Pollinator decline & pesticides

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Pollination services by honey bees

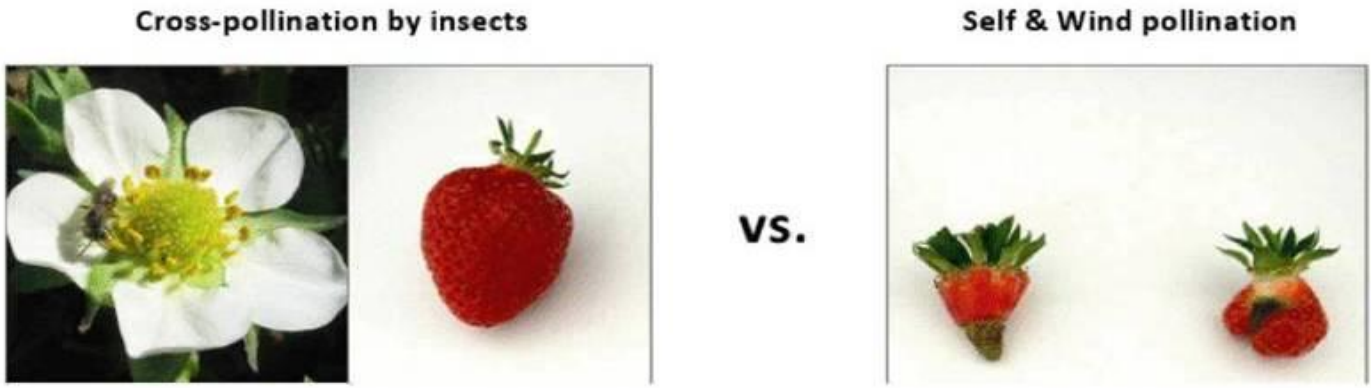
$19 billion in added US crop value
= 1/3 of our diet

Images: Seeds of Good Fortune, The Council of Canadians

Pollination services by bees

increases yield, uniformity, size & sweetness

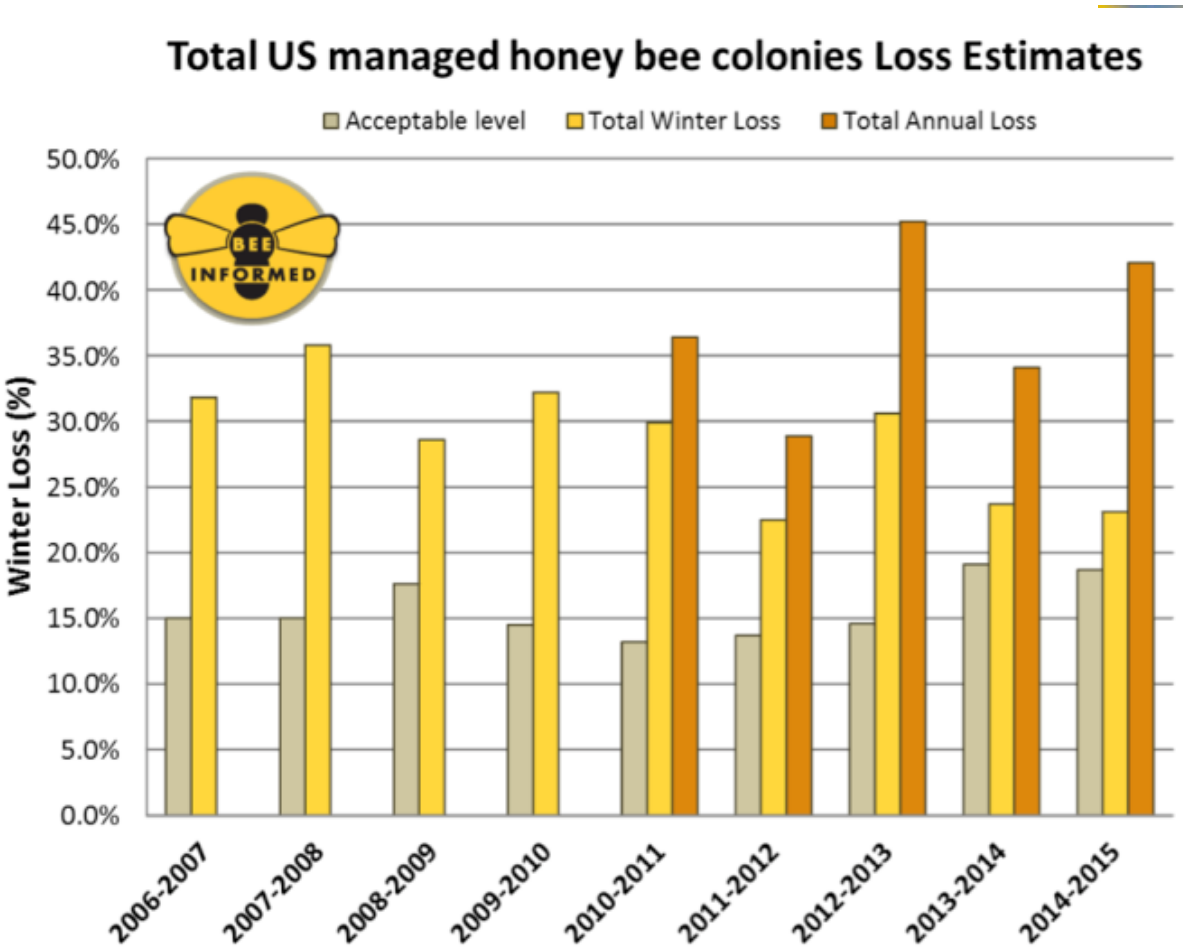
most nutritious foods
(fruits, vegetables, nuts)



