

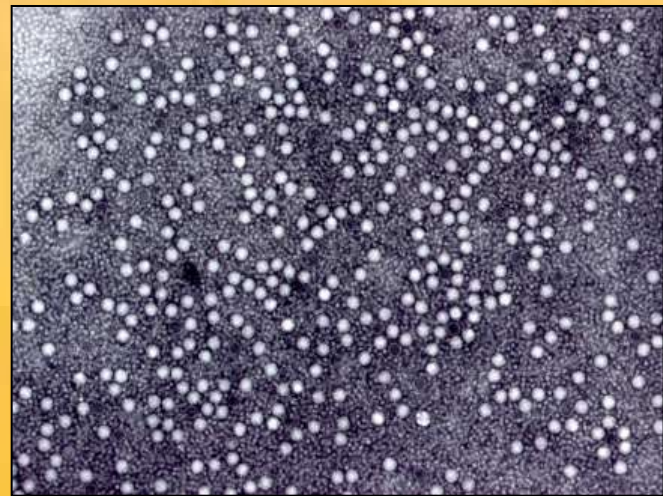
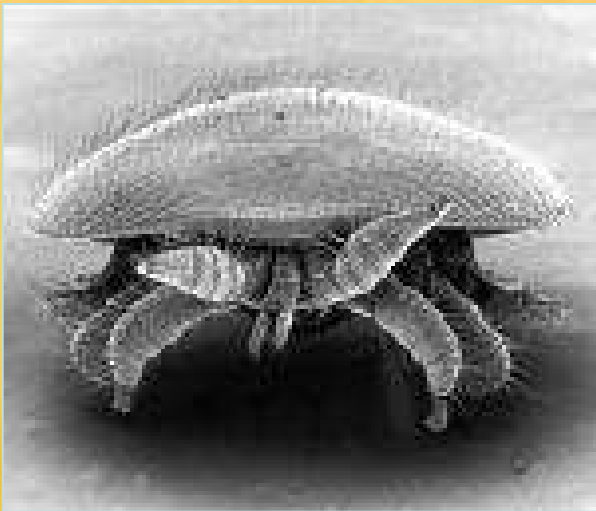
Deceiving the Host: The Effect of *Varroa* and DWV on the Honey Bee Recognition System



Ricarda Kather

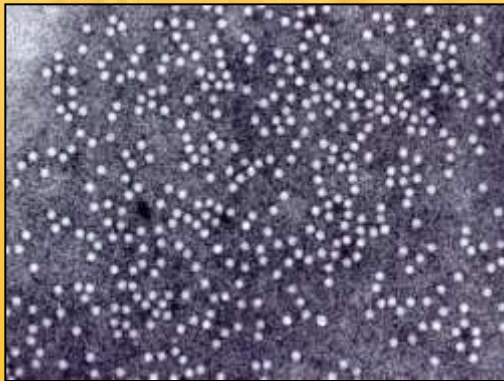
Introduction

- *Varroa* mite
- Deformed wing virus (DWV)
- Two of the most serious bee parasites



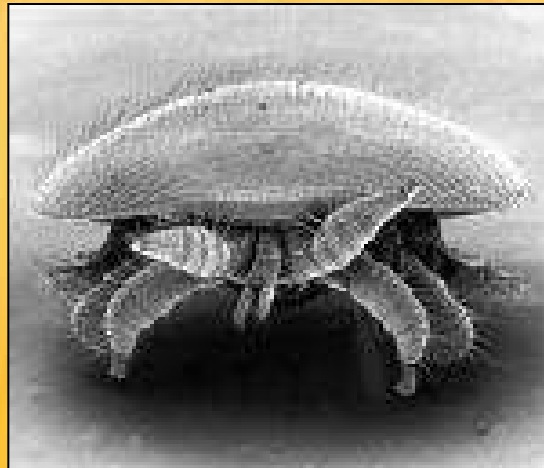
DWV (Deformed Wing Virus)

- Deformed wings, paralysis and death
- Colonies are weakened & can collapse
- Mainly transmitted by *Varroa*

