Disease Control in Organic beekeeping

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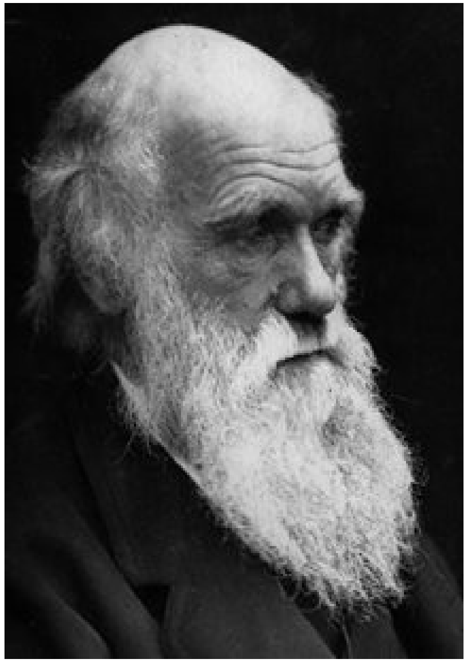
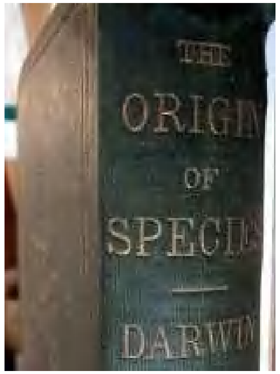


The theory of evolution is based on the concept of survival of the fittest. Those individuals best adapted to a changing environment will pass their genes to the next generation.

Adaptation is based on biological variation.

Without variation no long-term survival because the abiotic factors change, as do biotic factors such as pathogen pressure and composition



C. Darwin, 1859

Breeding of animals by man most often means a reduction in biological variation

- risks for loss of important traits, ex. pathogen resistance

For the honey bee (and most Hymenoptera) genetic variation is even more important than for other species

- the sex determination system

- the haplo-diploidy system

Why do bees become sick?

To understand disease control we need to understand why bees become sick

All available data suggest that wild populations of bees are less afflicted by disease compared to managed populations

Why do apiculture produce disease problems?

- unsuitable apiary locations
- crowding of colonies
- increased horisontal transmission of pathogens
- introduction of bees non-adapted to local climates
- management schemes that upset colony demography
- reducing the genetic variation through selection

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How do we breed vital bees?

The main problem with breeding vital bees is breeding

Beekeepers are often racists

Racists limit the genetic pool and choose bees (if bee breeders) with characteristics not necessarily fitness optimized

Adding isolated mating sites and instrumental insemination make the potential risk of loosing genetic variation acute

How do we breed vital bees?

Fortunately there are wild honey bee populations

Genetic variation will remain as long as man is not in control

Domesticated bees show higher incidence of disease
compared to wild bee populations (ex. AFB)┼

Beekeepers can probably influence bee colony fitness by breeding for hygienic bees