Healthy Bees = Healthy Lives

Honey bee decline

61 contributing factors to honey bee decline: poor nutrition, migratory stress, *Varroa* mites, *Nosema spp.,* pesticides, tracheal mites, viruses, bacterial, wax moths, hive beetles,…….



(vanEngelsdorp et al. 2009, 2010)

Wild Bee Pollinators Also in Decline

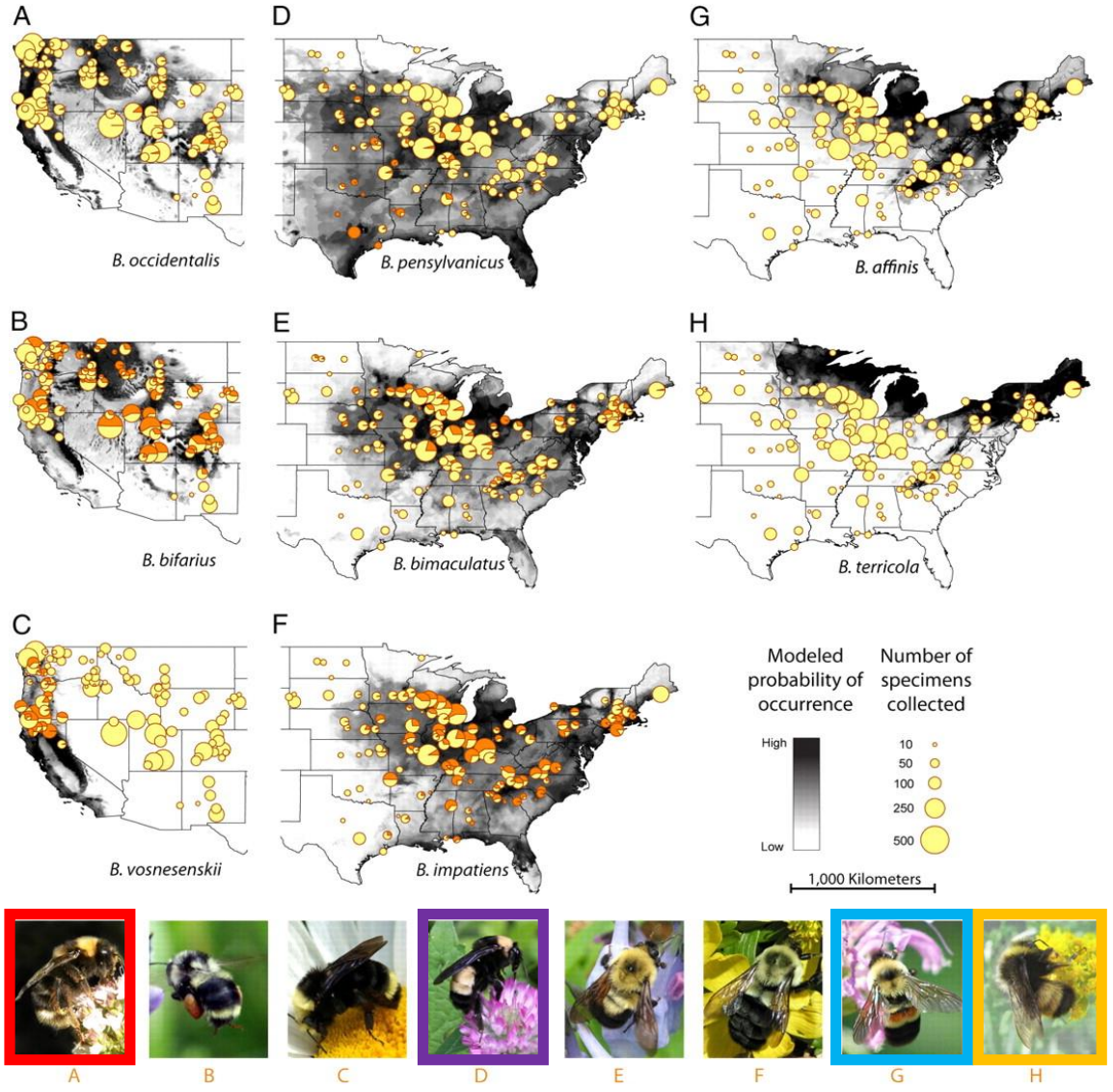
Over 4,000 species in the US

"Visitation by wild insects and honey bees promoted fruit set independently, so pollination by managed honey bees supplemented, rather than substituted for, pollination by wild insects."

Science 2013 – *Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance*

Patterns of widespread decline in North American bumble bees

Sydney A. Cameron et al. PNAS 2011;108:662-667



Examined 8 target species.

A) *B. occidentalis*
D) *B. pensylvanicus*
G) *B. affinis*
H) *B. terricola*

- declined by up to 96%
- surveyed geographic ranges have contracted by 23–87%

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“Pesticides”

- Definition: any substance used to kill an undesired pest

