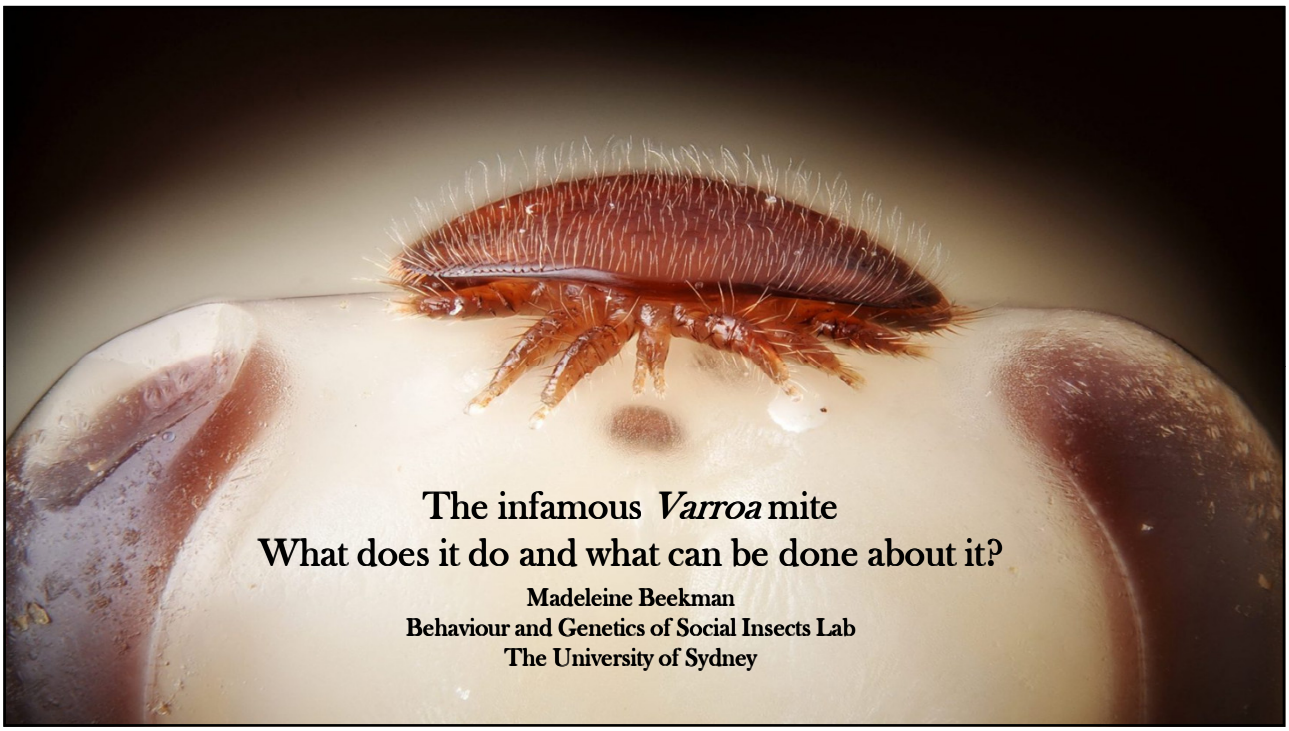


The infamous *Varroa* mite
What does it do and what can be done about it?

Madeleine Beekman
Behaviour and Genetics of Social Insects Lab
The University of Sydney

Varroa

First described from *Apis cerana* in Indonesia in 1904

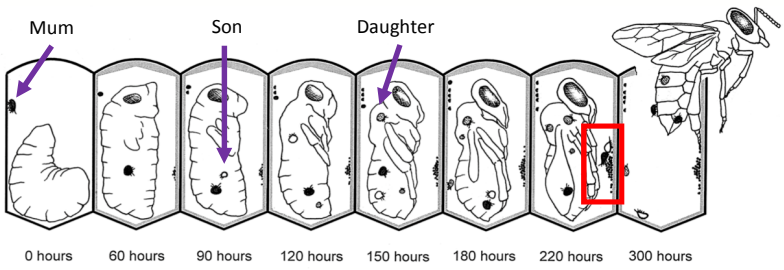
Ignored until early 1980s when it was found to cause damage on *Apis mellifera*

Oudemans, A.C. 1904. On a new genus and species of parasitic acari. Notes Leyden Mus. 24: 216–222
Ritter, W. 1981. *Varroa* disease of the honeybee Apis mellifera. Bee World 62: 141–153

