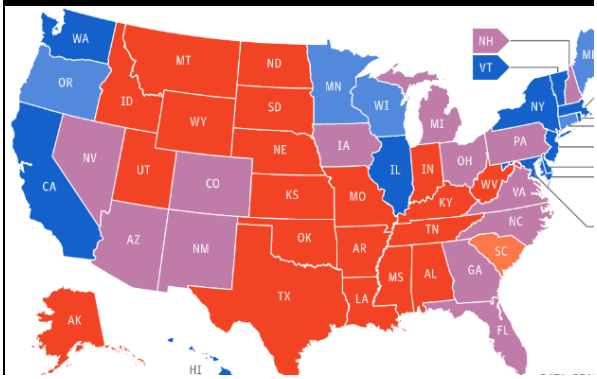
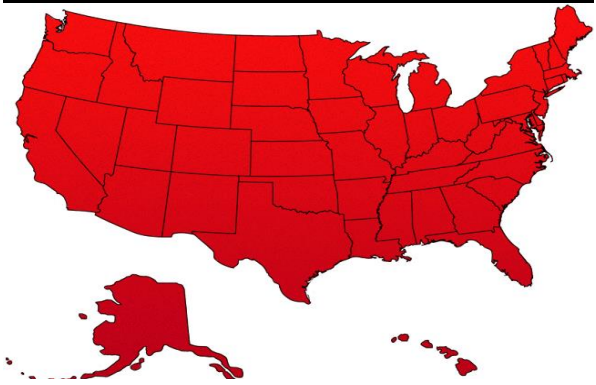
Varroa mite reproductive biology

Zachary Huang
Michigan State University
East Lansing, Michigan, USA

How Trump Won



How Varroa Won



Varroa destructor Anderson & Trueman (Acari: Varroidae)

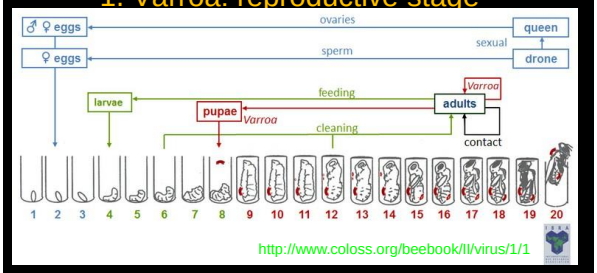
Adult female : 1.5 x 1.0 mm

ecto-parasitic mite of the honey bee, *Apis mellifera* L.

- Vectoring viruses DWV, IAPV
- Inhibit bee's immune response
- High mortality of pupae (PMS)
- Effect on adult bees

Severe impact on honey bee industry

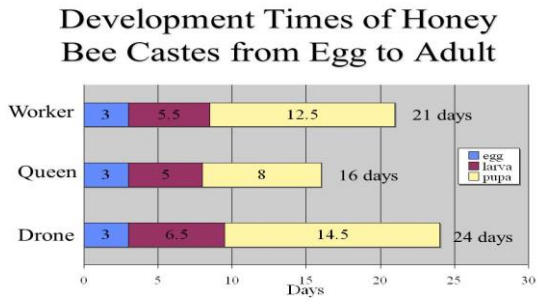
1. Varroa: reproductive stage



http://www.coloss.org/beebook/II/virus/1/1

60 hrs post capping: 1st ♂egg
1 ♀ egg every 20 hrs , ♀: 7-8 days to mature
Brother-sister mating
Immature ♀ and adult ♂ die after worker emerges
Viruses can be transmitted to pupae

2. Varroa prefers drones 9 x more



Rick Fell, Department of Entomology Virginia Tech.

