The Global Pollinator Situation and Potential Environmental Impacts

USDA Outlook 2/26/09

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Photo by Thomas

Plant requirements for survival

- Sunlight
- Water
- Nutrients
- Protection from pests
- Pollination (for 75% of the 240,000 species)

Despite the fact that pollination is fundamental to food production throughout the world, options for delivery of pollination services remain profoundly limited

Apis mellifera, the Western honey bee, is the world's premier managed pollinator

A phenomenon characterized by abrupt disappearances within honey bee hives of a majority of workers, known as colony collapse disorder, resulted in losses from one-quarter to one-third of colonies nationwide in 2006-2007 and 2007-2008

Photo-Keith Delaplane

Similar honey bee losses have been reported around the world

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British Honey Bee Population On The Decline

Posted on: Wednesday, 26 November 2008, 11:50 CST

In Britain, the honey bee population is on the decline, which has led to the prediction that the country will run out of English honey by Christmas.

But what's more important is the effect this decline will have on farmers in the region.

"We are extremely aware of the enormous threat there is to honey bees and the huge reduction in population," said Adrian Barlow, chief executive of trade group English Apples and Pears. "It is something we are very concerned about."

Honey bees have the responsibility of pollinating some 90 percent of apples in Britain. They are also important to other crops such as pears, raspberries and runner beans.

Britain has about 250,000 hives, about 80 percent of them looked after by small-scale beekeepers who sell most of their honey to friends, colleagues and at farm shops.

The other 20 percent are kept by larger bee farmers who produce honey on a more commercial scale.

http://www.redorbit.com/news/science/1602852/british_honey_bee_population_on_the_decline/

Colony collapse disorder captured the attention of Americans and became a topic of conversation in all kinds of venues--Hollywood and documentary films, late night talk shows, comic strips, popular books, sitcoms, and even two episodes of "CSI"

The Case of the Cross-Dressing Carp
Episode Number: 169   Season Num: 8   First Aired: Thursday October 18, 2007   Prod Code: 804

But CCD is just the latest in a long series of problems to befall the apiculture industry:

Varroa mites (1987)

Africanized “killer” bees (1990)


SCIENCE

Invasion of the Killer Bees!

Really—they're coming

Bzzzzzzzzz

Actual and projected spread

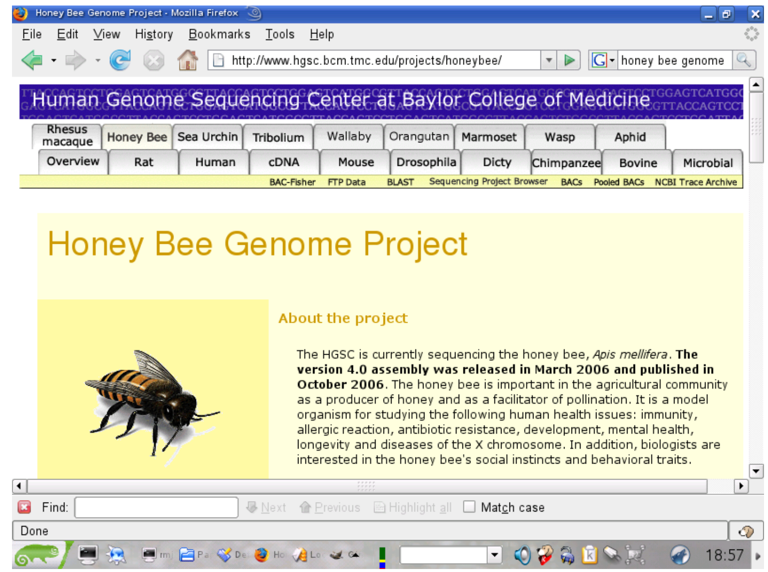
Small hive beetle (1998)

James D. Ellis, University of Florida, Bugwood.org

CCD losses and the inability to identify a definitive cause brought attention to the need for improved understanding of honey bee biology and for innovations in delivery of pollination services.