Varroa life cycle

Boot, W. J., et al. 1994 Behaviour of Varroa mites invading honey bee brood cells. Experimental & Applied Acarology 18(6): 371-379

Varroa life cycle



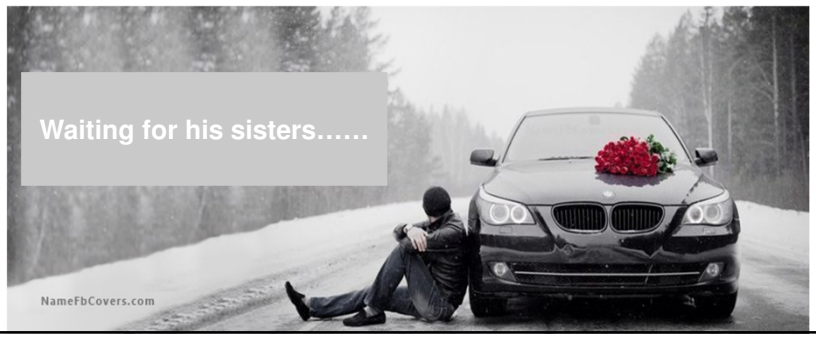
Oldroyd, B. P. 1999 Coevolution while you wait: *Varroa jacobsoni*, a new parasite of western honeybees. Trends in Ecology & Evolution 14(8): 312-315

Varroa sex life

Mother mite produces one son only

He will be the first born

Male patiently waits for his sisters to grow up



Varroa sex life

Just like bees, females and males are different

Females: two sets of chromosomes
Diploid

Males: one set of chromosomes
Haploid

Varroa sex life

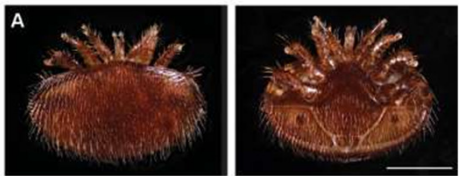
Unlike bees, females need to mate to produce sons
(pseudo arrhenotoky)

Females: two sets of chromosomes
Diploid

Males: one set of chromosomes
Haploid

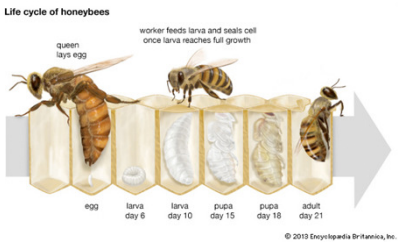
Varroa sex life

That means that if she fails to produce a son, her daughters will be infertile



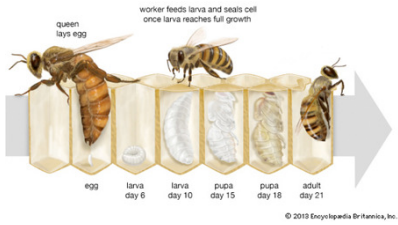
Why doesn't *Varroa* harm *Apis cerana*?

Why doesn't *Varroa* harm *Apis cerana*?



Because the mother mite continues to produce daughters, the longer the bee's developmental time, the more daughters are produced

Why doesn't *Varroa* harm *Apis cerana*?

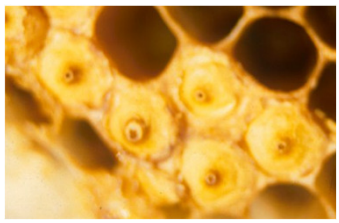


Brood developmental time for *A. cerana* and *A. mellifera*

Species	Worker			Queen			Drone		
	Egg	Larva	Pupa	Egg	Larva	Pupa	Egg	Larva	Pupa
A. cerana[1]	3	5	11	3	4-5.5	6-7.5	3	6	14
A. mellifera[2]	3	6	12	3	5	5	3	7	14

[1] Rahman (1945), Lap & Chinh (1996) Rosenkranz & Engels (1994a), Punchihewa (1994), Dung et al. (1993)
[2] Moritz and Southwick (1992)

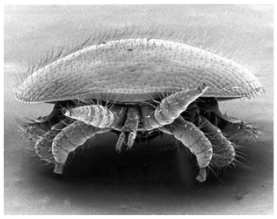
Could it be that simple?