  Insecticide Herbicide Fungicide

  Rodenticide Bactericide Larvicide/ovicide

- Agricultural: protection of large scale food crops
- Urban & landscape: cosmetic purposes
- Applied various ways: spray, chemigation, granular, injection, dusting
- Persistence of compounds vary and can impact toxicity
- Bee exposure: oral (nectar, pollen, water), dermal, or respiratory
- Bee kills occur from direct contact or from residues

Every pollen load a honey bee brings home 6-30 detectable pesticides

Types of insecticides

- Pyrethroids
- Organophosphates
- Carbamates
- Neonicotinoids
- Insect Growth Regulators
- Organochlorines
- Chlorinated Cyclodienes

Bee packs pollen grains on hind legs to carry to colony

Honey bees store pollen in wax combs

Variety of pollens with different protein contents

Pesticide exposure to bees

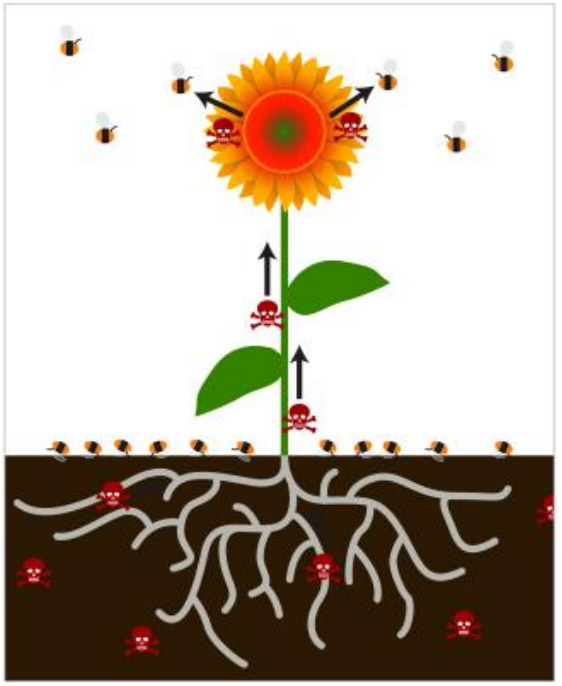
Mullin et al. 2010 study

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

121 different pesticides and metabolites within 887 wax, pollen, bee and associated hive samples.