Beekeeping technology has changed little since the 19th century. For an industry worth about $15 billion annually, it’s remarkably unimproved

Over the past two years, intensive efforts have revealed new information that can be applied toward reducing mortality risks



October 2006—the honey bee genome project provided the first pollinator genome sequence

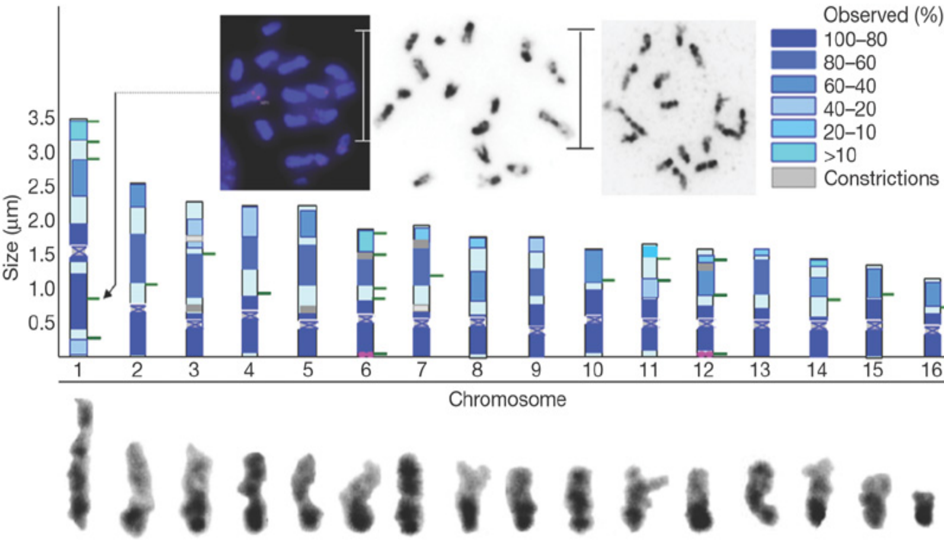
Sciencexpress Report

A Metagenomic Survey of Microbes in Honey Bee Colony Collapse Disorder

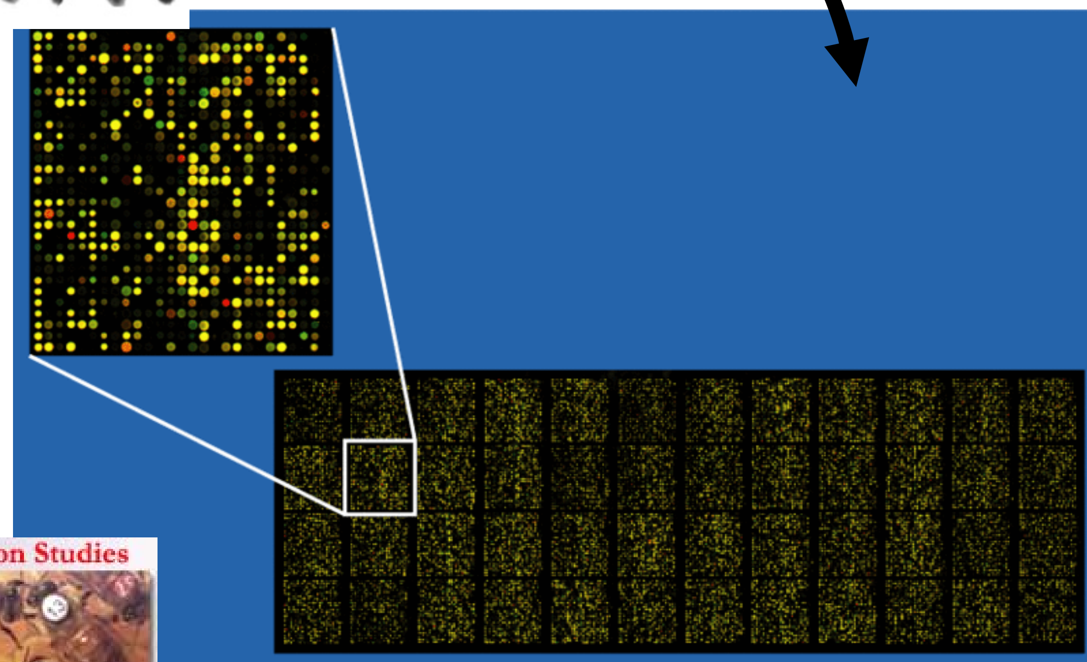
Diana L. Cox-Foster,[1] Sean Conlan,[2] Edward C. Holmes,[3,4] Gustavo Palacios,[2] Jay D. Evans,[5] Nancy A. Moran,[6] Phenix-Lan Quan,[2] Thomas Briese,[2] Mady Hornig,[2] David M. Geiser,[7] Vince Martinson,[8] Dennis vanEngelsdorp,[1,9] Abby L. Kalkstein,[1] Andrew Drysdale,[2] Jeffrey Hui,[2] Junhui Zhai,[2] Liwang Cui,[1] Stephen K. Hutchison,[10] Jan Fredrik Simons,[10] Michael Egholm,[10] Jeffery S. Pettis,[5] W. Ian Lipkin[2*]