Indeed, *Varroa* only reproduces in drone cells in *Apis cerana*, and not in worker cells

As a result, mite numbers never build up significantly

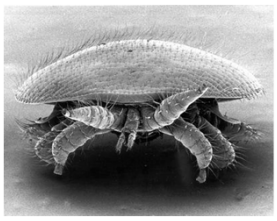
However…..



***Varroa* enters *Apis cerana* worker cells, but does not reproduce**

Boot, W. J., et al. 1999 Natural selection of *Varroa jacobsoni* explains the different reproductive strategies in colonies of *Apis cerana* and *Apis mellifera*. Experimental and Applied Acarology 23: 133-144

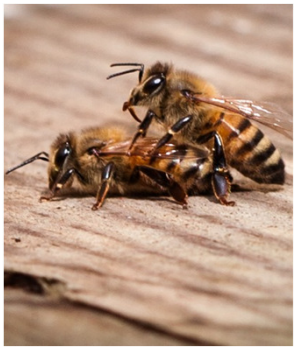
Well, that seems weird…..

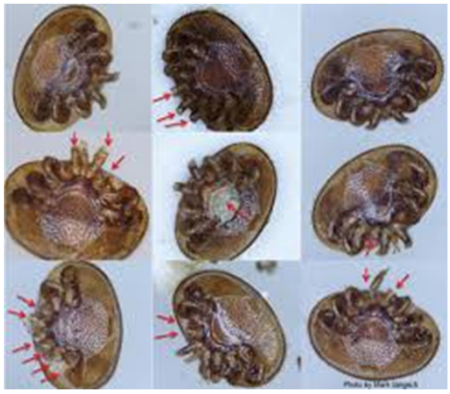


Modelling studies have shown that 'hiding' in worker cells, when there are no drone cells available, can be a wise strategy

Boot, W. J., et al. 1995 Why do *Varroa* mites invade worker brood cells of the honey bee despite lower reproductive success? Behavioral Ecology and Sociobiology 36(4): 283-289

Apis cerana grooming behaviour





When mites stay on bees, they might die

Boot, W. J., et al. 1995 Why do *Varroa* mites invade worker brood cells of the honey bee despite lower reproductive success? Behavioral Ecology and Sociobiology 36(4): 283-289

In addition….

Cells with more than one mite (eg reproducing mite) are removed

Rath, W. and W. Drescher 1990 Response of *Apis cerana* Fabr towards brood infested with *Varroa jacobsoni* Oud and infestation rate of colonies in Thailand. Apidologie 21(4): 311-321

In the meantime in PNG and Indonesia

***Varroa* present in *Apis mellifera* colonies were found not to reproduce**

A. mellifera* colonies showed low levels of mite infestation, probably due to mites coming in from nearby *A. cerana

Anderson, D. L. 1994 Non-reproduction of *Varroa jacobsoni* in *Apis mellifera* colonies in Papua New Guinea and Indonesia. Apidologie 25: 412-421

How one mite became two

Moving mites from *A. cerana* to *A. mellifera* and *vice versa*

Boot, W. J., et al. 1999 Natural selection of *Varroa jacobsoni* explains the different reproductive strategies in colonies of *Apis cerana* and *Apis mellifera*. Experimental and Applied Acarology 23: 133-144