over 47% had both **in-hive miticides** fluvalinate and coumaphos, and chlorothalonil, a widely-used **fungicide**

60% of the 259 wax and 350 pollen samples contained at least one **systemic pesticide** (fungicide, herbicide, insecticide)



Interactions are likely to occur

Multiple chemicals may interact with one another and cause different effects.

Pesticides can also interact with other pathogens (ex. Neonicotinoids increase susceptibility to *Nosema* infection)

Difficult to study effects of every possible interaction between pesticides found in the environment

Exposure to multiple compounds

are likely in wild bees as well

particularly in provisioned pollen

for brood

Agricultural bee kills

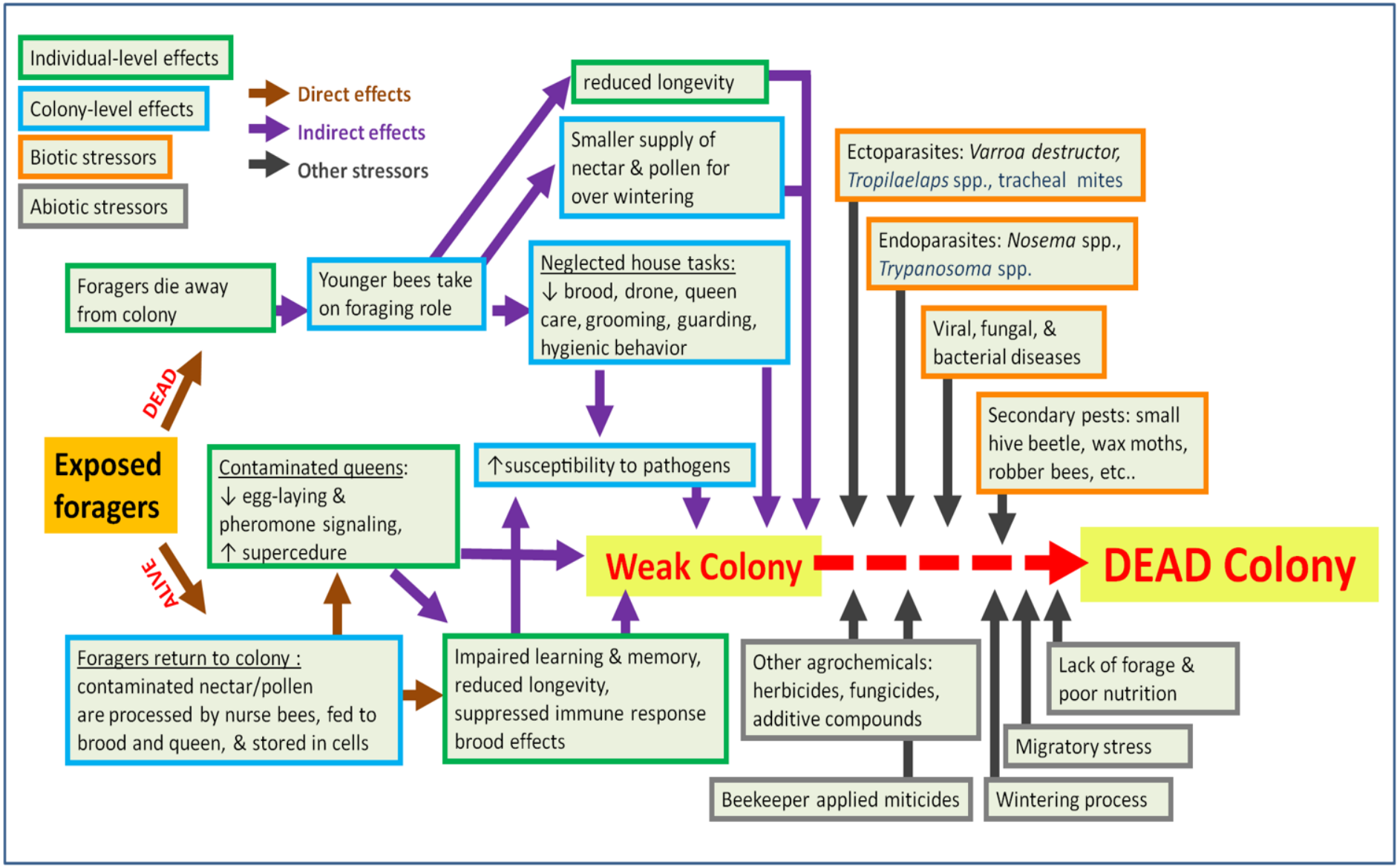
Crop planting dust = acute exposure Clothianidin