Agent	Number of positive samples n (% positive of samples tested)			Positive Predictive Value (%)	Sensitivity (%)	Specificity (%)
	CCD (n = 30)	non-CCD (n = 21)	Total (n = 51)			
IAPV	25 (83.3%)	1 (4.8%)	26 (51.0%)	96.1	83.3	95.2
KBV	30 (100%)	16 (76.2%)	46 (90.2%)	65.2	100	23.8
N. apis	27 (90%)	10 (47.6%)	37 (72.5%)	73.0	90.0	52.4
N. ceranae	30 (100%)	17 (80.9%)	47 (92.1%)	63.8	100	19.0
All 4 agents	23 (76.7%)	0 (0%)	23 (45.0%)	100	76.7	100

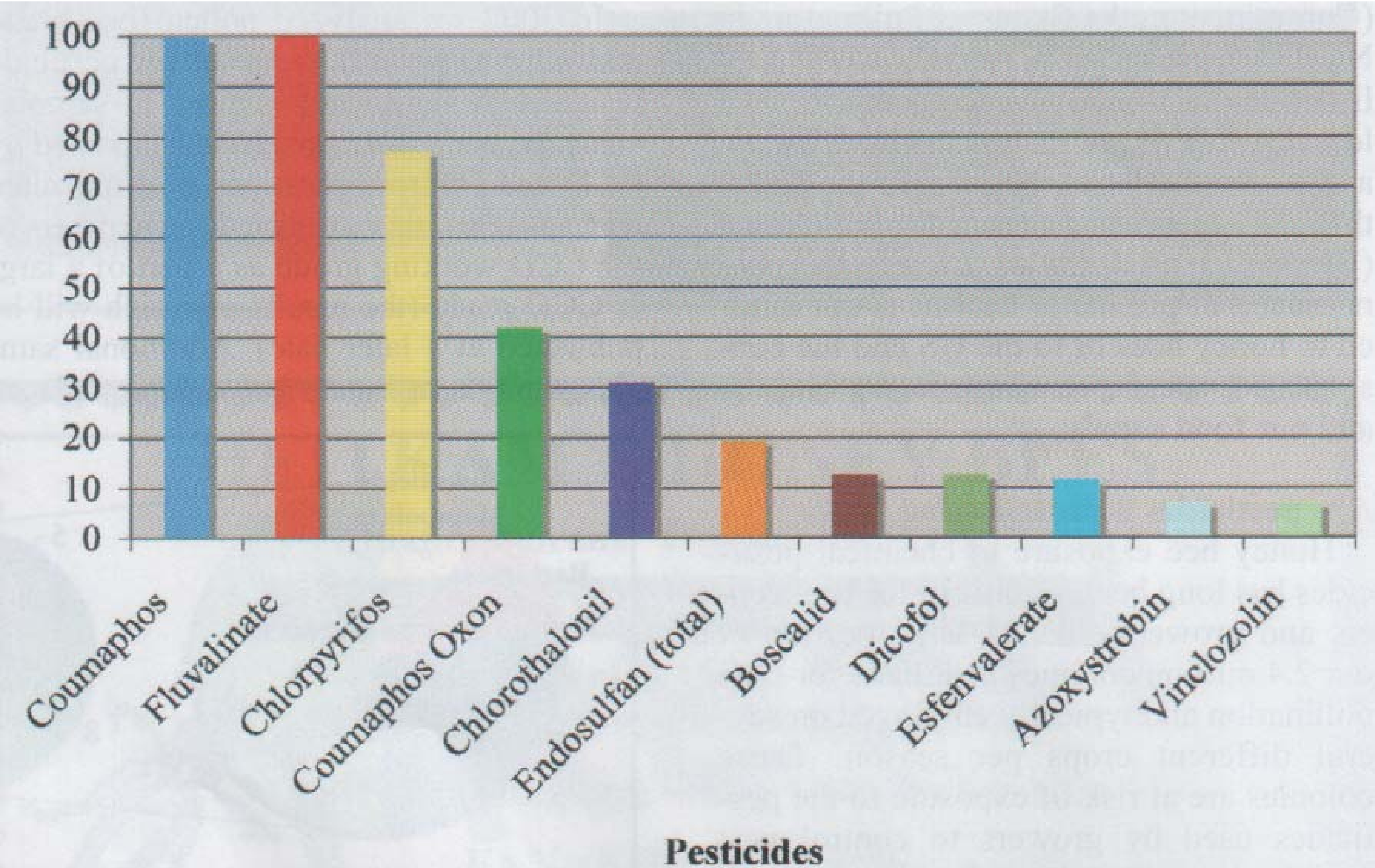
A metagenomic survey revealed ubiquitous viral and fungal infection (Israeli Acute Paralysis Virus, Kashmir Bee Virus, *Nosema apis*, *Nosema ceranae)*