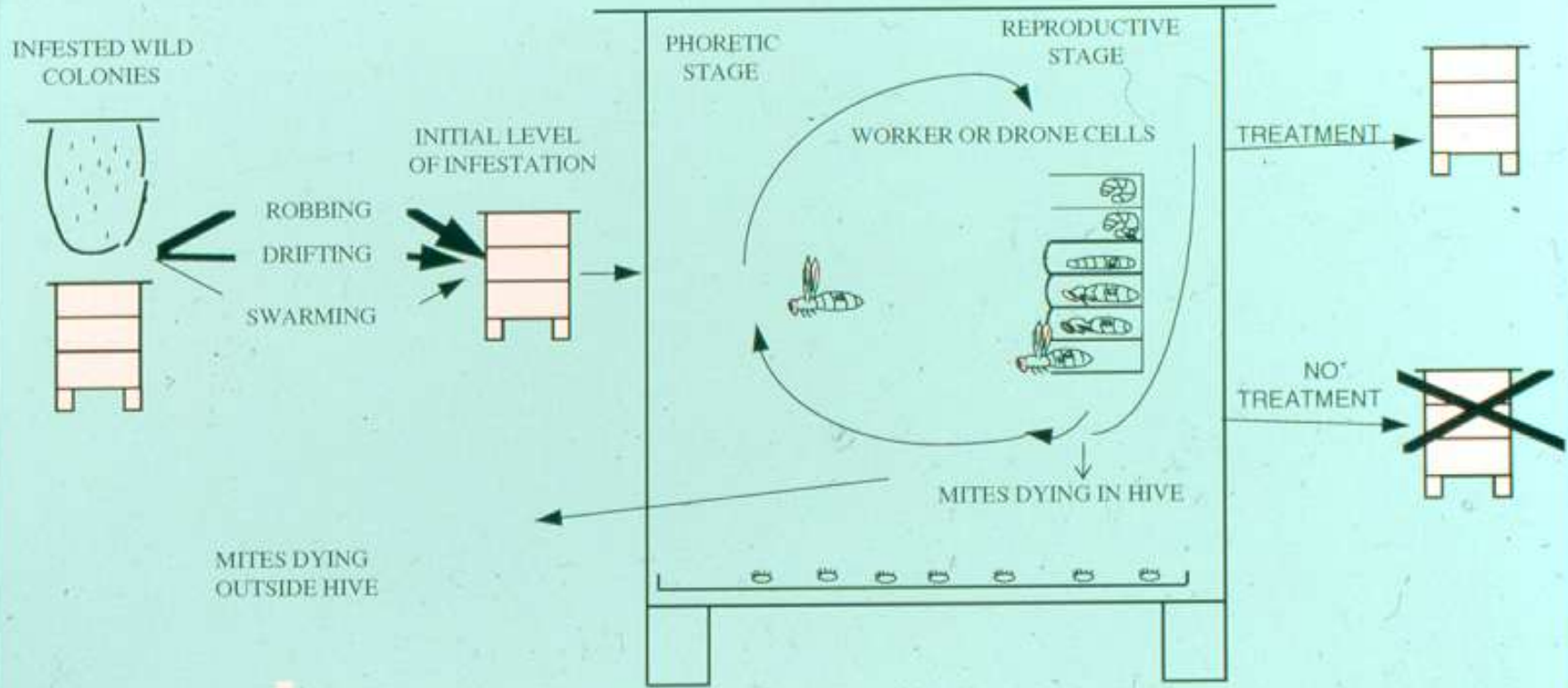


Varroa Mite

- Feeds on hemolymph & reproduces in brood
- Attaches to drifters & robbers



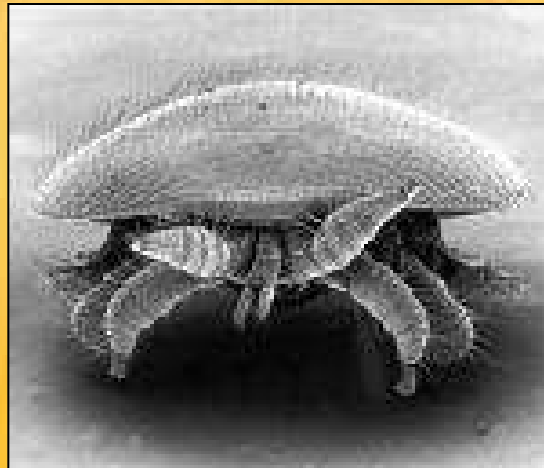
KEY FACTORS IN THE BEE-MITE RELATIONSHIP





Varroa Mite

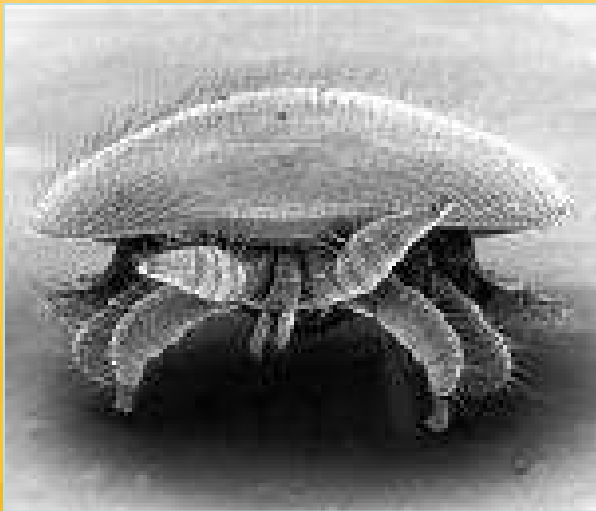
- Feeds on hemolymph & reproduces in brood
- Attaches to drifters & robbers
- Transmits DWV
- Resistant to pesticides





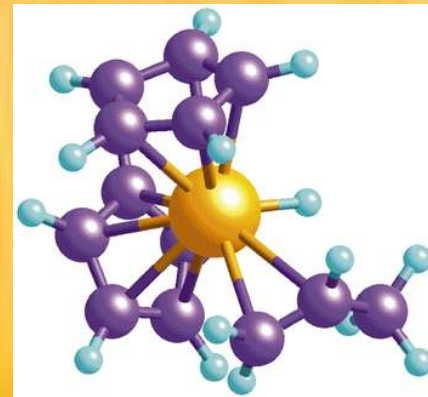
EARS Project

- How spread so rapidly?
 1. Deception
 2. Possible effect on recognition behaviour



Background

- Communication/Recognition in Insects
- Olfaction, i.e. Chemical Communication



Chemical Communication

- Oldest & often primary mode of communication
- Widespread across range of taxa



Chemical Communication in Social Insects

- Very complex in social insects
- Facilitates organisation of 1000s of individuals
- Different smells have different functions
- Either gland-based or 'skin'-based smell