Urban landscape bee kills

- Oregon (50,000 bumble bees killed by Safari (Dinotefuran)

Wilsonville trees netted after 50,000 bees die | KOIN.com

Sub-lethal effects from pesticides: It's complicated



What can you do?

87.5 % flowering plants are animal-pollinated (Ollerton et al. 2011)

Economic consequences of bee decline?
Ecological consequences of ↓ plant diversity?

PROVIDE BEE HABITAT:

Grow bee-friendly plants, leave weeds until after bloom

- -bee-friendly = nectar and/or pollen providing
- -supply blooming flowers all season *(various colors, sizes, shapes, heights, etc. will attract more species)*
- -diversity & abundance of pollen is very important
- -provide shelter for nesting bees *(stems/ twigs, wood blocks, bare undisturbed soil)*
- -provide water source *(shallow; and don't breed mosquitoes)*

REDUCE PESTICIDE EXPOSURE:

Practice bee-friendly pest control (low tox/non-chem)

- -reduce/eliminate cosmetic pesticide use
- -avoid systemic insecticides

SPREAD THE WORD:

Change perceptions

Increase awareness

Talk to garden centers, fellow gardener, growers, etc…

Moving on to …..

Oil-collecting bees

Nutritional requirements of all bees

- Pollen - protein
- Nectar – carbohydrates
- Water
- **Oils**

Oil-collecting bees

A Great Reference:

The Ecology of Oil Flowers and their Bees

- Stephen Buchmann
- Annual Review of Ecology and Systematics Vol 18 (1987)

General overview

Slightly dated but no a lot of current information

Obtains lists:

Flowers that provide oils & floral lipids

Families & genera of oil-collecting bees

Oil-collecting bees

Oil-producing flowers are mostly found in neotropical areas

Oil-collecting bees

4 families (Melittidae, Ctenoplectridae, Anthophoridae, Apidae)

15 of the 800 genera = estimated 1.4% of the 30,000 species

Uses for floral oils:

nutrition:

energetic value of floral lipids are higher

mixed in larval food and consumed by adults

water-proofing brood cells

outer plug for nests (insulation? protection?)

*aromatic compounds (including oils) used as sex attractant

Oil-collecting bees: Macropis steironema opaca

Xerces Red List Status: Critically Imperiled (Possibly Extinct)

Specialist forager of *Lysimachia* (loosestrife)
Oils are mixed into larval foods & used to line brood cells

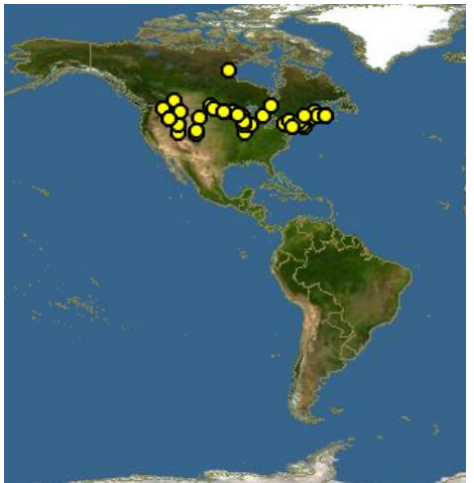
***Macropis steironematis* Robertson, 1891**