Hygienic bees show more resistance to all brood infections/infestations

American foulbrood

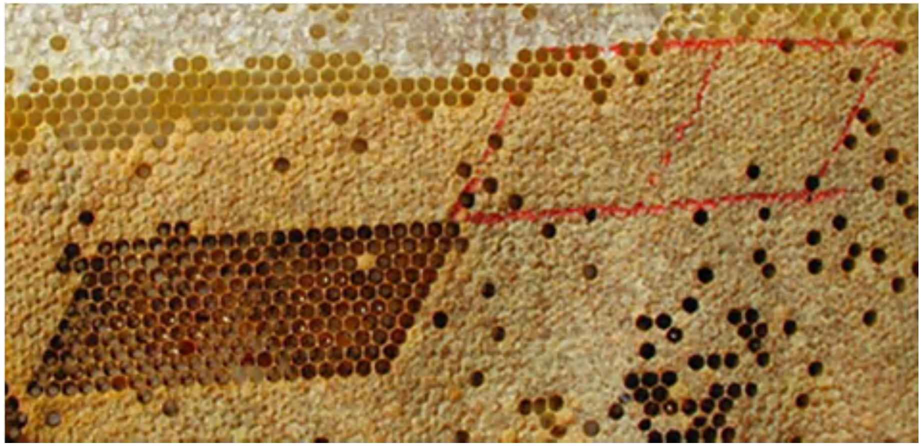
European brood

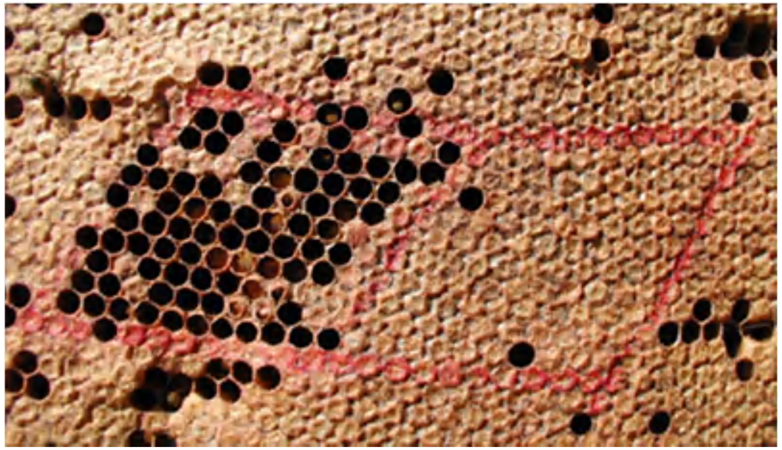
Chalk brood

Sac brood

Varroa

Hygienic bees remove
diseased brood fast





Non-hygienic bees remove
diseased brood much slower

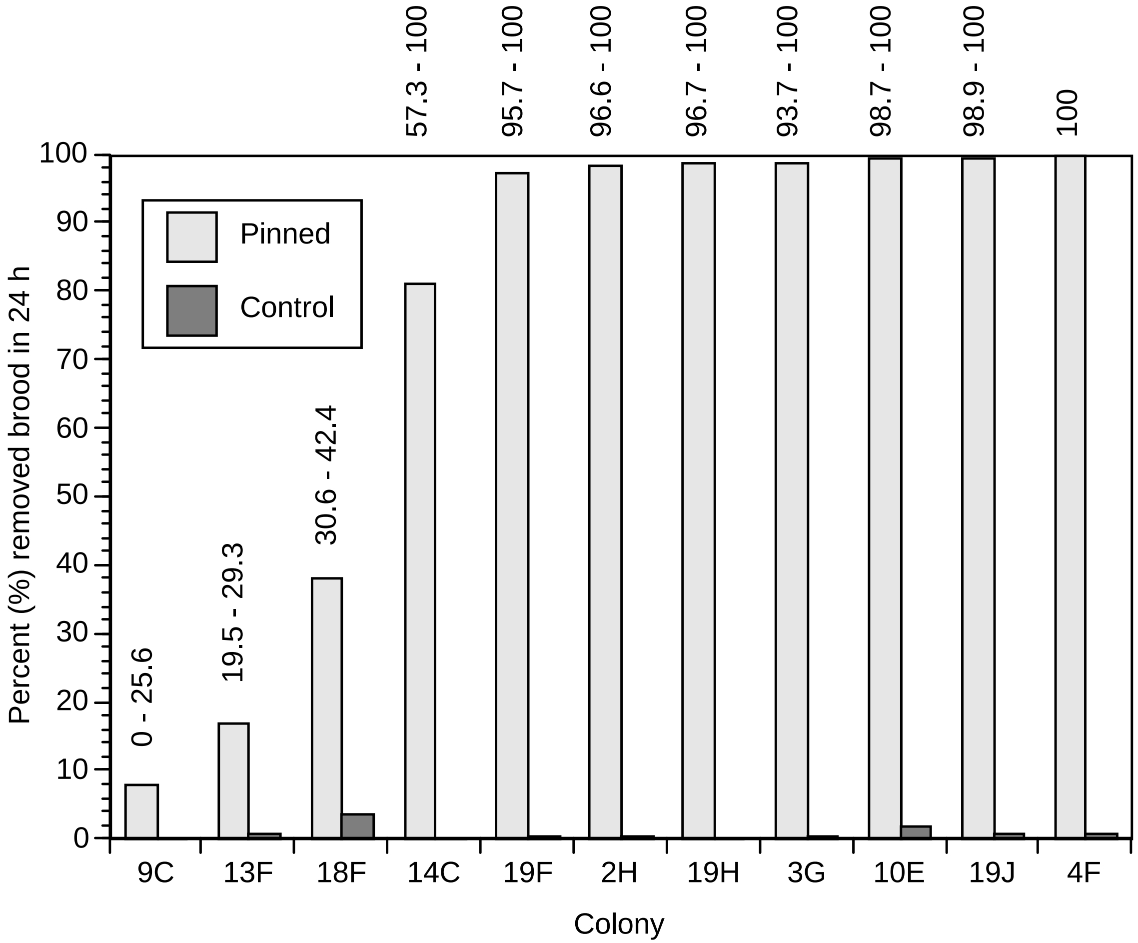


Figure 1. Average removal rate (N=3) of pin-killed brood 24 h. post treatment in 11 colonies of *A. mellifera scutellata*. The range of removed pin-killed brood (min. Ğmax) is given above the bar for each treated colony

Fries, I., Raina, S. 2003. American foulbrood (*Paenibacillus larvae larvae*) and African honey bees (*Apis mellifera scutellata*). *Journal of Economic Entomology 96*, 1641-1646.

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The Good, The Bad and The Ugly

Varroa Control Strategy

Varroa mites are the biggest menace to beekeeping world wide

It is an established fact that European honey bees will die if effective mite control is not employed

This mite was detected in Sweden 1987

I have spent 15 years working on control strategies

In reality this means I have spent 15 years pouring things on bees to see what happens….