10,157 genes

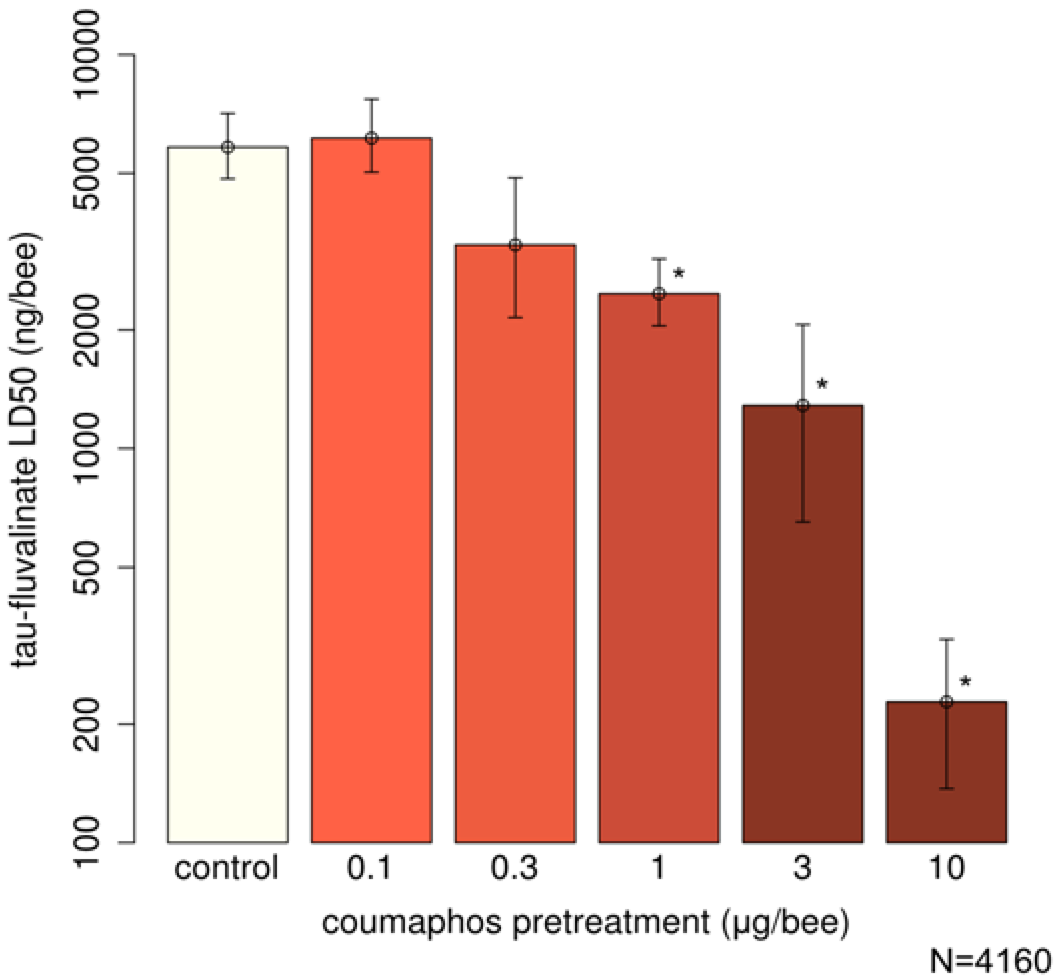


Honey bee whole genome microarray analysis is underway to identify genetic markers for CCD