Apoidea Melittidae Macropis

Subgenus: *Macropis*

Macropis steironema opaca

Macropis nuda



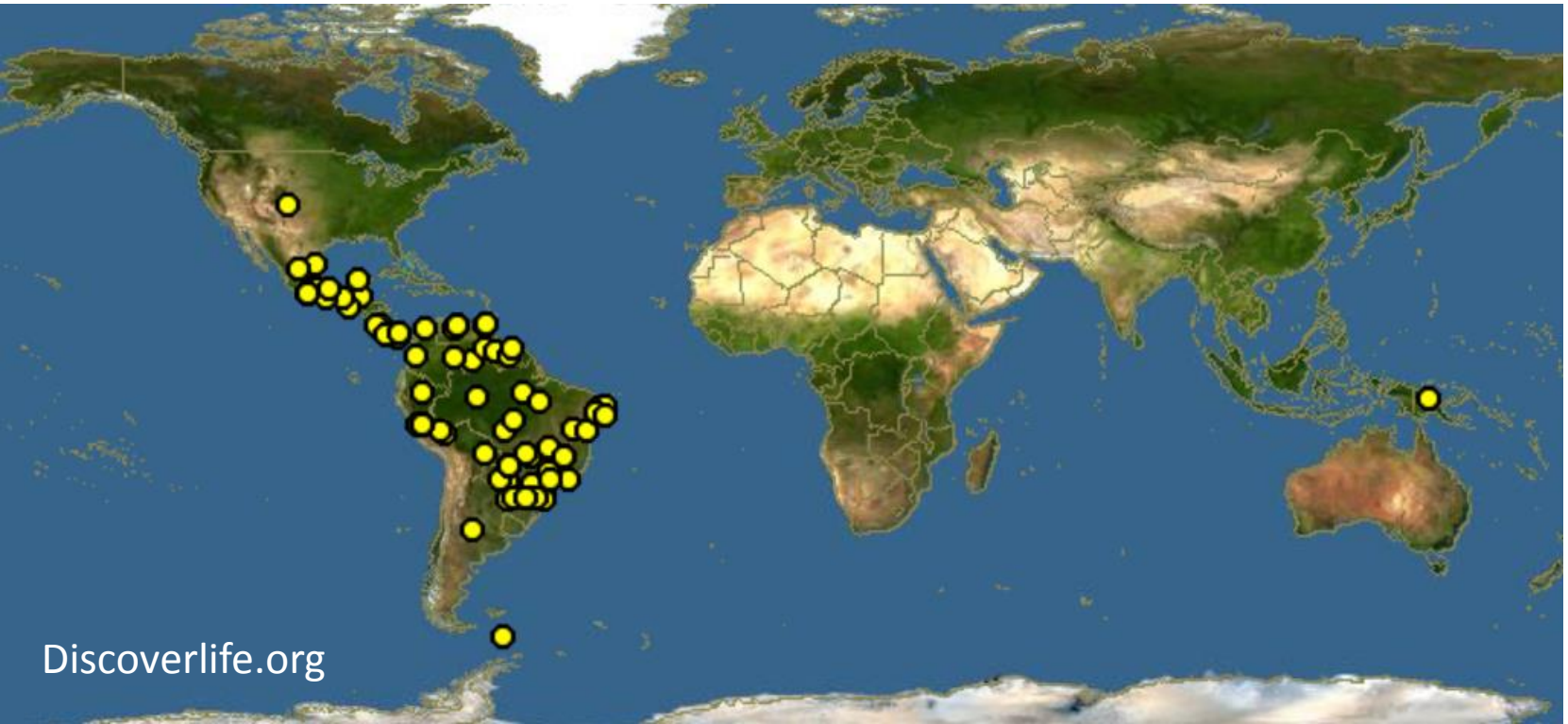
Oil-collecting bees

Centris “digger bees”
12-14 subgenera
Females of most Centris collect oils
mix into larval food
nest protection/construction

Oil-collecting bees

All bees in Epicharis genus collect oils
Mostly in South America
E. rustica collected in CO, 1983

© Copyright John Ascher, 2006-2014
Epicharis rustica



Euglossa viridissima story …

"Euglossa are especially glittery. Like tiny flying metallic prisms with long tongues." Cameron 2004