Queen Pheromone

- Signals queen's presence
- Messenger Bees
- Prevents worker ovary development



Brood Pheromone

- Feeding
- Cell Capping



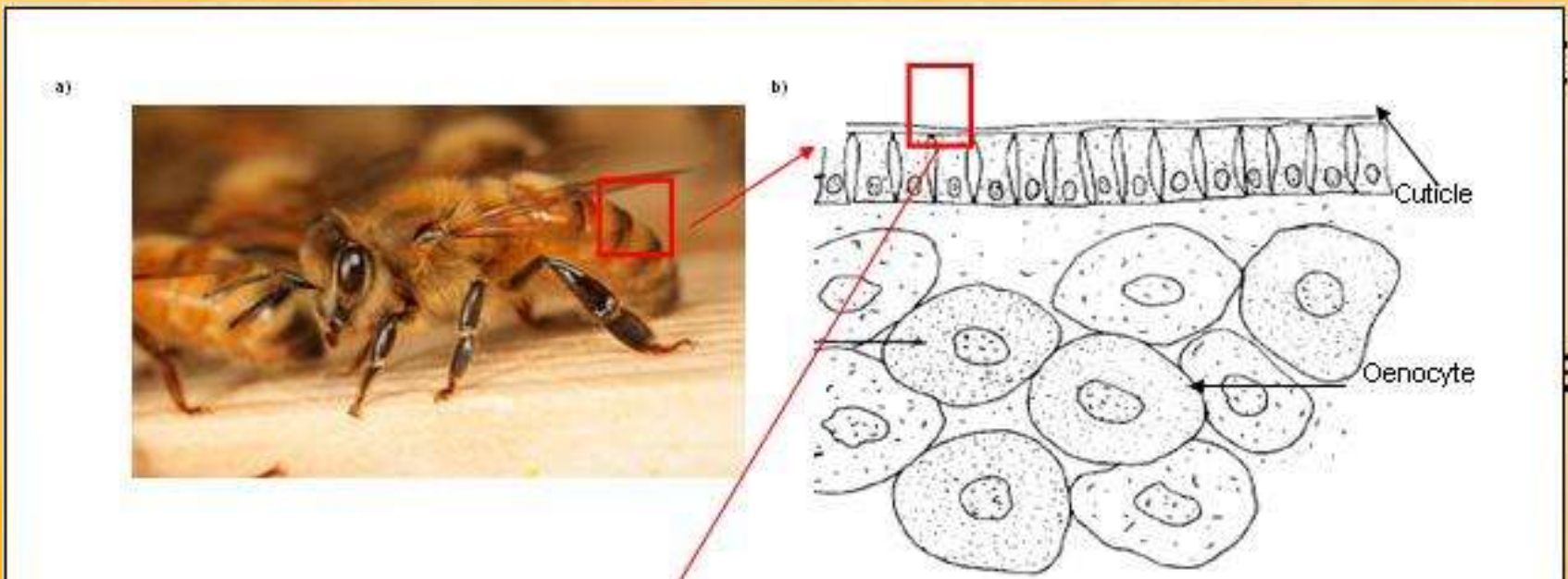
Alarm & Recruitment

- Alarm Pheromone

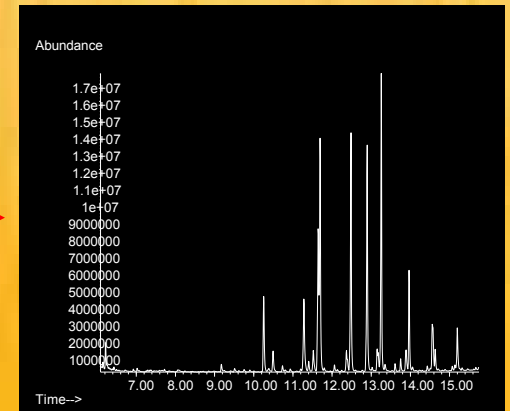


Chemical Communication in Social Insects

- 'Skin' covered in smells (Cuticular Chemicals)
- Produced by oenocytes
- Perceived by other bees and other insects

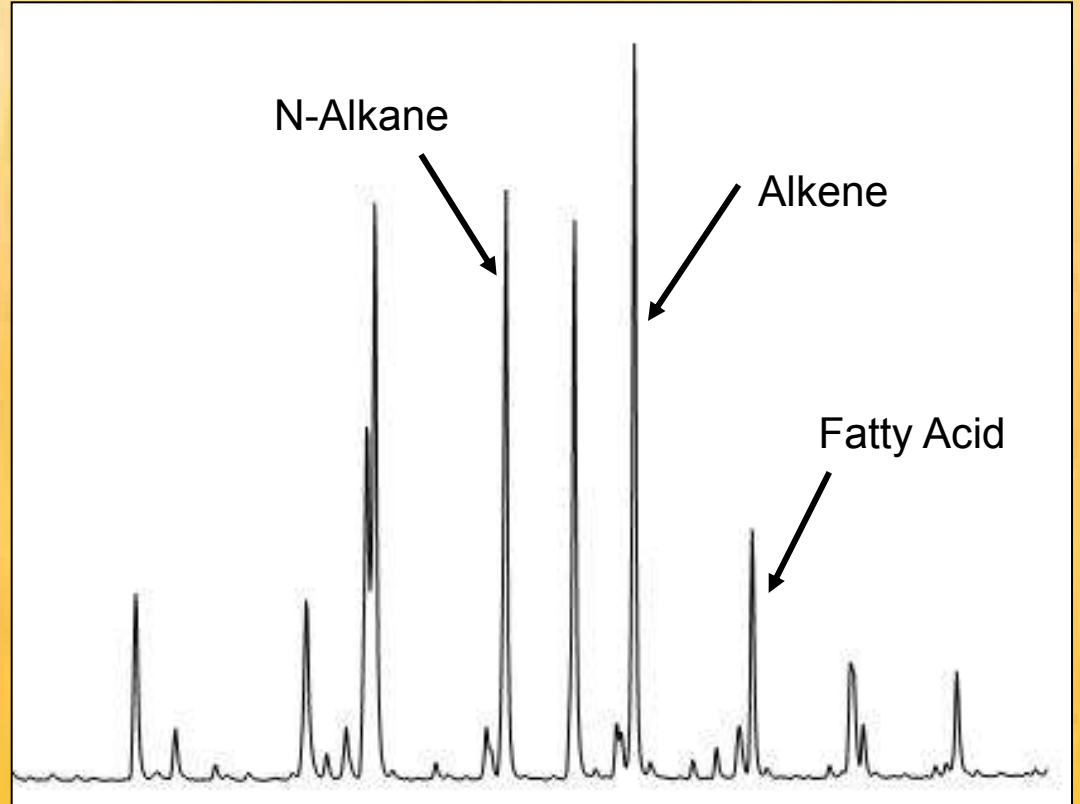


Cuticular Chemical Analysis



Chemical Analysis

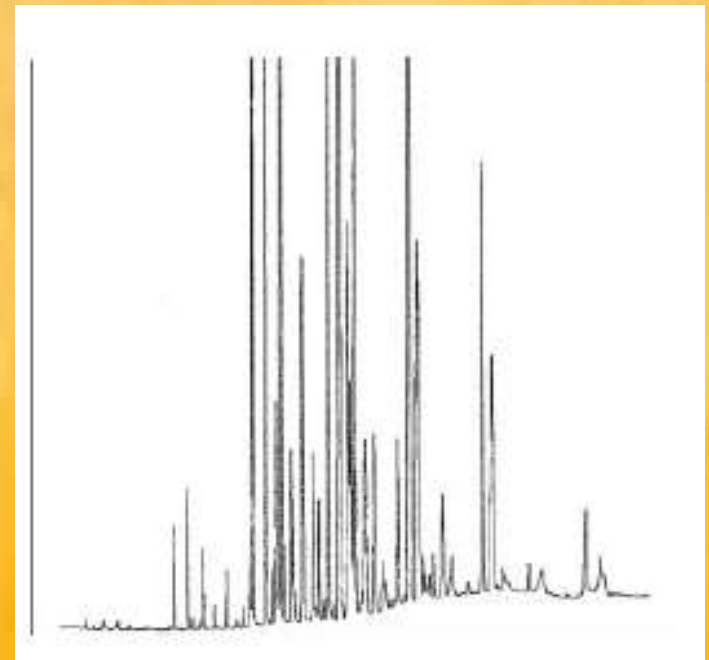
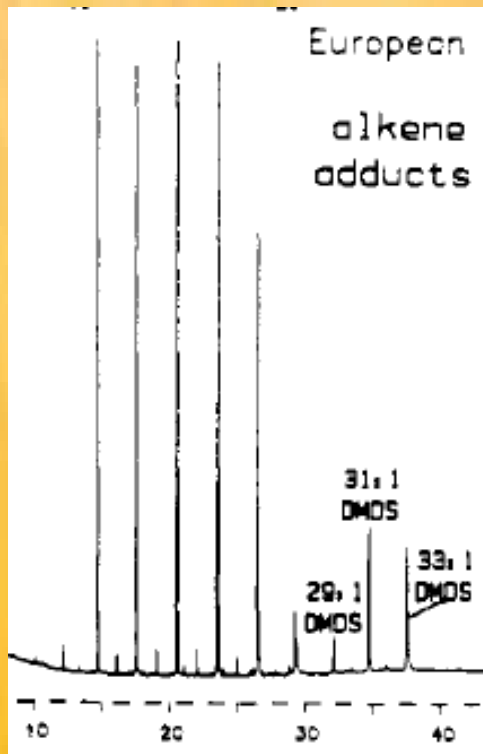
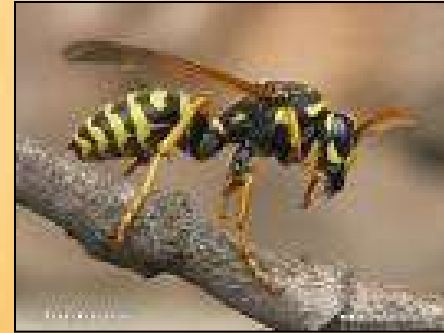
- Every peak a different compound
- Peak Area = Compound Abundance