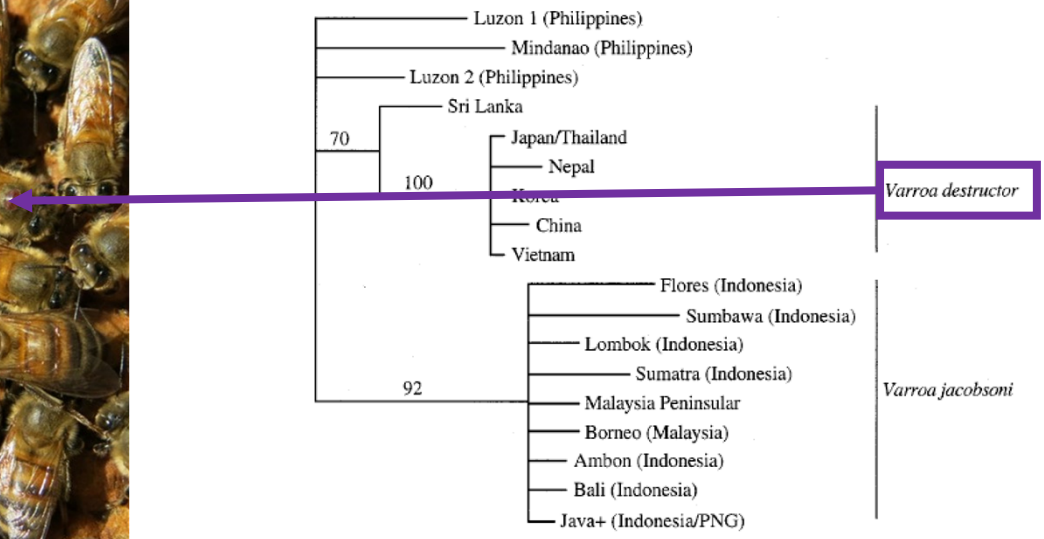
How one mite became two

Reproduction of *V. jacobsoni* in naturally and artificially infested worker cells

	Total number of cells	Brood removed	Mites lost	Without offspring	With offspring
Mites from *A. mellifera* colonies					
Naturally infested cells	77	–	–	16	61
Artificially infested cells of *A. mellifera*	104	33	21	9	41
Artificially infested cells of *A. cerana*	131	38	36	13	44
Mites from *A. cerana* colonies					
Naturally infested cells	13	–	–	12	1
Artificially infested cells of *A. mellifera*	57	14	3	38	2

Boot, W. J., et al. 1999 Natural selection of *Varroa jacobsoni* explains the different reproductive strategies in colonies of *Apis cerana* and *Apis mellifera*. Experimental and Applied Acarology 23: 133-144

The birth of *Varroa destructor*



Anderson, D. L. and J. W. H. Trueman 2000 *Varroa jacobsoni* (Acari: Varroidae) is more than one species. Experimental and Applied Acarology 24: 165-189

How does *Varroa* damage bees?

By drinking bee blood *Varroa* transmits viruses from bee to bee in the same way as that mosquitoes transmit diseases

Studies seem to indicate that *Varroa* is associated with more harmful (virulent) viruses

Currently main damage assumed to be linked to more virulent viruses

More in other talks later today

What can we do?

Many European researchers have been or are selecting for tolerance to *Varroa*

Colonies are kept isolated from other apiaries and not treated against *Varroa*

Colonies deemed strong enough after winter are kept

Panziera, D., et al. 2017 *Varroa* sensitive hygiene contributes to naturally selected varroa resistance in honey bees. Journal of Apicultural Research 56: 635-642

What can we do?

Two separate population

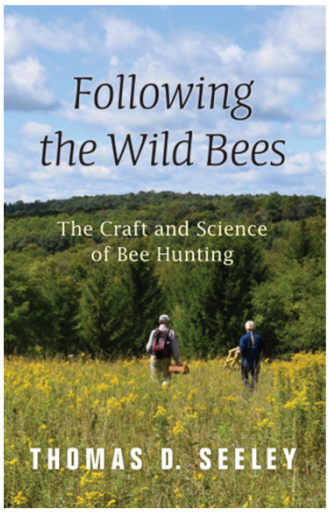
One population: bees remove reproducing mites from brood cells

Other population: mites do not reproduce in worker cells

Mite numbers similar to those in control (treated) colonies

Panziera, D., et al. 2017 *Varroa* sensitive hygiene contributes to naturally selected varroa resistance in honey bees. Journal of Apicultural Research 56: 635-642

And in the woods of upstate New York…



Key: colonies produce swarms each year

Result: period without brood, thus breaking the mite's reproductive cycle

And in South Africa…..

The Cape honeybee *Apis mellifera capensis* became *Varroa* tolerant within 3-5 years after the arrival of *Varroa*

***Apis mellifera scutellata*: 6-7 years**

Allsopp, M. H. 2006 Analysis of *Varroa destructor* infestation of southern African honeybee populations. Faculty of Natural and Agricultural Science. Pretoria, University of Pretoria. MSc: 285 pages

Evolving towards a less destructive relationship?

Natural selection is a powerful force

Interesting that the tolerance mechanisms seem to mirror mechanisms found in *Apis cerana*

Evolving towards a less destructive relationship?

There are different means by which bees can keep mite numbers low

Evolving towards a less destructive relationship?

There are different means by which bees can keep mite numbers low

But selection will only act when the mites are present

Evolving towards a less destructive relationship?

There are different means by which bees can keep mite numbers low

But selection will only act when the mites are present

Impossible to select for tolerance mechanisms in the absence of *Varroa*