Formic acid

short term treatment
1-5 days

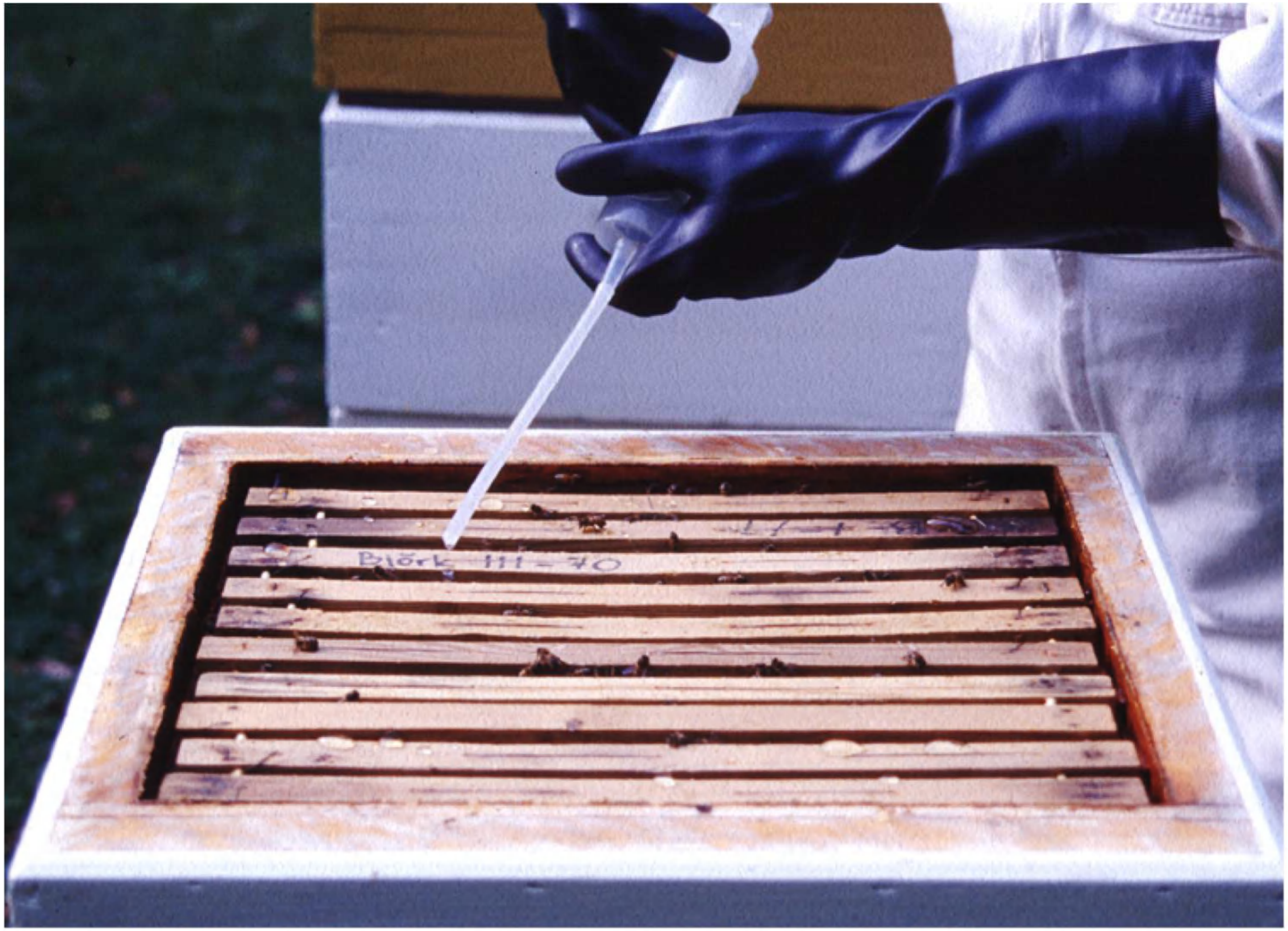
long term treatment
2-3 weeks

Slide courtesy Preben Kristiansen

Lactic acid

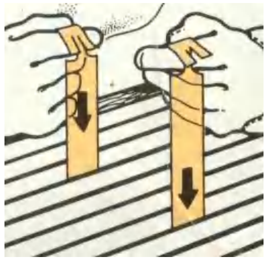
Slide courtesy Preben Kristiansen

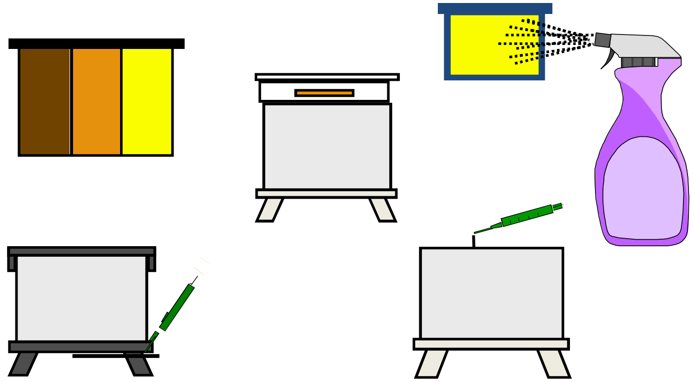
Oxalic acid



Slide courtesy Preben Kristiansen

Which control option should I choose?





Apistan	Ecological control options
• high efficacy	• variation in efficacy
• low labor cost	• often high labor cost
• expensive	• cheap
• residues in wax (& possibly in honey)	• none or low residue problems
• resistant mites develop	• resistant mites less likely

Slide courtesy Preben Kristiansen

We have been succesful….