Chemical Communication in Social Insects

- Each smell has different function
- Cuticular chemicals are basis of:
 - Species Smell
 - Gender Smell
 - Task Smell
 - Colony Smell
- So conveys a lot of information on individual

Species Recognition

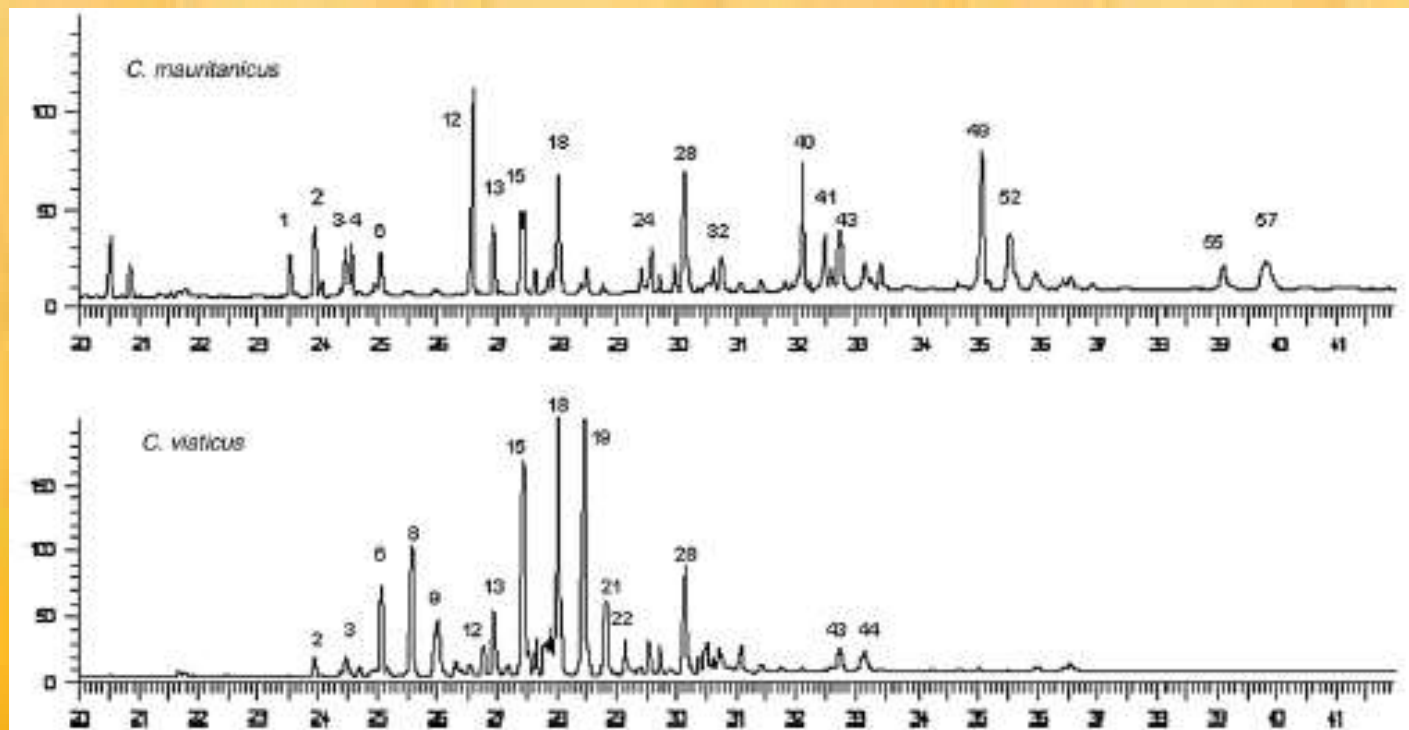




Species Smell

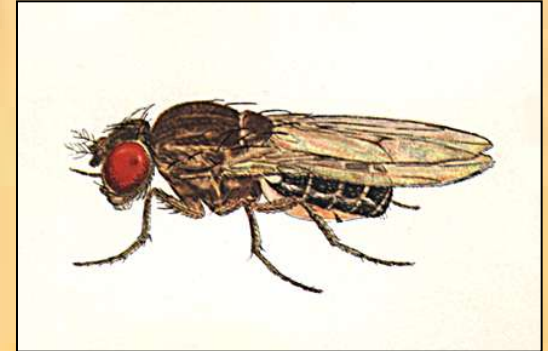


- Ants: *Cataglyphis mauritanicus* & *C. viaticus*
- Difference in quality/range

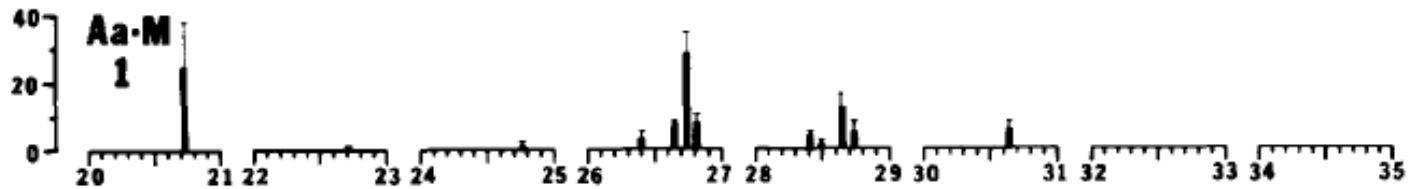


Gender Smell

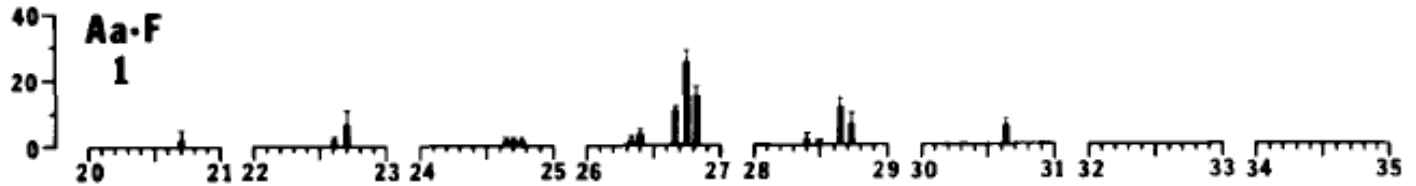
- *Drosophila americana*
- 9-heneicosene