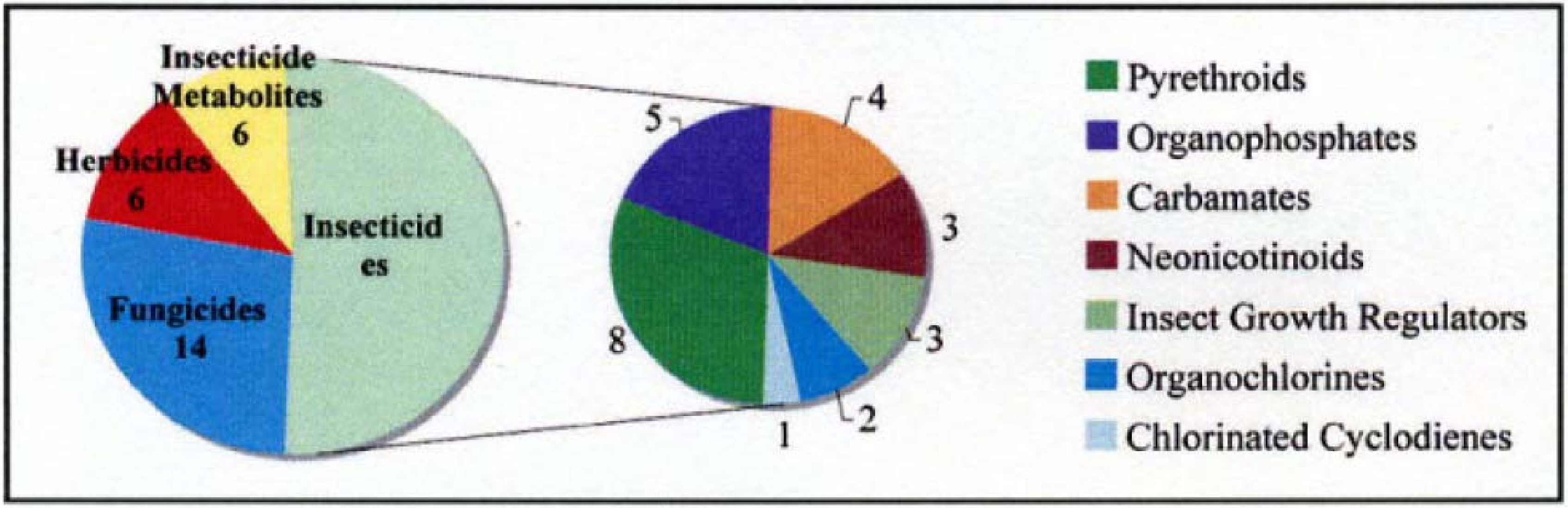
Chemical analysis of beeswax revealed extensive contamination, particularly by the two miticides licensed for in-hive use   Frazier et al., 2008. Am Bee Journal 148: 521-523.

Bioassays demonstrating that these two miticides can synergize each other to enhance toxicity suggest an immediate need for alternative approaches to mite control (Johnson et al. 2009)