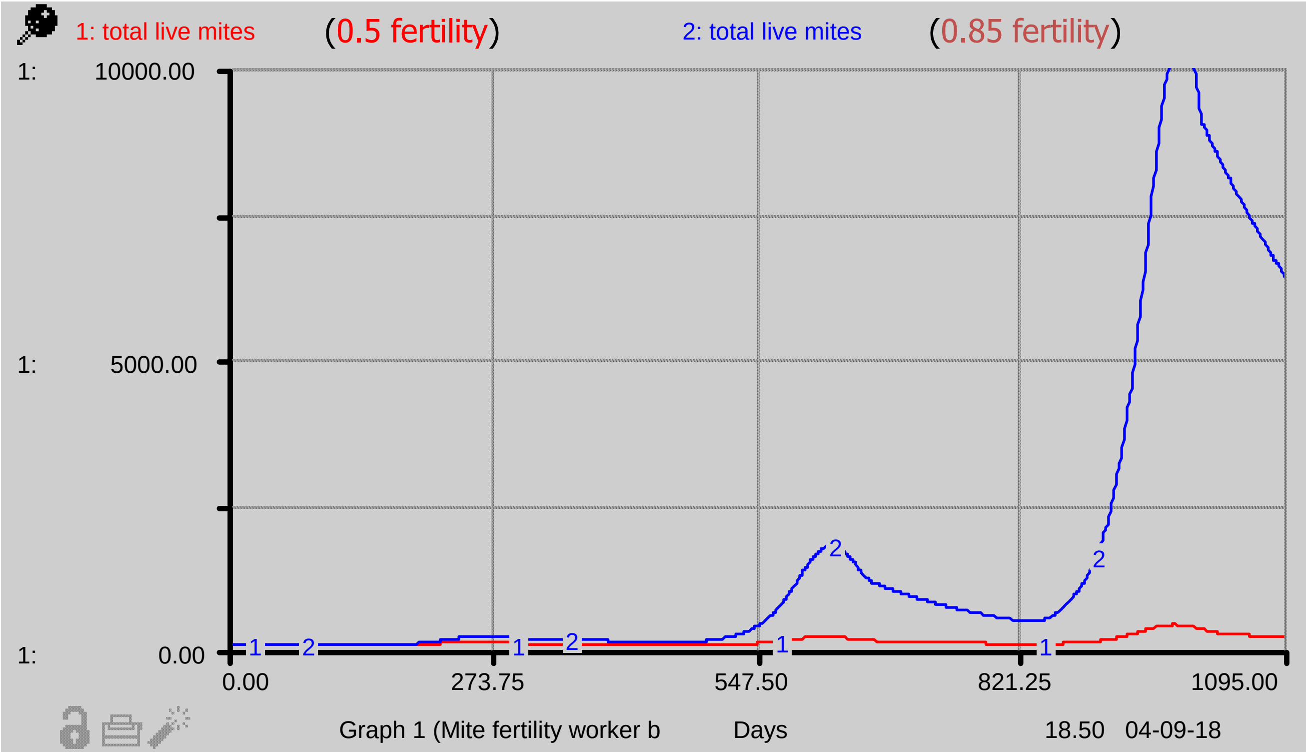
But we are also stuck….

Africanized honey bees (*Apis mellifera adansoni* imported into Brazil) survive and coexist with *Varroa* mites in South America (reviewed in Rosenkranz, 1999; Rosenkranz et al., 2010)

The course of events leading to this co-existance largely remains unknown

Parameters investigated and suggested to explain co-existance include:

– Reduced fertility of female mites on worker brood (Camazine, 1986)



Calculations based on model by Calis et al., 1999

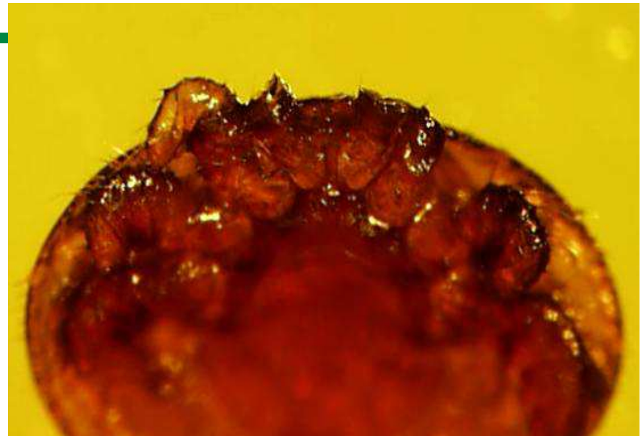
Parameters investigated and suggested to explain co-existance include:

– Reduced fertility of female mites on worker brood (Camazine, 1986)

– Lower brood attractivity in Africanized bees (Vandame et al, 1995)

– Increased grooming behavior in Africanized bees (Moretto et al., 1993)

Bees may damage live mites (Ruttner & Hänel, 1992)



Courtesy R. Büchler

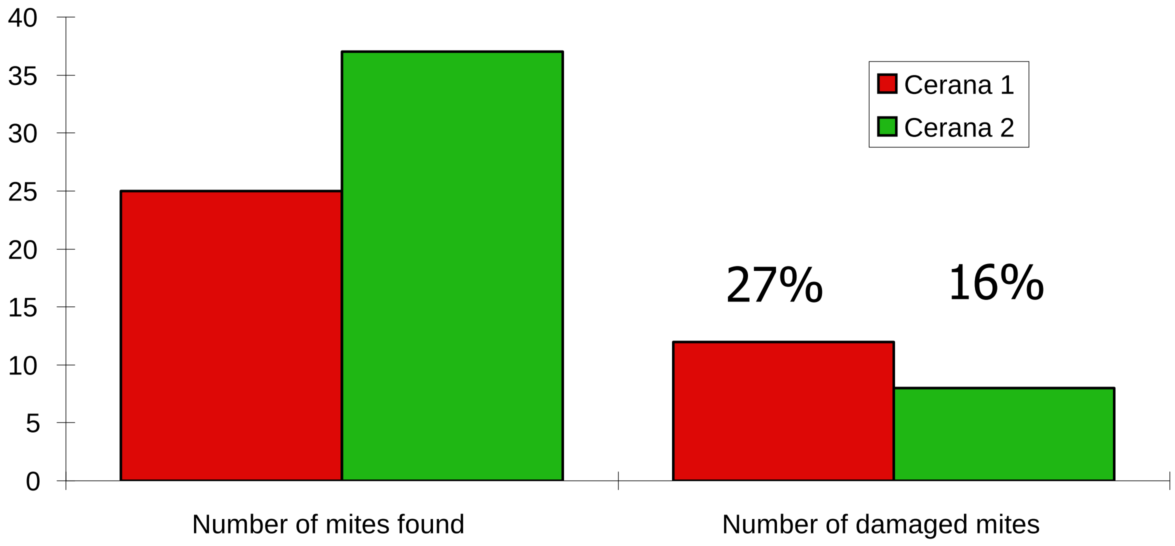
Some data do suggest that grooming (expressed as proportion of damaged mites) actually do influence mite population development (Moosbeckhoofer, 1992)