Male

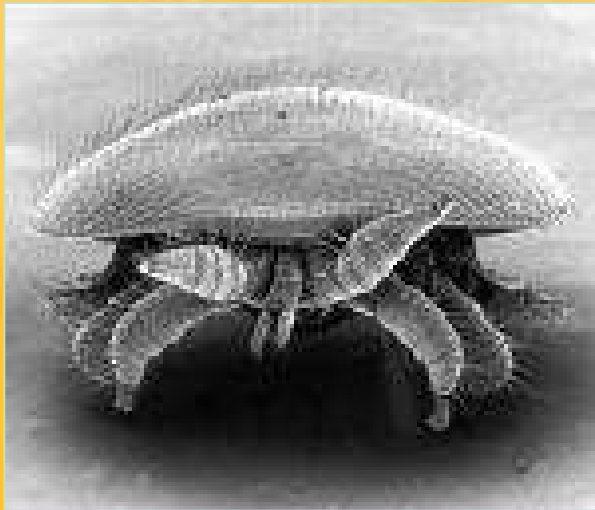


Female



EARS Project

- 2 stages:
 1. Chemical Strategy (Deception)
 2. Effect on Recognition Behaviour

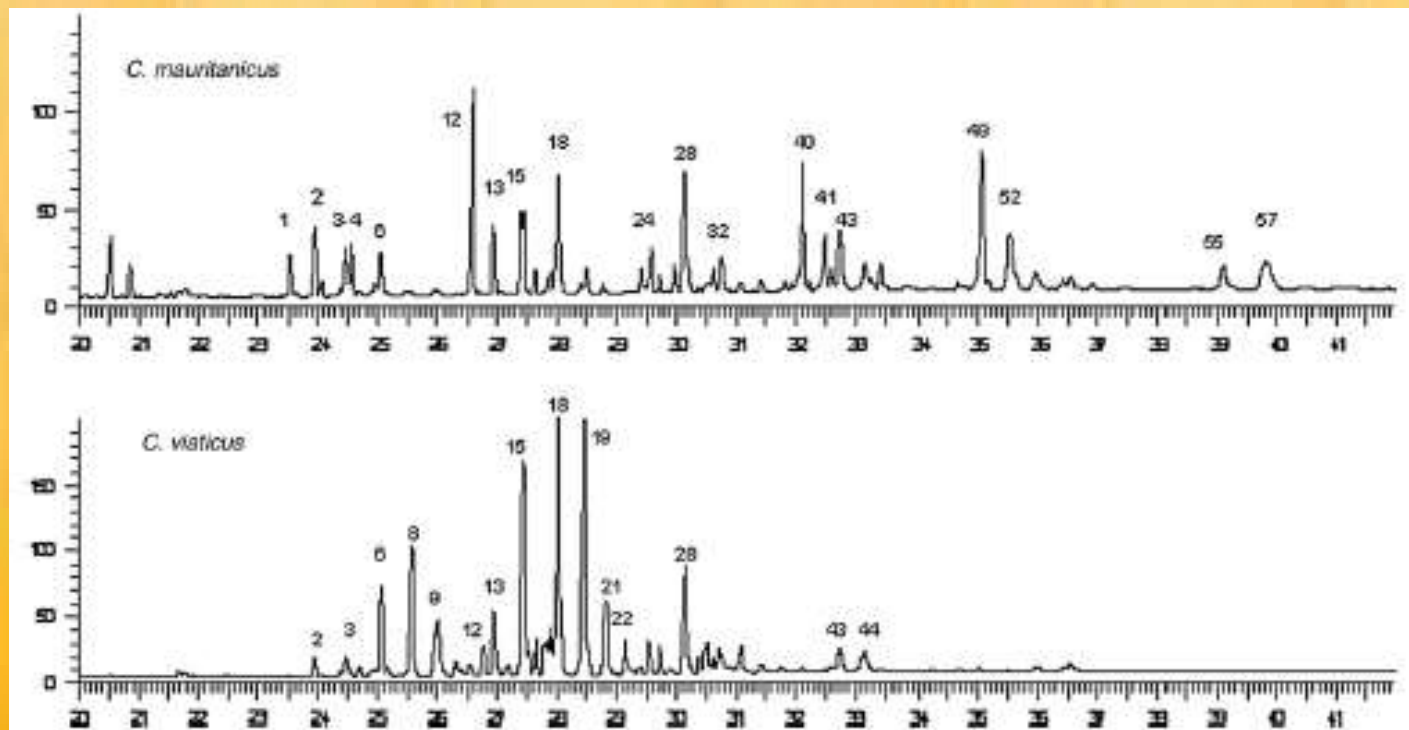




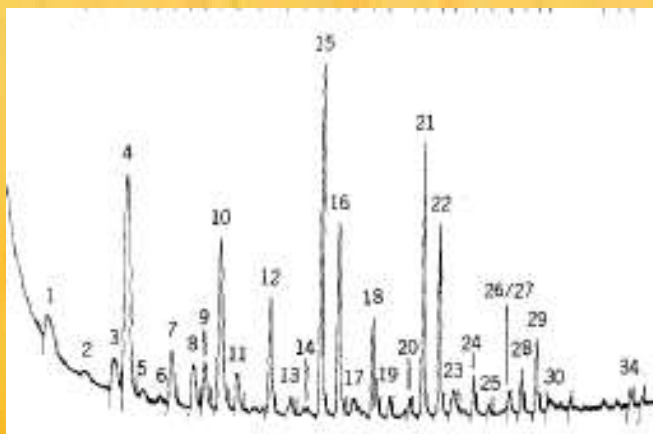
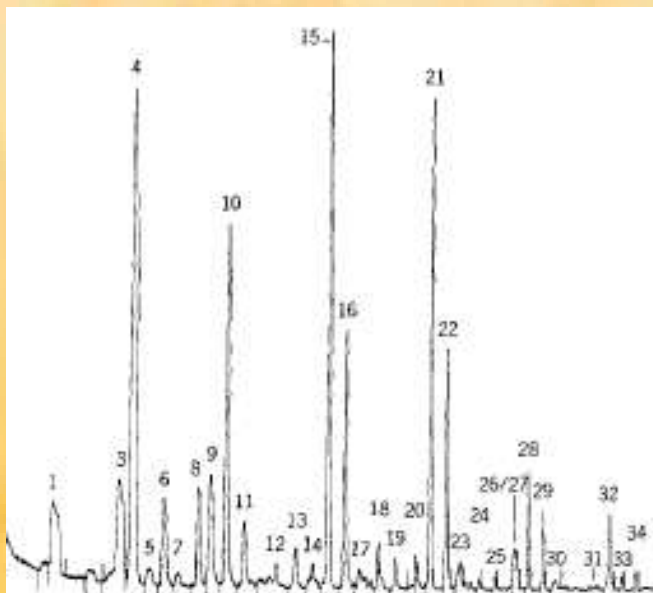
Species Smell