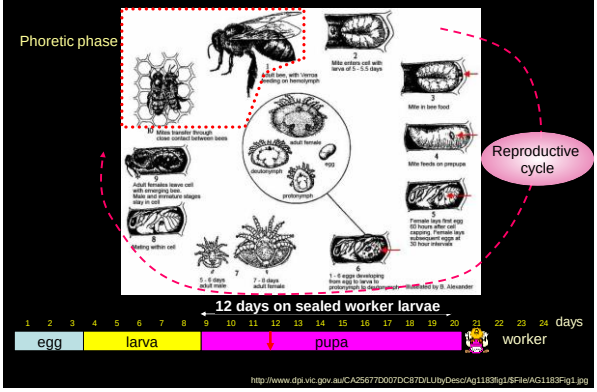
3. Mites defecating on pupae do not have babies

4. Varroa: phoretic stage (3 to 7 days)

estimated feeding interval: every 4-5 hrs: transmit viruses

http://cyberbee.net

Life History of Varroa



http://www.dpi.vic.gov.au/CA25677D007DC87D/LUbyDesc/Ag1183fig1/$File/AG1183Fig1.jpg

5. Mites transmit viruses

Of the 13 bee viruses, 3 are transmitted by Varroa

Acute bee paralysis virus /Kashmir bee virus /Israeli acute paralysis virus
Aphid lethal paralysis virus & Big Sioux River virus
Apis mellifera filamentous virus
Apis iridescent virus
Arkansas bee virus & Berkeley bee virus
Bee virus X /Bee virus Y
Black queen cell virus
Chronic bee paralysis virus /satellite virus
Cloudy wing virus
Deformed wing virus /kakugo virus /Varroa d virus-1 /Egypt bee virus
Lake Sinai virus-1 /Lake Sinai virus-2
Sacbrood virus /Thai sacbrood virus
Slow bee paralysis virus

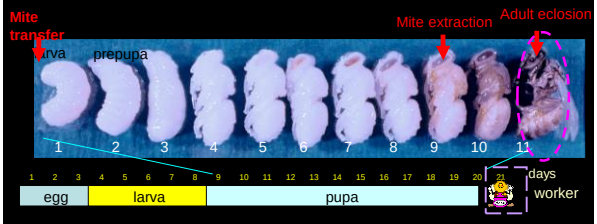
Z. Huang photo

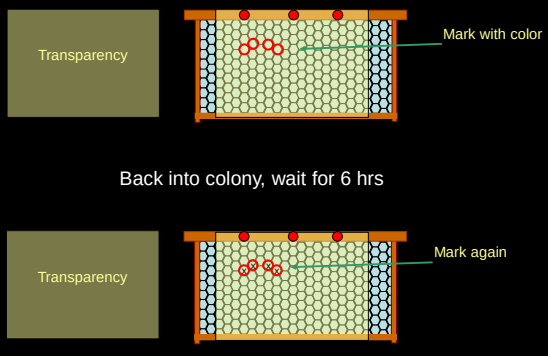
1. Varroa mite reproduction when transferred across species

Methods

Obtain phoretic mites
Transfer mites to cells
Incubate at 34ºC, 50% RH
Checked daily for wax moth
On day 9 (transfer at day 1), open cells for checking mite progenies

Mites were captured & transferred into newly sealed (within 6 hrs) worker brood cells on mite-free recipient frames. Brood was then incubated at 34ºC and 50% relative humidity.





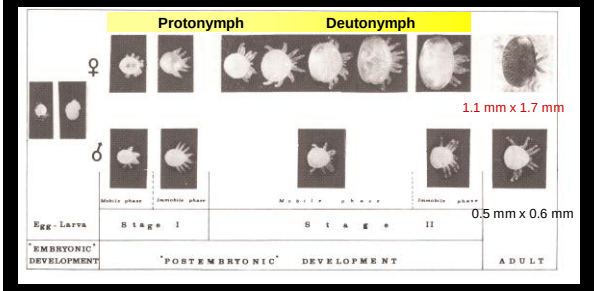
Confining the queen to a Q excluder cage

Mapping brood to obtain newly capped cells

Catching mites by hand! (prior to sugar dusting)