Bees also damage dead mites (Rosenkranz et al., 1997)

Variations in grooming can not explain the difference in impact from *Varroa* infestations between Aricanized and European races of honey bees in South America (Aumeier, 2001)

The original host, *Apis* cerana, is more effective in grooming compared to European races of honey bees (Peng, 1987)

However, it still remains to be demonstrated that grooming is an important part of the mite resistance in *A. cerana* (Fries et al., 1996)



Data from Fries et al., 1996

Parameters investigated and suggested to be involved in co-existance include:

- Reduced fertility of female mites on worker brood (Camazine, 1986)
- Lower brood attractivity in Africanized bees (Vandame et al, 1995)
- Increased grooming behavior in Africanized bees (Moretto et al., 1993)
- Climate (Ritter & de Jong, 1984)
- Hygienic behavior (Corrêa-Marques & de Jong, 1998)
- The flight behavior of infested bees (Kralj & Fuchs, 2004)
- The cell size in Africanized bees (Erickson, 1990)

So, what parameters to focus on!??

Why not all at the same time!??

- Why not use……..

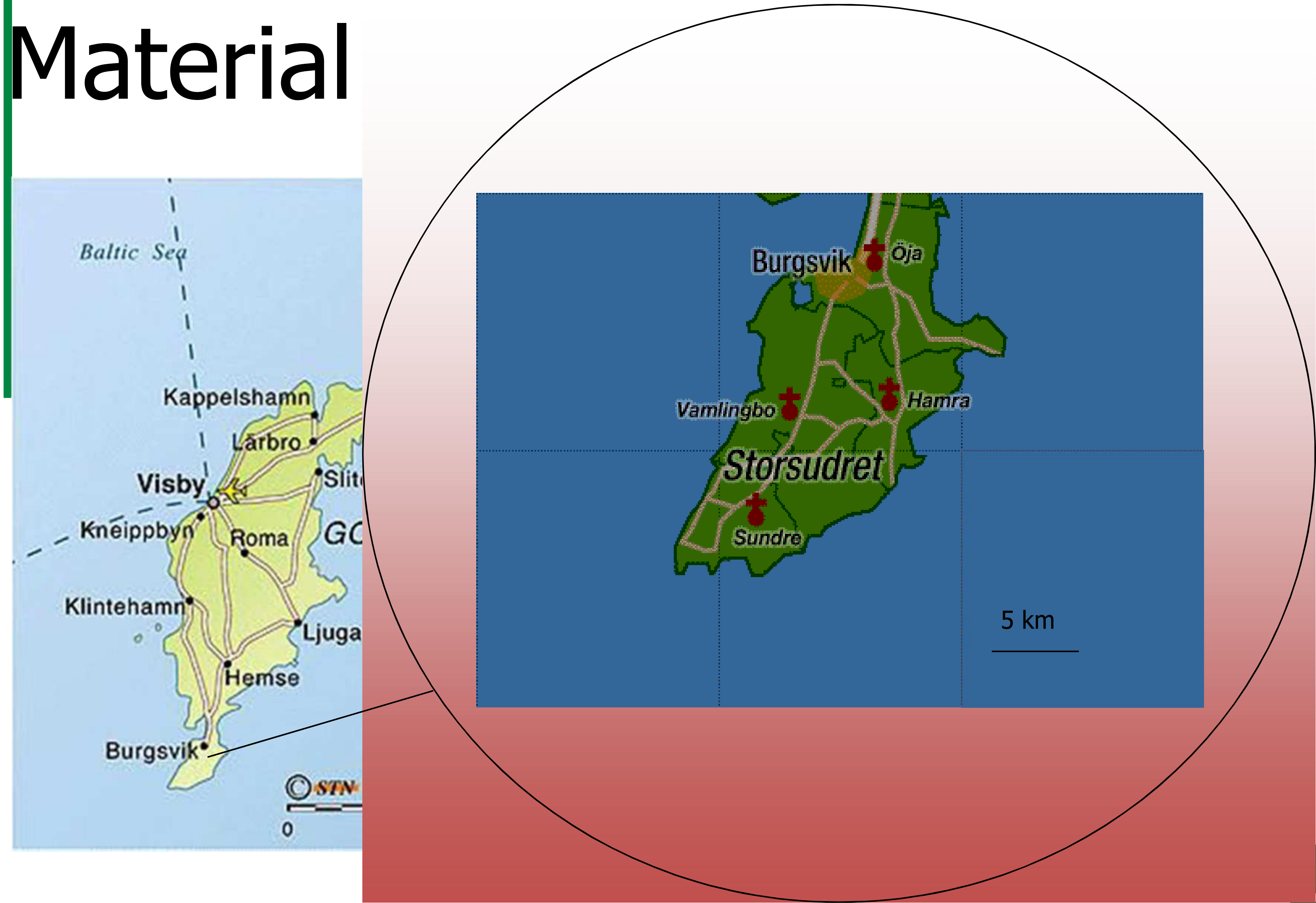
The Bond Test

Live and Let Die

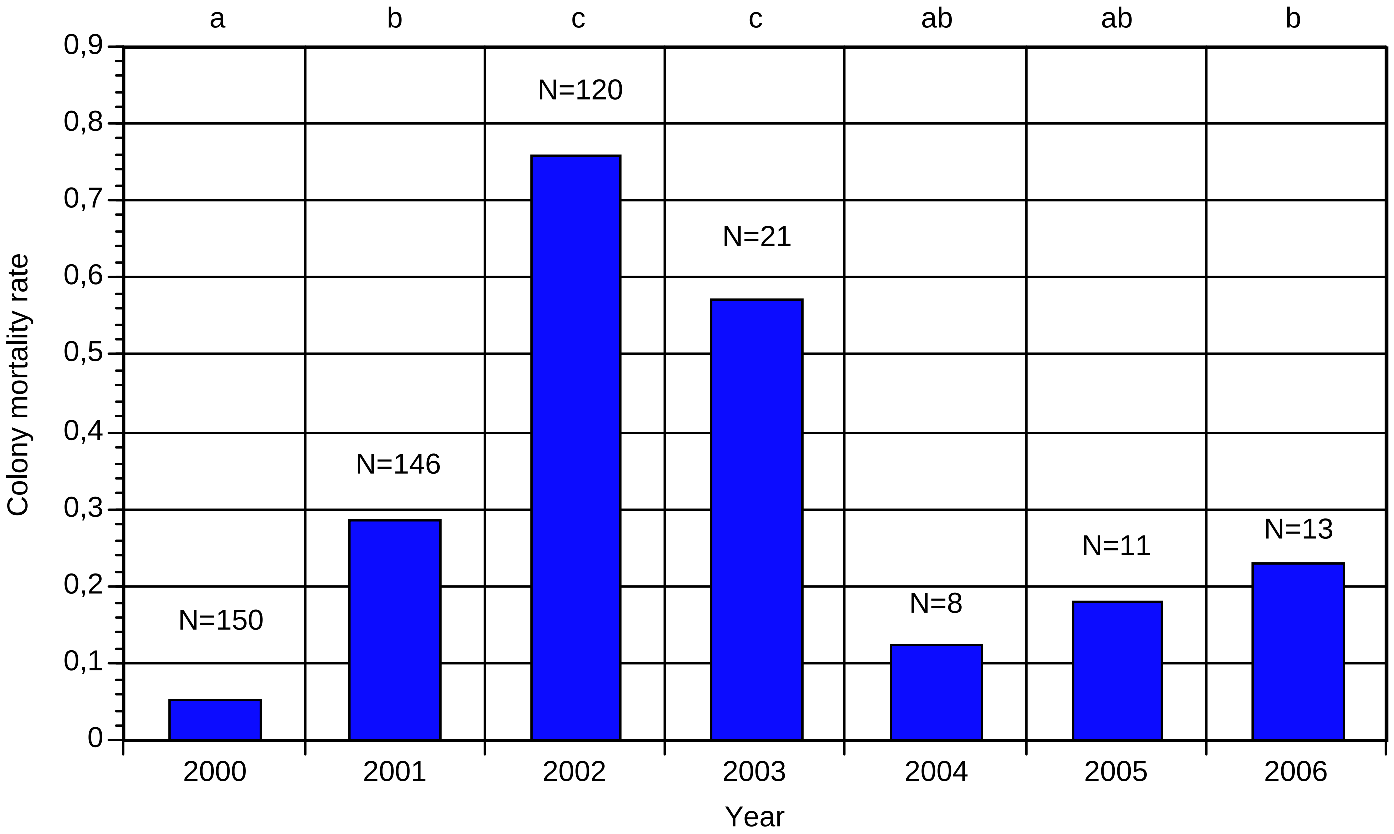
Bond concept stolen from

John Kefuss (1999)