- Classic example of co-evolutionary mutualism:
  - male orchid bee pollinates orchids
  - orchids provide aromatic oils for male bees (mating pheromone)
- The bee had never been reported in the US
- The orchids are not found in the US

Photos by E Ross modified from Cameron 2004

Photo by Bob Peterson

2003 in Southern Florida

Euglossine “orchid” bees

http://www.orcheeder.com

In some areas, Euglossines make up 25% of total bee community (species richness)

More diverse in cloud forest than lowland forests with some areas containing > 50 species

This is also where the richest diversity of tropical orchids are found

Photo by Luis Olarte

http://www.symbiosis-travel.com

Refs: Cameron 2004, Roubik & Hanson 2004,

Euglossine “orchid” bees

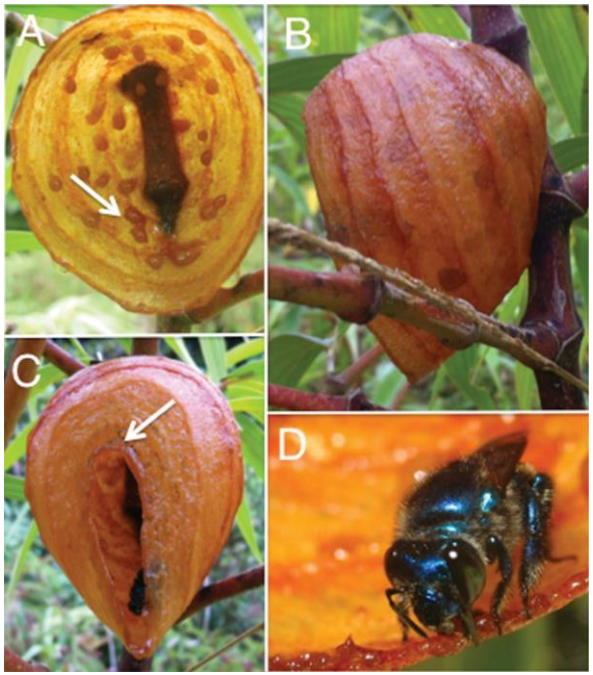
Females:

- Pollen sources: “brush flowers”- Bixaceae, Cochlospermaceae, Myrataceae, Leguminosae, Solanaceae
- Buzz pollination
- Resin sources & nesting material: Euphorbiaceae, Burseraceae, Anacardiaceae, Leguminosae, mud, vertebrate feces, bark fragments

Photo by Fabio Diniz

http://www.cobiopa.org/galeria

Wikimedia commons



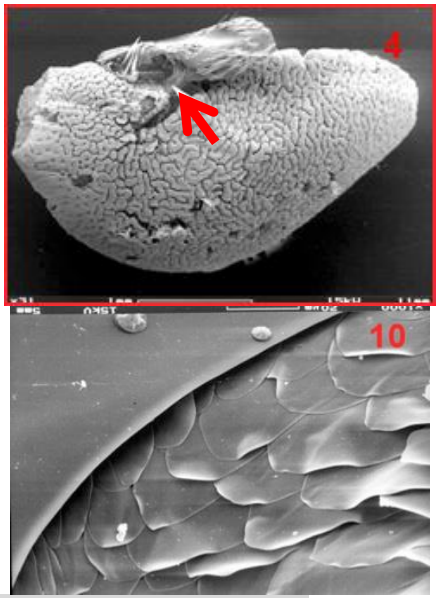
Free-standing aerial & cavity nests

Euglossine “orchid” bees

Photo by Bob Peterson

Males:

- Leave natal nest after emergence
- Live vagabond lifestyle, up to 6 months
- Are the sole pollinator for certain orchids
- Collect volatile compounds to attract females
- Do not assist in construction, maintenance, or defense of nest



Specialized hairs/scales for oil collection & modified storage organ

Refs: Dodson et al 1969,

E. viridissima story

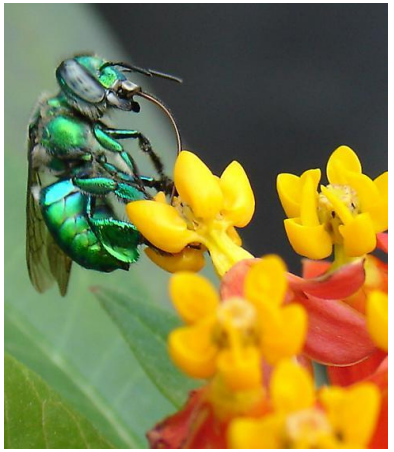


Photo by Nicole Tharp

- 2003- 1st specimen collected in Fort Lauderdale, FL fly monitoring trap)

