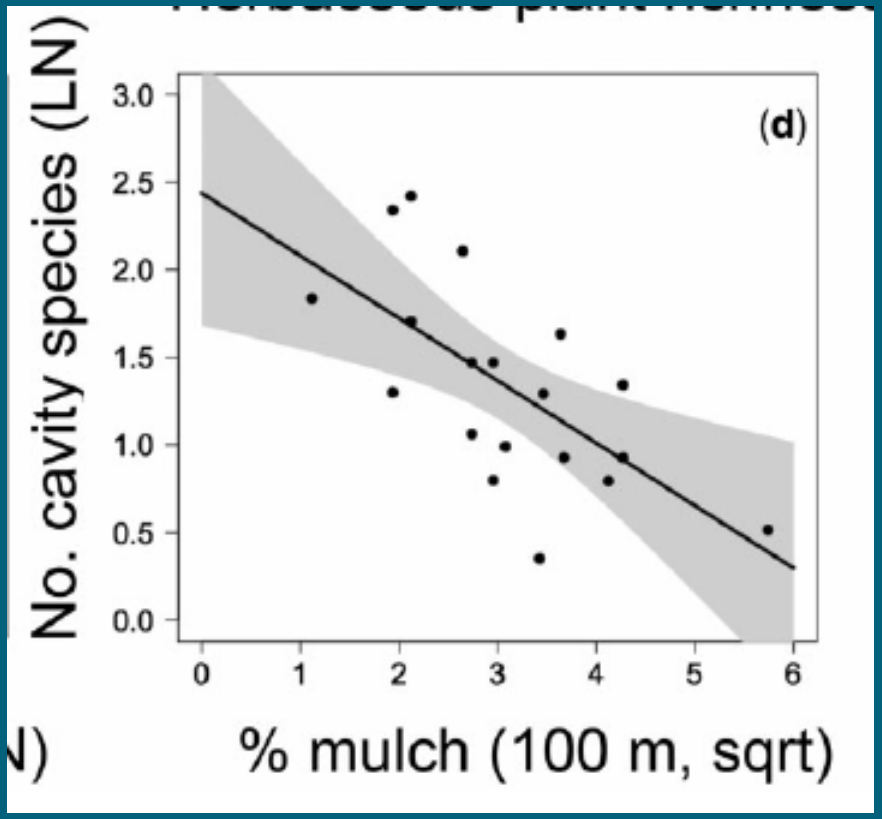
Mallinger et al., 2016



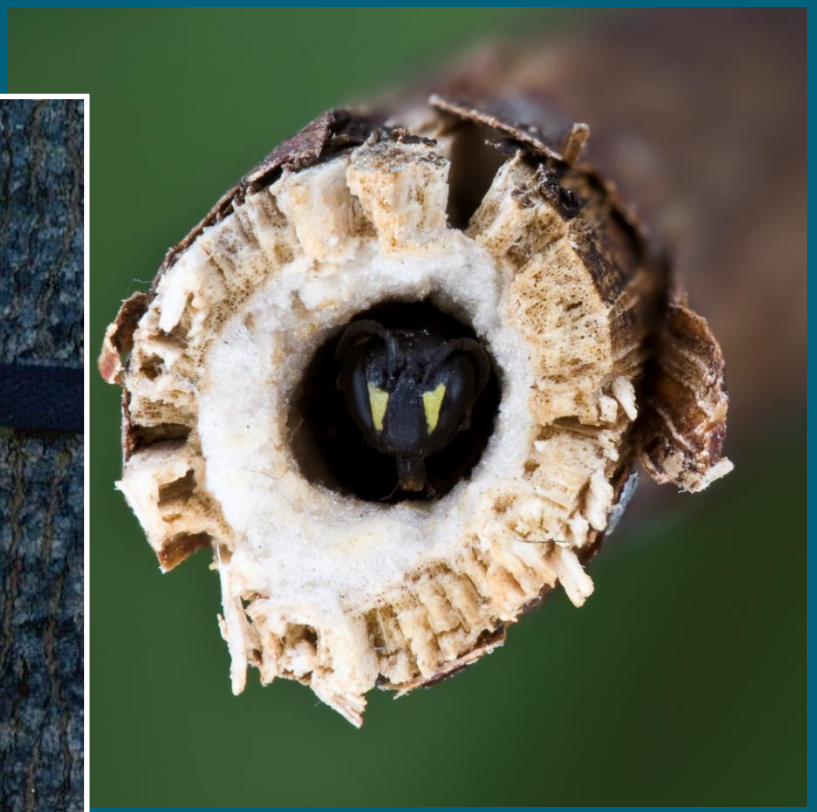
Minimize mulch

Quistberg et al. 2016



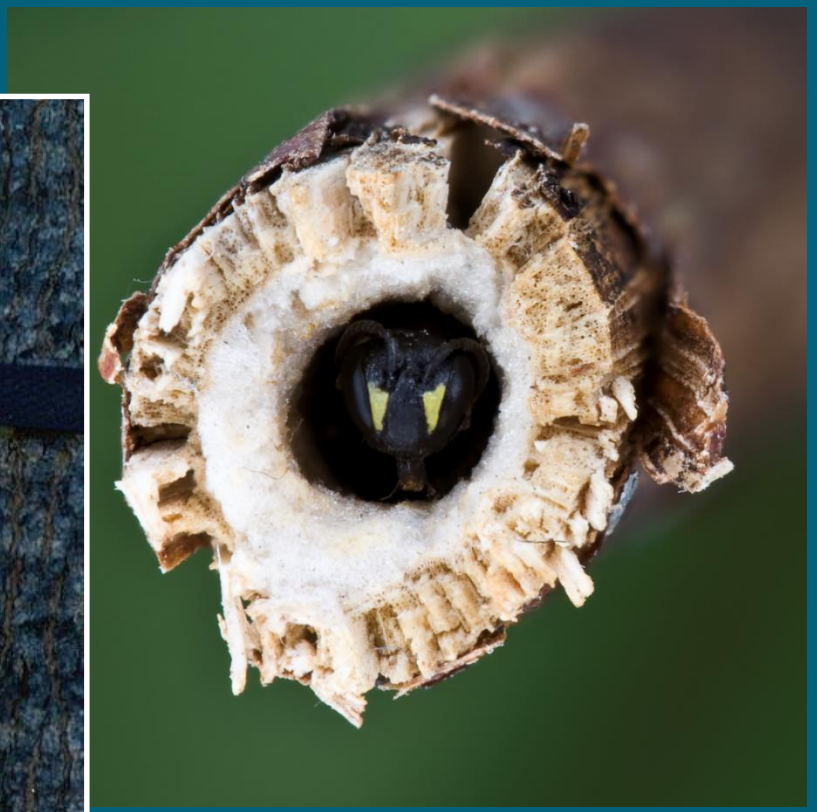


Construct nest sites, or at least don't destroy them: though lots more work is needed to ensure "bee hotel" designs are beneficial rather than detrimental



Ignore don’t walk on the grass signs

Construct nest sites, or at least don’t destroy them



Summary

No

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- Images of bees can be downloaded for free from my website: google “bugsrus”. Most Canadian species are illustrated there and almost all the world’s bee genera will soon be available also.

THANK YOU!

Xeromelissa rozeni on *Nolana*

Image: Amro Zayed

Local Sutton Beehive – Carole Langford & Family