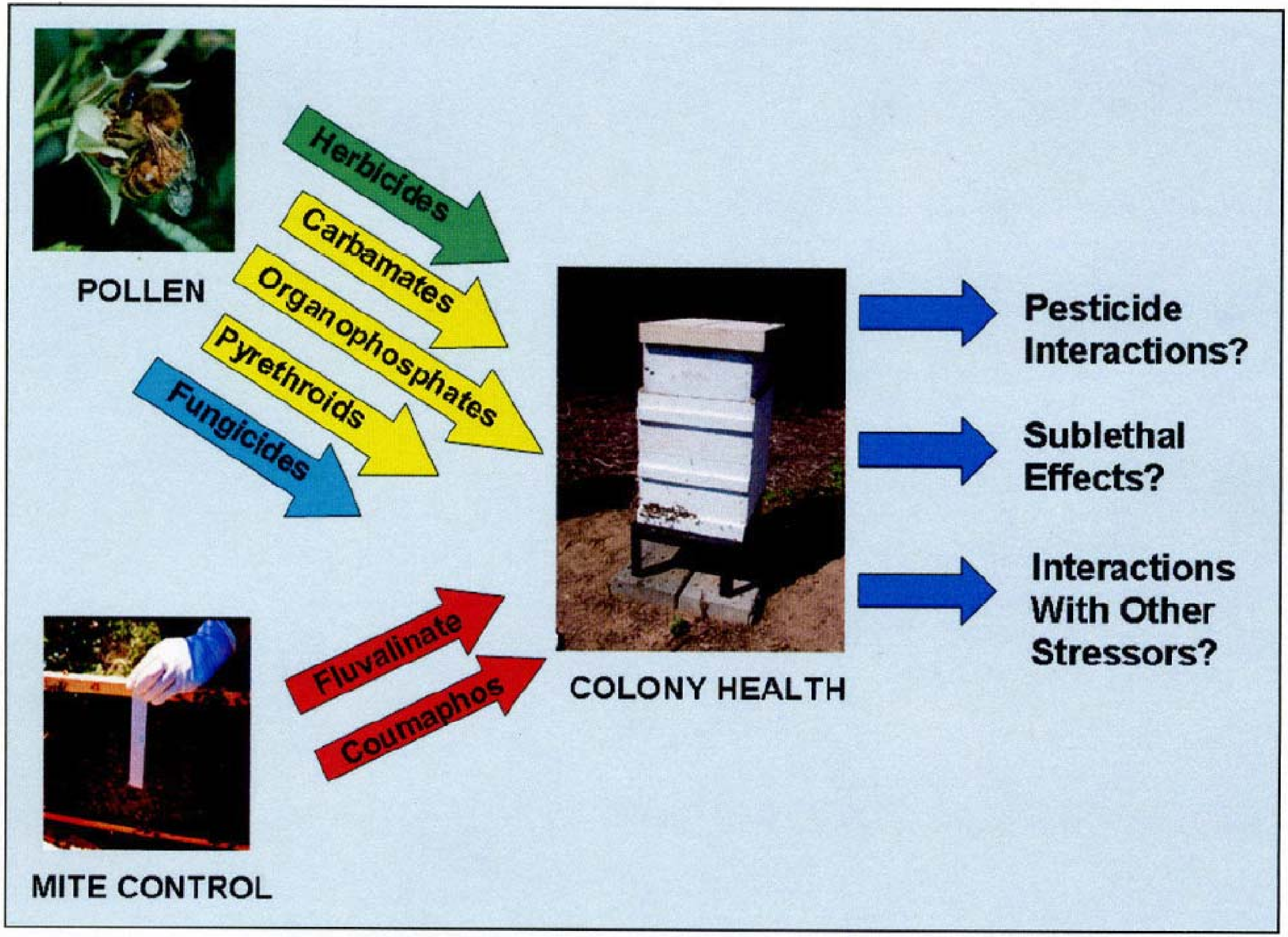


Outside the hive, bees encounter pesticides as well

Pesticide contaminants were detected in 108 pollen samples; samples on average contained five different residues



Frazier et al., 2008. Am. Bee J: 521-523.