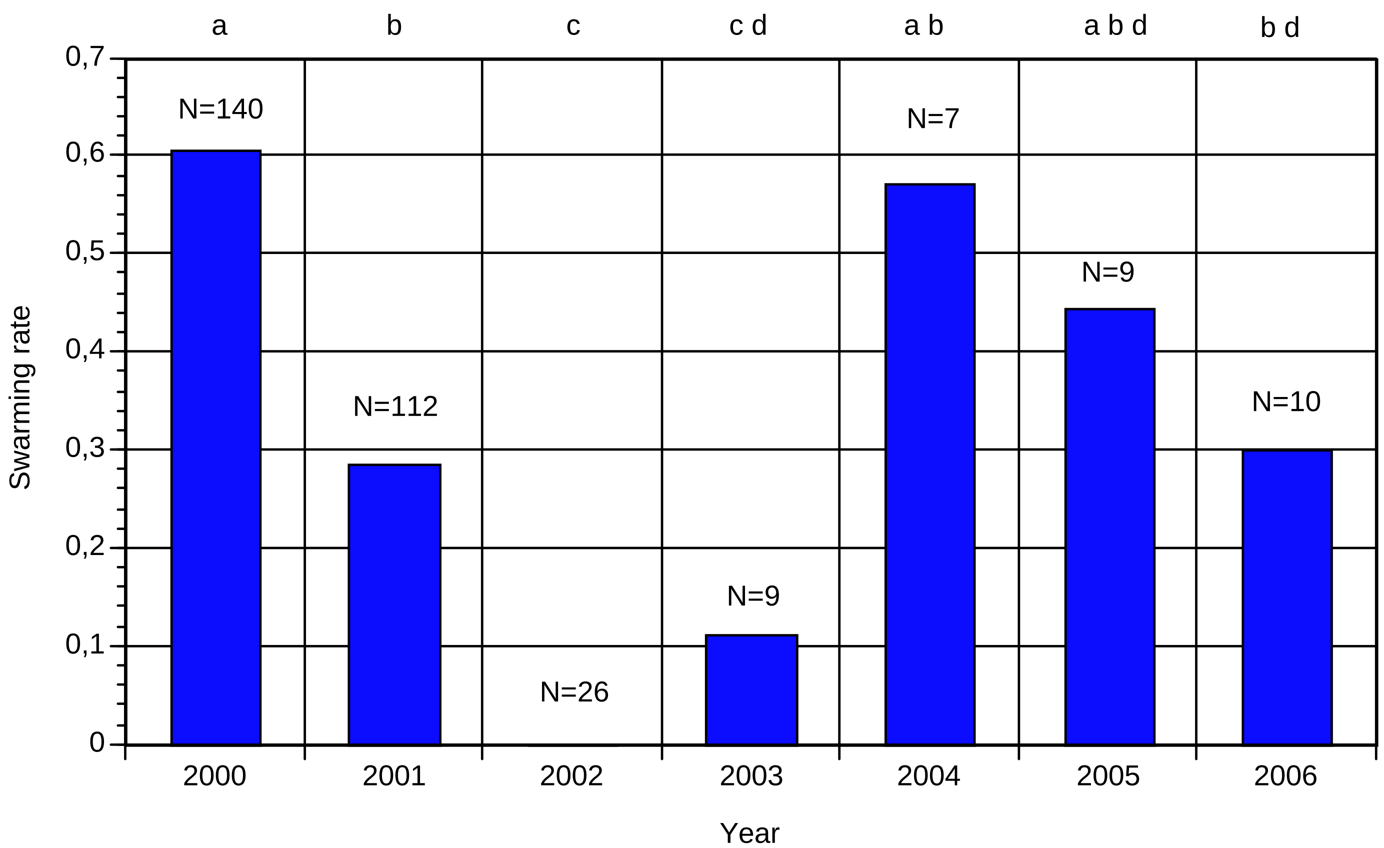
Material


Baltic Sea
Kappelshamn
Lärbro
Visby
Slit
Kneippbyn
Roma
Klintehamn
Ljuga
Hemse
Burgsvik
STN
0
Burgsvik
Öja
Vamlingbo
Hamra
Storsudret
Sundre
5 km