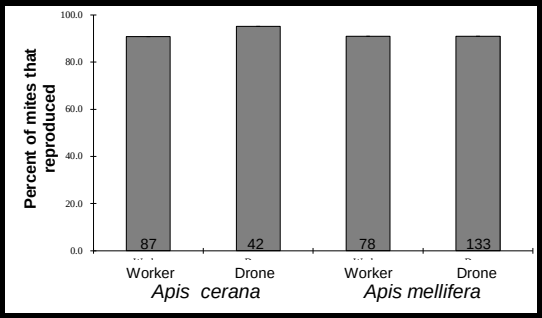
Determining number of offspring per mite

Ontogenetic development of the varroa mite



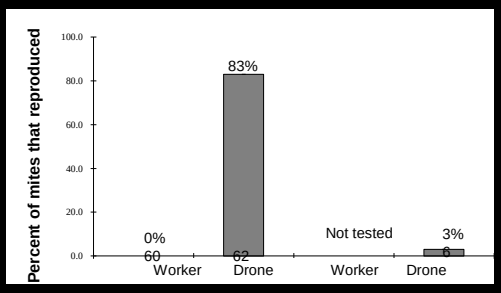
(from Ifantidis 1983)

Varroa from *A. mellifera (Korean Haplotype)* and transferred to different hosts (Beijing)



Korea haplotype Varroa from mellifera can reproduce on both species and on both castes: % mites reproduced almost identical

Varroa from *A. cerana (Vietnam haplotype)* and transferred to different hosts (Xishuangbanna)



Vietnam haplotype Varroa from *A. cerana* can reproduce only on drones of cerana. Even on *A. mellifera* drone it was low.

2. Large cell size reduces varroa reproduction

2. *Large cell size reduces varroa reproduction*

Varroa from mellifera transferred to worker larvae

That were reared in worker or drone cells

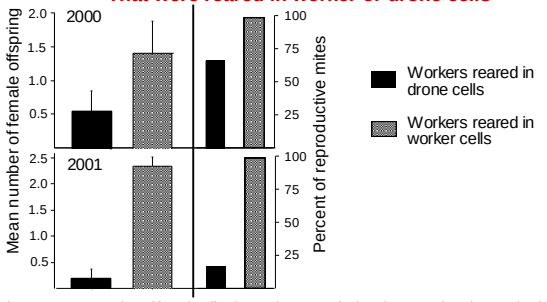


Figure 1. Mean number of female offspring and percent of mites that reproduced on worker brood reared in different cell types. Experiments were conducted in 2000 and 2001 in Beijing, China.

Varroa reproduced better in worker cells, suggesting large cells can inhibit reproduction. It is not cleare if workers are different (e.g. more queen-like), or due to actual cell size difference.

3. Chemical mimicry of mites to different species of honey bees

Previous studies have shown that the varroa mites can mimic the host cuticular hydrocarbons, perhaps enabling them to escape the hygienic behavior of the host honey bees.

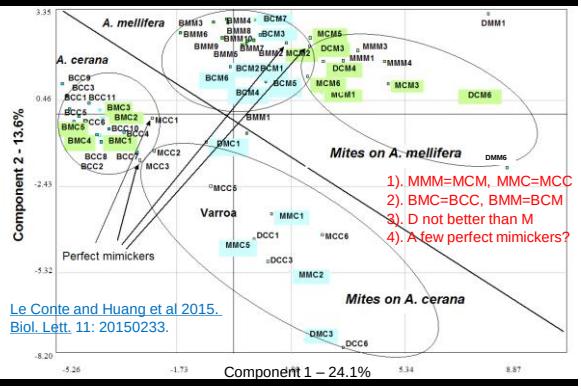
Martin C, Salvy M, Provost E, Bagnères A, Roux M, Crauser D, Clement J, Le Conte Y. 2001 Variations in chemical mimicry by the ectoparasitic mite *Varroa jacobsoni* according to the developmental stage of the host honey-bee *Apis mellifera*. Insect Biochem Mol Biol. 31: 365-79.