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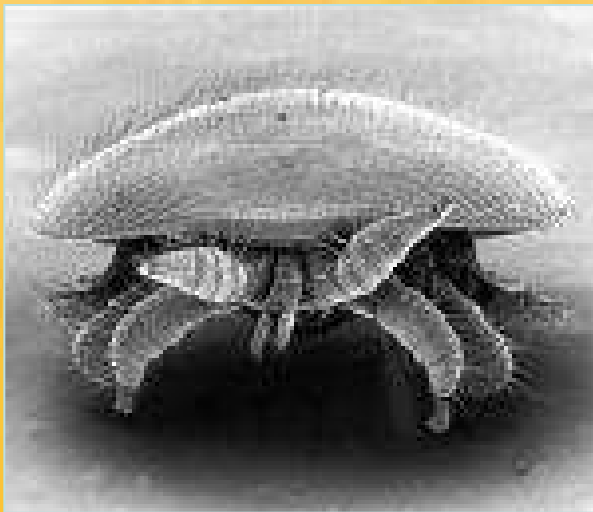
Varroa vs. *Apis m.* Chemistry



Nation et al. 1992

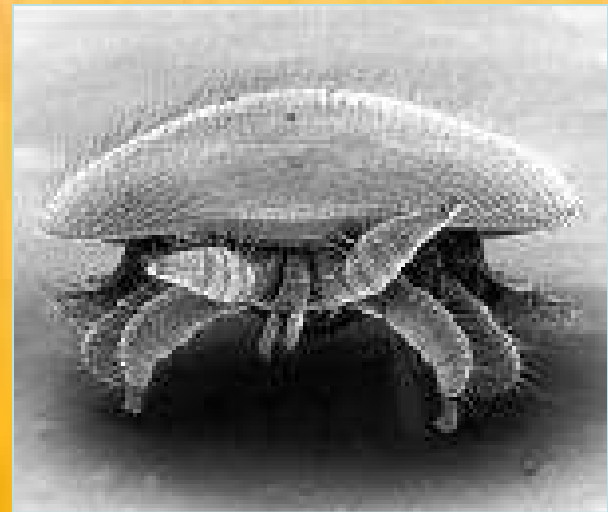
1. Chemical Strategy

- Does *Varroa* mimic its host's chemistry?
- To what extent (colony, task)?
- How?



1. Chemical Strategy

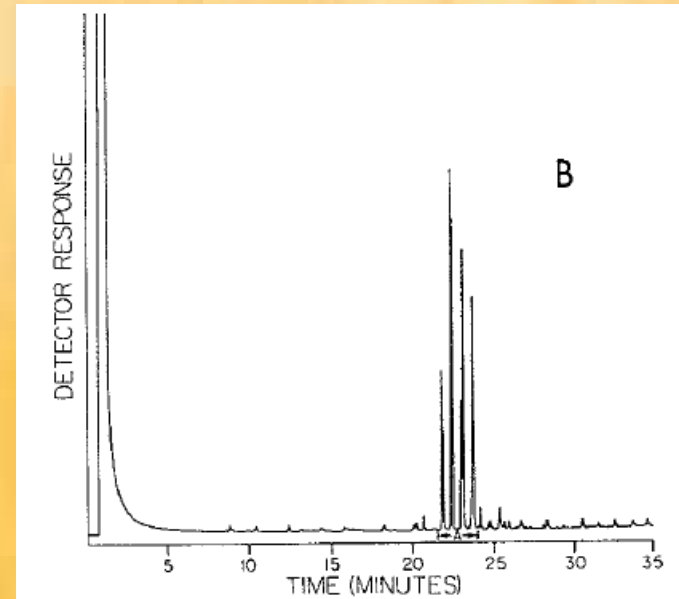
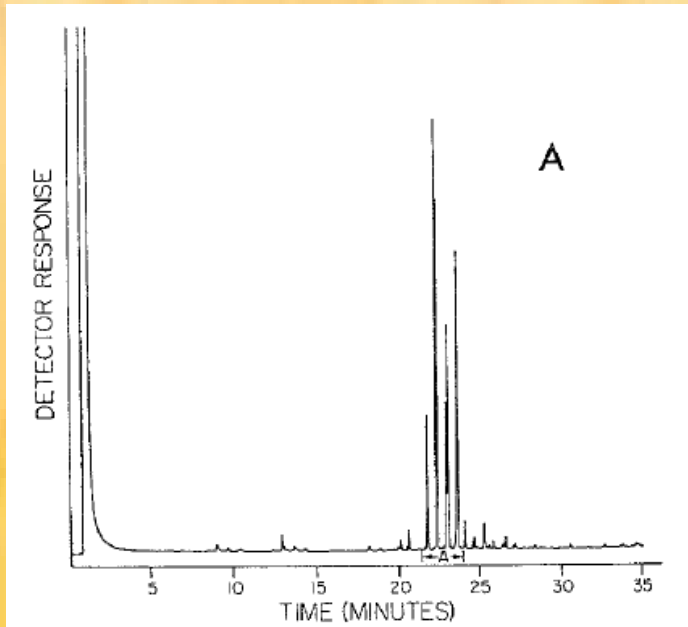
- 2 classical parasite strategies:
 - Chemical mimicry
 - Chemical insignificance