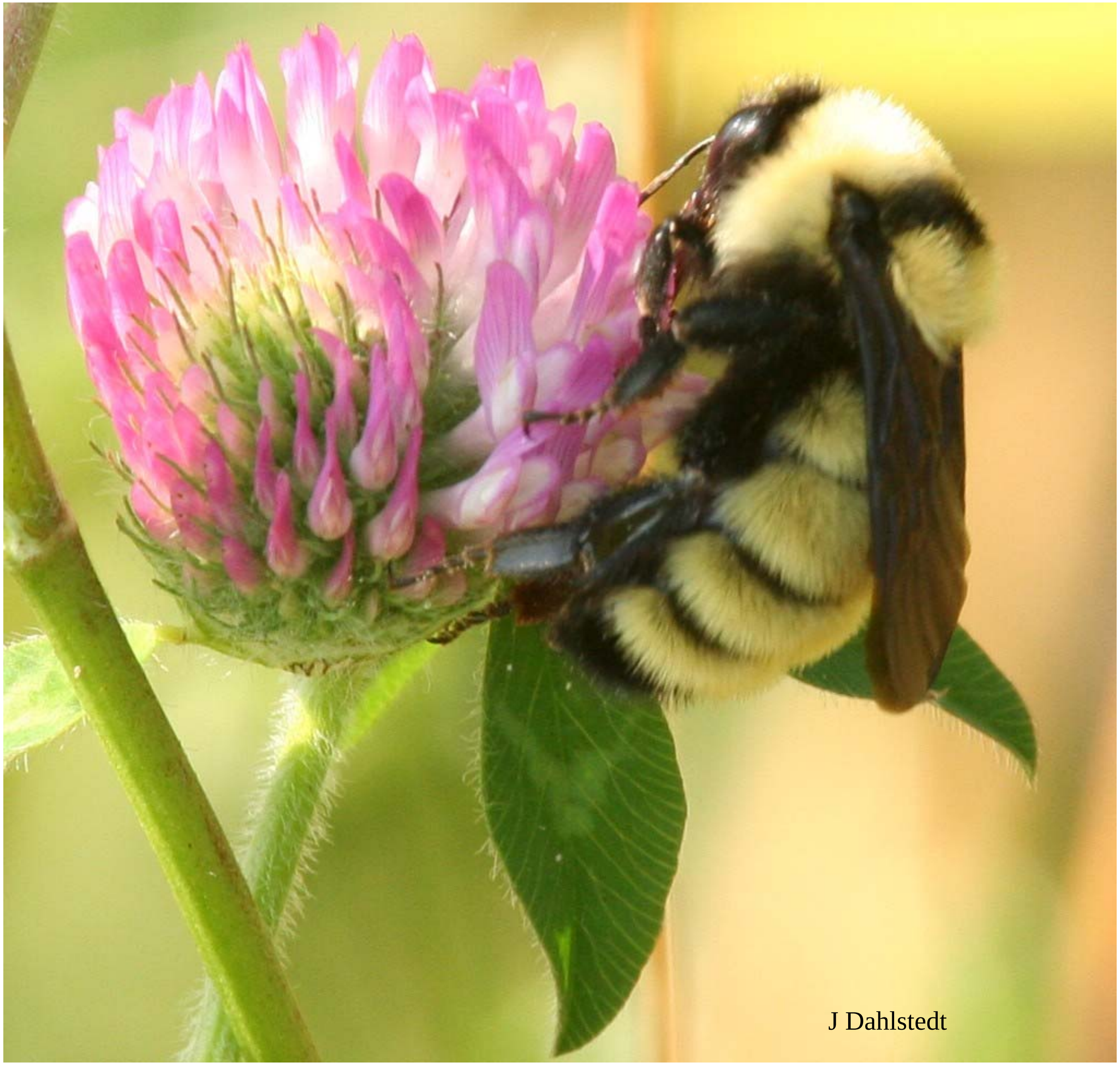
Frazier et al., 2008. Am. Bee 248J: 521-523.

Portfolio effect

- diversification of holdings minimizes risk and volatility

Photo: MAAREC

Contributions of native pollinators are estimated to be worth $3 billion (Losey and Vaughan 2007); under some conditions, native bees can supply full pollination services for key crops (Winfree et al.2007)


J Dahlstedt

Bombus affinis, the rusty-patched bumble bee, is one of several native pollinators that have experienced significant declines throughout its range

Native pollinator declines are thought to be linked to many of the same mortality factors affecting honey bees: introduced pathogens, pesticides, and habitat fragmentation (NAS 2006)

The presence of virus (e.g., deformed wing virus, black queen cell virus) in pollen pellets suggests transmission among pollinator species may take place through shared floral resources (Singh et al. 2008, Ent Soc. Amer. Abstract)

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ANALYSIS

Economic valuation of the vulnerability of world agriculture confronted with pollinator decline

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A recent study (Gallai et al. 2008) estimated the worldwide economic value of the pollination service provided by insect pollinators at €153 billion ($217 billion in US$), accounting for 9.5% of the value of world agricultural food production

Economic impact of insect pollination of the world agricultural production used for human food and rates of vulnerability to pollinator loss

Crop category	Average value of a production unit	Total production economic value (EV)	Insect pollination economic value (IPEV)	Rate of vulnerability (IPEV/EV)
	€ per metric ton	10^9€	10^9€	%
Stimulant crops	1225	19	7.0	39.0
Nuts	1269	13	4.2	31.0
Fruits	452	219	50.6	23.1
Edible oil crops	385	240	39.0	16.3
Vegetables	468	418	50.9	12.2
Pulse	515	24	1.0	4.3
Spices	1003	7	0.2	2.7
Cereals	139	312	0.0	0.0
Sugar crops	177	268	0.0	0.0
Roots and tubers	137	98	0.0	0.0
All categories pooled together		1618	152.9	9.5

Particularly vulnerable to pollinator loss are fruits and vegetables, which have high economic value and low storage ability

It's unlikely that all pollinators will go extinct (there are close to 20,000 species of bees), but the beekeeping industry in the U.S. might not survive. Prospects for survival of wild pollinators are impossible to assess without baseline data. **Unlike sunshine, pollination is not an inexhaustible resource**