3. Chemical mimicry of mites

- Transfer of mites from *Ac* brood
  - *Ac* brood (MCC)
  - *Am* brood (MCM)
- Transfer mites from an *Am* brood
  - *Am* brood (MMM)
  - *Ac* brood (MMC)

After 8 days, the mother mite, their daughters and the host pupae were extracted from cells and washed in hexane. The chemical signatures of both *Apis* puape and their *Varroa* parasites were determined by GC/MS.

MMM: mother-mite, mellifera to mellifera, MCM: mother-mite, cerana to mellifera
MMC: mother-mite, mellifera to cerana, DCC: daughter, cerana to cerana
BCM = *A. mellifera* hosting Ac mite (K3), BMC = *A. cerana* hosting Am mite (K2)



1). MMM=MCM, MMC=MCC
2). BMC=BCC, BMM=BCM
3). D not better than M
4). A few perfect mimickers?

Le Conte and Huang et al 2015. Biol. Lett. 11: 20150233.

3. Chemical mimicry of mites to different species of honey bees

Summary:

1.Regardless of previous hosts (cerana or mellifera), mites transferred to *A. cerana* are more similar to A. cerana pupae profile

2.Regardless of previous hosts (*cerana* or *mellifera*), mites transferred to *A. mellifera* are more similar to A. mellifera pupae

Mites are able to mimic their hosts, even when the hosts are of different species! Remarkable ability to use chemical camouflage.

4. Do ph*oretic mites prefer nurse in a colony setting?*

Although mite biology has been well studied, we still do not know:

Whether Varroa mites prefer nurse bees over older and younger bees in colonies.

-- Prior studies used petri-dishes/caged bees

Materials and Methods

4. Preference for phoretic hosts

Triple cohort colonies:
500 of each: foragers, nurse bees and newly emerged bees
+ a frame of honey, a frame with pollen, and a queen

Mite source:
Sugar dusting adult bees

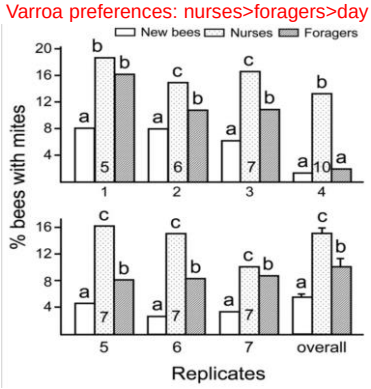
Sugar dusting

~200 mites introduced into the triple cohort colony

24 hrs later, workers in each group recovered with forceps

Killed in alcohol and mites recovered

4. Varroa preferences: nurses>foragers>day olds



Xie, X., **Z.Y. Huang**, Z. Zeng. 2016. Scientific Reports doi:10.1038/srep28228

5. Why pho*retic mites prefer nurse in a colony setting?*

Several possibilities:

1. Foragers should be avoided due to higher risk
2. Nurses are close to larvae, more opportunity to jump in
3. Nurses may have different nutrition, resulting in higher fitness?

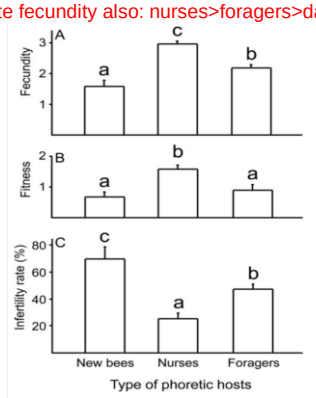
We tested hypothesis #3: do mites which had previously fed on nurses show higher fitness?