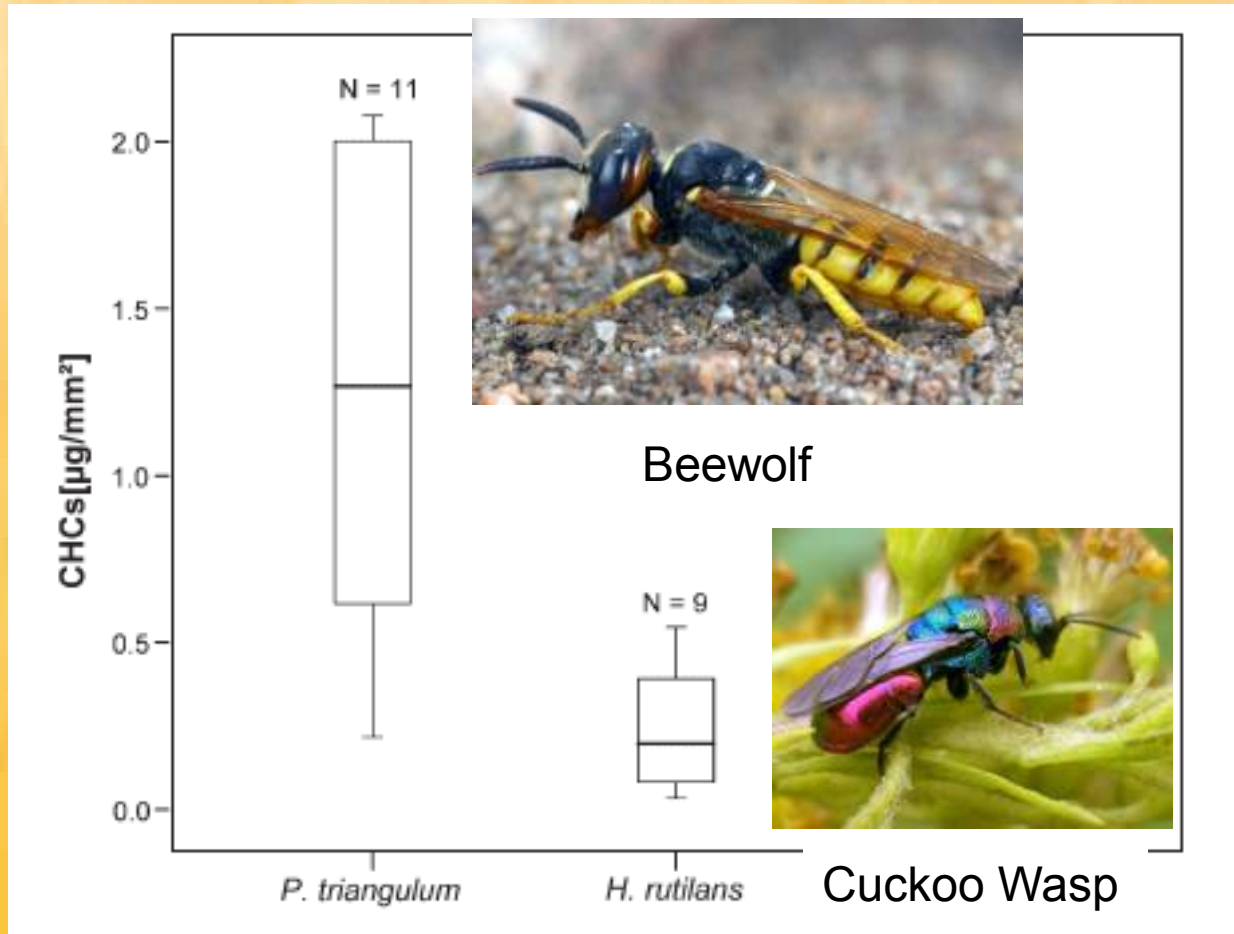
Chemical Mimicry

Fire Ant

***Orasema* wasp**



Chemical Insignificance



1/5th of host's
CHC ($\mu\text{g}/\text{mm}^2$)

1. Chemical Strategy

- Mimicry or Insignificance?
=> Adapt to each colony?



Colony 1



Colony 2



Colony 3

1. Chemical Strategy

- Mimicry or Insignificance?
=> Adapt to each colony?
=> Each task?



Colony 1



Colony 2

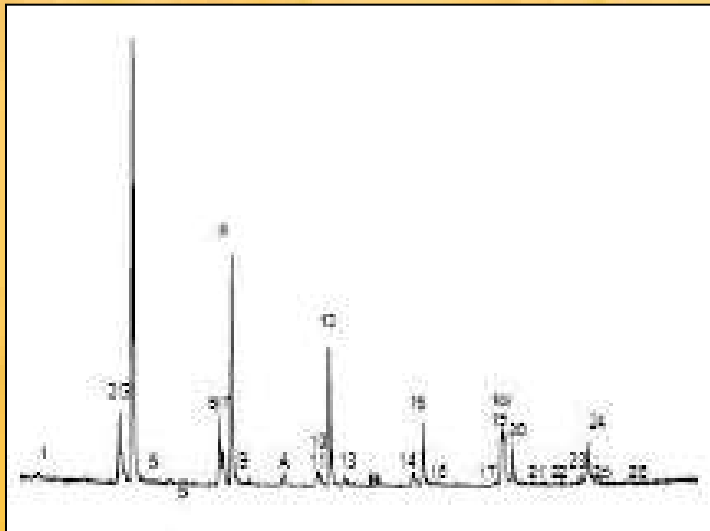


Colony 3

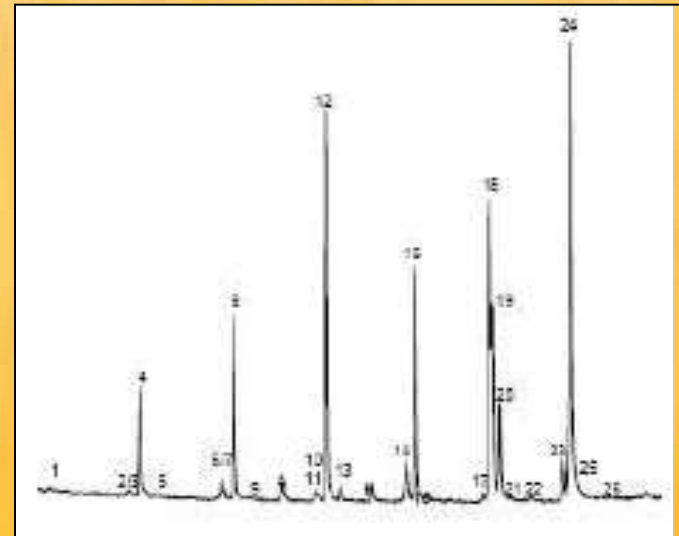
1. Chemical Strategy

- Task Level:

Forager

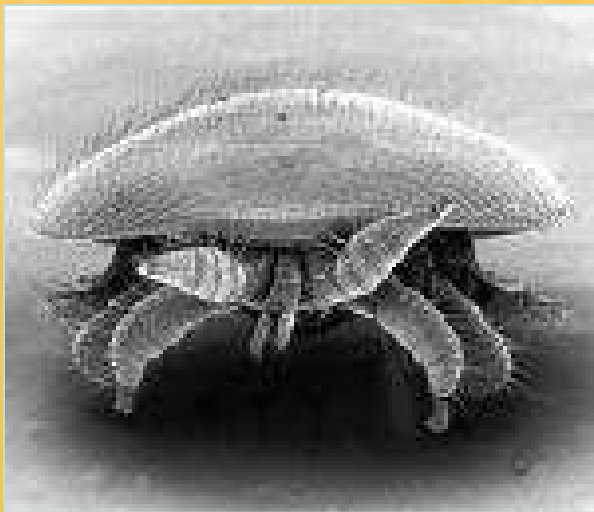


Nurse



1. Chemical Strategy

- Mimicry or Insignificance?
=> *Varroa* vs. Bee concentration ($\mu\text{g}/\text{mg}$)