- 2004- bee identified as *Euglossa viridissima* Friese

  (reclassified as cryptic sibling species *Euglossa dilemma* (Eltz et al. *in press*)

- (2006 Pemberton & Wheeler) USDA-ARS IPRL
  - Eugenol baits set to attract male bees
  - Greater abundance to bait than in native regions

    26 bees/hour Florida vs. 8 bees/hour Costa Rica
  - 59 male bees collected for chemical analysis

E. viridissima story

So what did they find?

- 55 compounds
- 27 were floral fragrance components from 9 known native orchid species

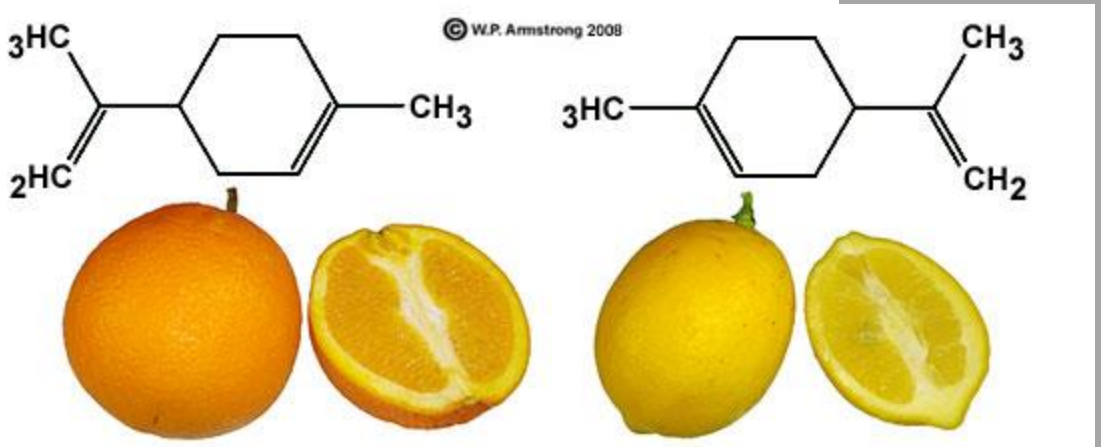
But no native orchids so from where?

- Aromatic leaves!
  - Basil varieties (contains 14)
  - Allspice (contains 7)
  - Melaleuca (contains 17)

E. viridissima story

Other odd observations

- Bees visiting rotting wood panels (fungi)
- Cleaning agents (solvent limonene?)
- Pesticide sprayers (methyl salicylate? wintergreen oil -used to mask odor in some organophosphate formulations)



http://www.kadinplus.com/wp-content/uploads/limonene1.jpg

http://www.youtube.com/watch?v=szkV71HYvJk

E. viridissima story

Observations:

- Bees seen visiting 45 species of plants from 18 families (includes 42 plants to obtain nectar/pollen)

- Females were observed collecting resin from *Clusia lanceolata* (exotic ornamental shrub)
  - require resin to construct & provision brood cells.

- Source of introduction unclear
  - Butterfly World from plant shipment crates containing nests

Photo from Fairchild Gardens

E. viridissima story

"E. viridissisma" actually *E. dilemma*:

- able to obtain nectar, pollen, "floral oils", and resin everything required to establish in Southern Florida
- modified behavior: chewing aromatic leaves to obtain oils
- new floral & non-floral sources = new combinations/blends?
- geographically isolated

Is this speciation in real time?

Photo by Alan Chin-Lee

Final thoughts

Pollinator mixes generally focus on floral abundance and diversity that are attractive to most common bees

Specialist bees (including oil-collectors)

are typically not considered in protection plans

A lot is still unknown

-life histories

-habitat & forage needs

-abundance & distribution

Bee & land use surveys can be helpful in designing protection plans