Experiment 5

All mites harvested from pupae
Mites let to feed on caged bees (three types of hosts) for 3 days

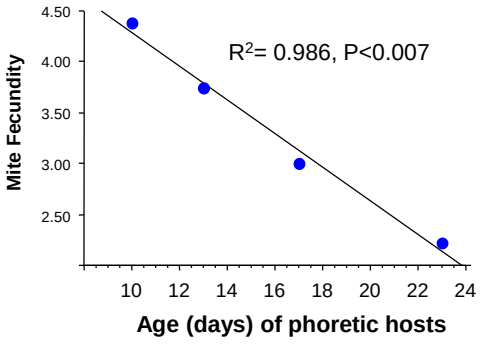
9 days later, mite reproductive success were evaluated

5. Mite fecundity also: nurses>foragers>day olds



Xie, X., **Z.Y. Huang**, Z. Zeng. 2016. Scientific Reports doi:10.1038/srep28228

6. Younger phoretic hosts: more mite babies



Xie, X., **Z.Y. Huang**, Z. Zeng. 2016. Scientific Reports doi:10.1038/srep28228

Summary

4. Do Varroa mites prefer nurse bees over older and younger bees?

-- Yes, not only in petri dishes or caged bees, but also in more natural colony settings.

5. Is mite reproduction affected by feeding on different phoretic hosts?
-- Yes, and there is an inverse relationship between age of bees and mite fecundity, except newly emerged bees.

Conclusions

1. Mite reproductions affected by many factors:
   1. Pupal host type
   2. Cell size
   3. Phoretic host type
2. Mites clearly prefer nurses, perhaps mainly due to a fitness gain.
3. Mites have remarkable ability to mimic their host cuticular hydrocarbons.

Bee Audacious

Letting Varroa and our bees co-exist?

Changing bees: resistant to mites

Change mites: less virulent?

1. Manipulate their reproduction so that they only reproduce on drones? (like in Apis cerana!)
2. Understand how it was done in A. cerana
3. Transfer the gene to our bees?
4. Using RNAi for mite control?

A collaboration with Asian, French and Australian scientists





Mite monitoring and management

Use the mite check kit (Meghan and Walt, MSU)

Report mite numbers to beeinformed.org

Rotate miticides

http://articles.extension.org/pages/65450/varroa-mite-reproductive-biology

eXtension

Home Resource Areas eXtension.org

Varroa Mite Reproductive Biology

July 26, 2013

by Zachary Huang, Department of Entomology, Michigan State University, E. Lansing, MI 48824

CAP Updates: 29

- Jointly published in the American Bee Journal and in Bee Culture, October 2012

The varroa mite (*Varroa destructor* Anderson and Trueman) is an ecto-parasite of the Western honey bee (*Apis mellifera*) and is distributed worldwide. Because *A. mellifera* colonies almost always die within two to three years after mite infestation, if not treated, feral bee colonies (unmanaged colonies in the wild) in U.S. were almost totally wiped out by this mite around 1995, less than a decade after it was introduced to the USA (around 1987). There is anecdotal evidence that honey bees might be becoming feral again in recent years (resistant genetics possibly leaking out due to swarming), but there is no systematic study proving this. Unless otherwise noted, throughout this paper I will use "varroa", "varroa mite" or the generic "mite" interchangeably to refer to *V. destructor*. The varroa mite is currently the most severe pest of managed honey bees worldwide. Understanding

Managed Pollinator Coordinated Agriculture Program (CAP) Updates

A National Research and Extension Initiative to Reverse Pollinator Decline

This is part of an ongoing series of updates from the Managed Pollinator CAP. Additional installments can be found at the:

CAP Updates Table of Contents

More information about the CAP can be found at:

Connect with us

Welcome

This is where you can find research-based information from America's land-grant universities enabled by eXtension.org

Select a different institution

LOCATE

Recent Webinars

All Bugs Good and Bad Webinar Series: Where Have All the Honey Bees Gone? Hope for the Future.

All Bugs Good and Bad Webinar Series: If Flowers are Restaurants to Bees, Then What Are Bees to Flowers?

Risk Management for Pesticides and Honey Bees