1. Chemical Strategy

- How?
 - => Isolation Experiments
 - => Radiolabelling



2. Effect on Recognition

- Do *Varroa* & DWV impair host's recognition behaviour?
- E.g. to promote their transmission



Colony 1



Colony 2

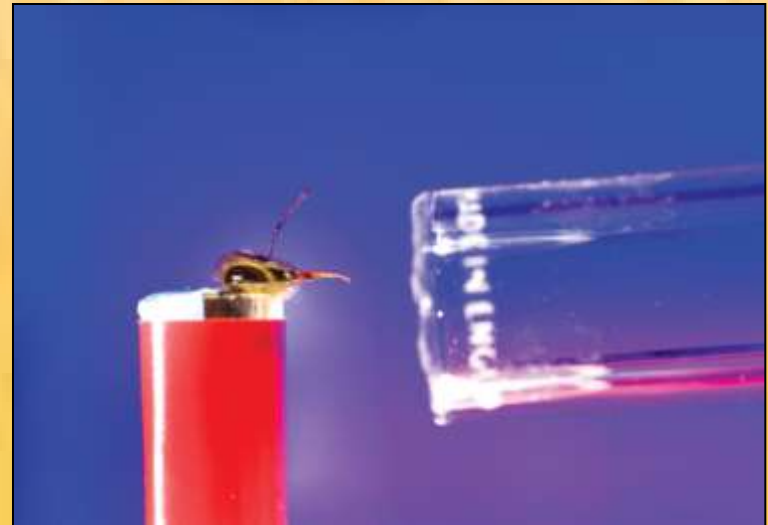
Host Learning & Memory

- DWV affects learning & memory

(Iqbal & Mueller 2007)

- *Varroa* has marginal effect on learning

(Kralj et al. 2007)



- But *Varroa* down-regulates *A. mellifera* genes responsible for olfaction and learning

(Navajas et al. 2008)

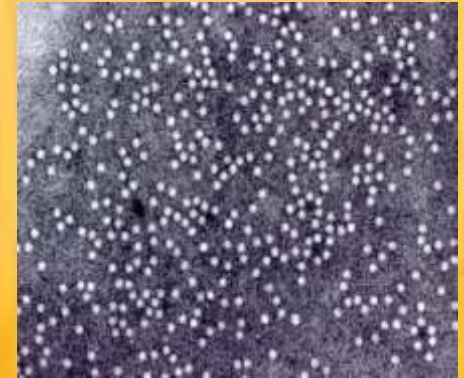
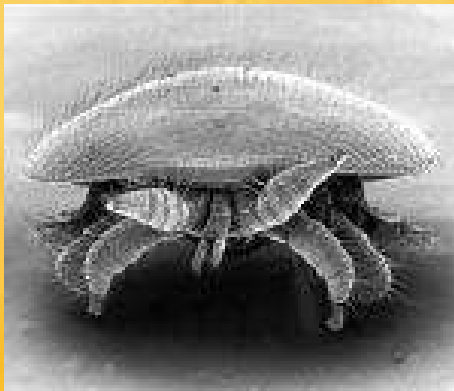
2. Effect on Recognition

- Bioassays:
 - Mite-infested vs. Control
 - DWV-infested vs. Control
 - Mite & DWV – infested vs. Control



Implications

- Better understanding of this system
- Basis for future mite treatments
- Need to understand how mites/DWV manipulate bees to see how we can counteract this.



Acknowledgements

- Supervisors: Dr SJ Martin & Prof RK Butlin
- Collaborators: Dr G Budge & Dr F Drijfhout
- Sponsors: BBSRC & East-Anglian Beekeepers



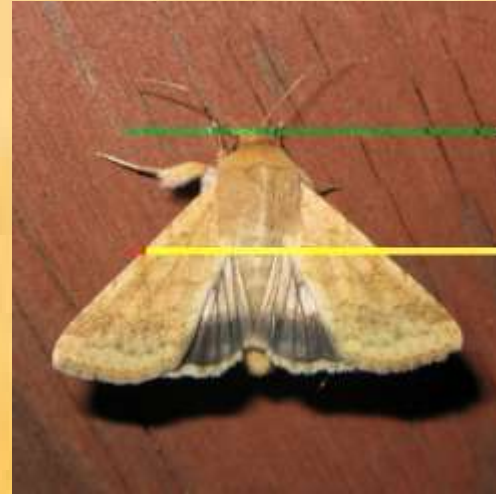
Thank you for listening!

Any Questions?

Effect on Host Behaviour

- *Helicoverpa zea*
& Hz-2V virus

(Burand *et al.* 2005)



- *Bombyx mori*
& baculovirus

(Goulson 1997, Kamita *et al.* 2005)



Effect on Host Behaviour

- Nematomorph Hairworm manipulates cricket's nervous system

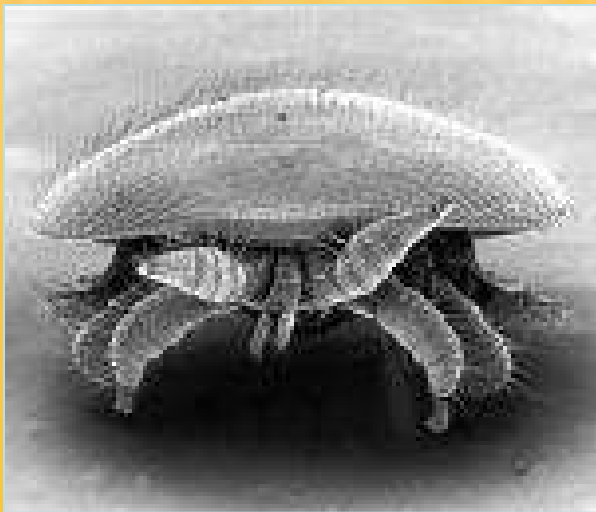


Talk Outline:

1. Introduction
2. Chemical Recognition System (use of 'smell')
in Insects & other Animals
3. EARS Project
4. Implications for Beekeepers
5. Any Questions?

1. Chemical Strategy

- Mimicry or insignificance?
=> How close a match? (GCMS)
=> All or subset of compounds?



Summary

- How does *Varroa* spread so quickly & undetected?
- *Varroa* chemistry: mimicry vs. insignificance
=> GCMS, mite-transfer experiments
- Origin of cuticular chemicals => Radiolabeling
- *Varroa*/DWV effect on host's recognition behaviour
=> Bioassays