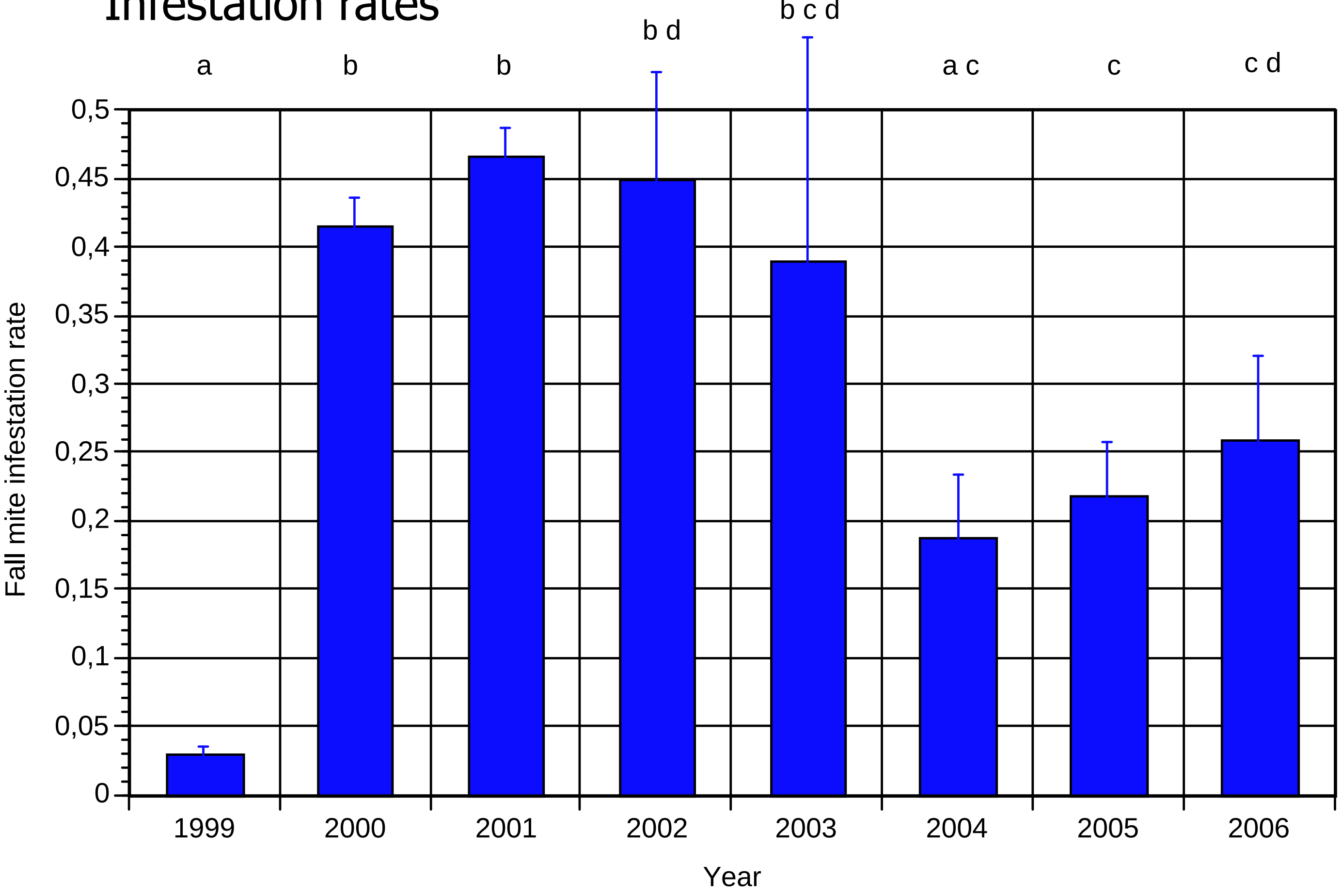
Mortality rates



Swarming rates



Infestation rates



Method

Apiary A

Mite source

Apiary B

Control mites

Bond mites

10 colonies

10 colonies

10 colonies

10 colonies

Bond

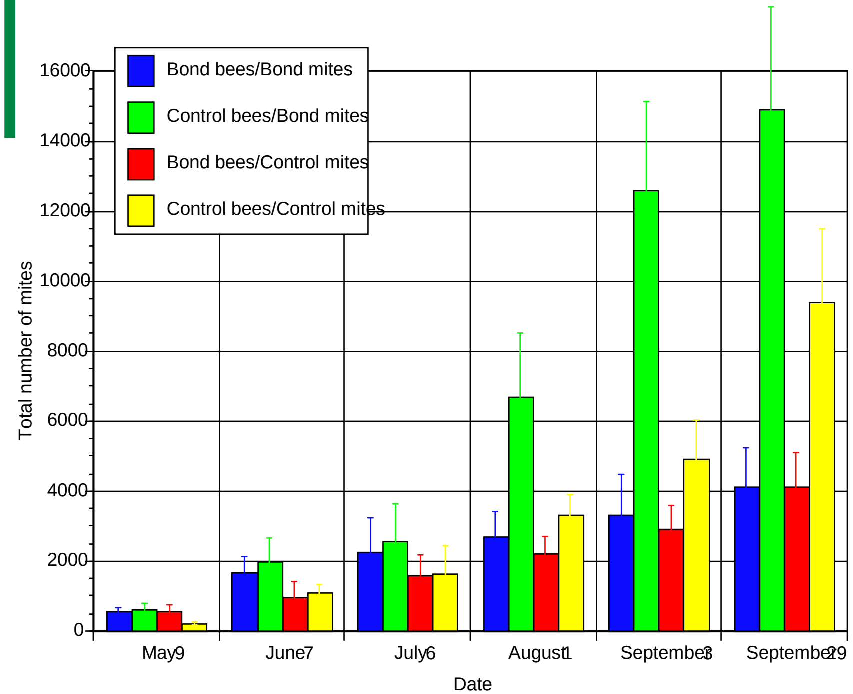
Control

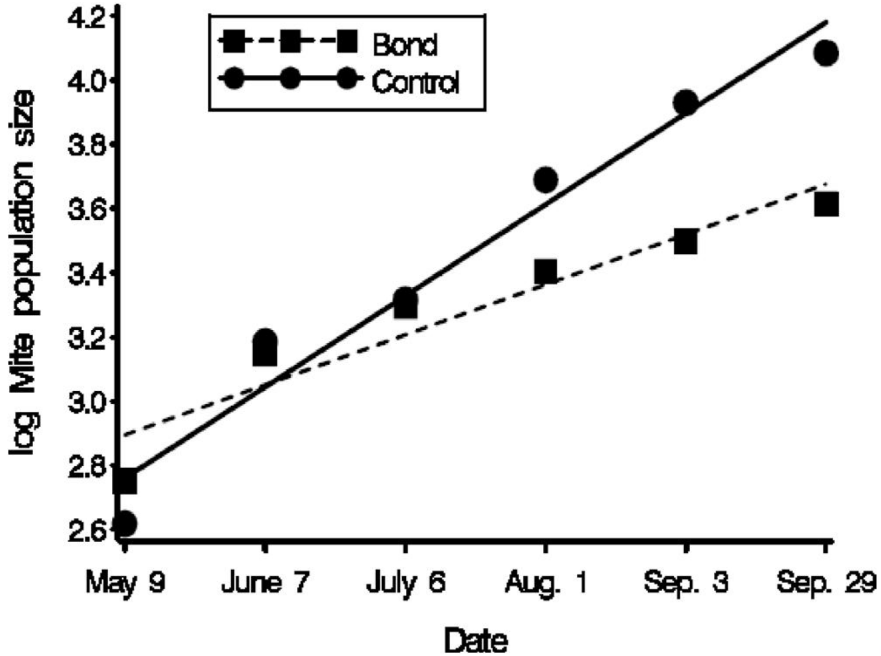
Bond

Control

Queen type

There is no indication that the source of mites influences the mite population development





So, what are the options for the poor beekeeper!??

Organic disease
control ??

Natural selection
(i.e. the Bond test) ??

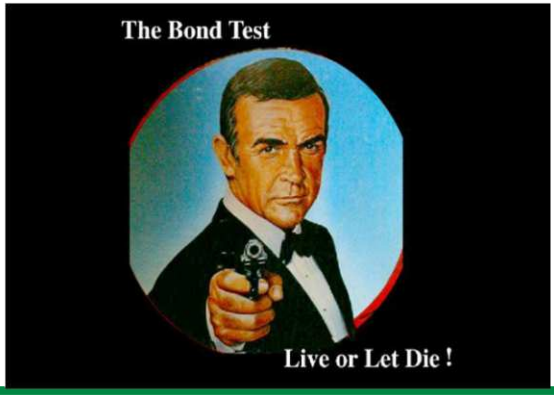
Conventional
mite control ??

There are three strategies for Varroa control and breeding of tolerant bees:

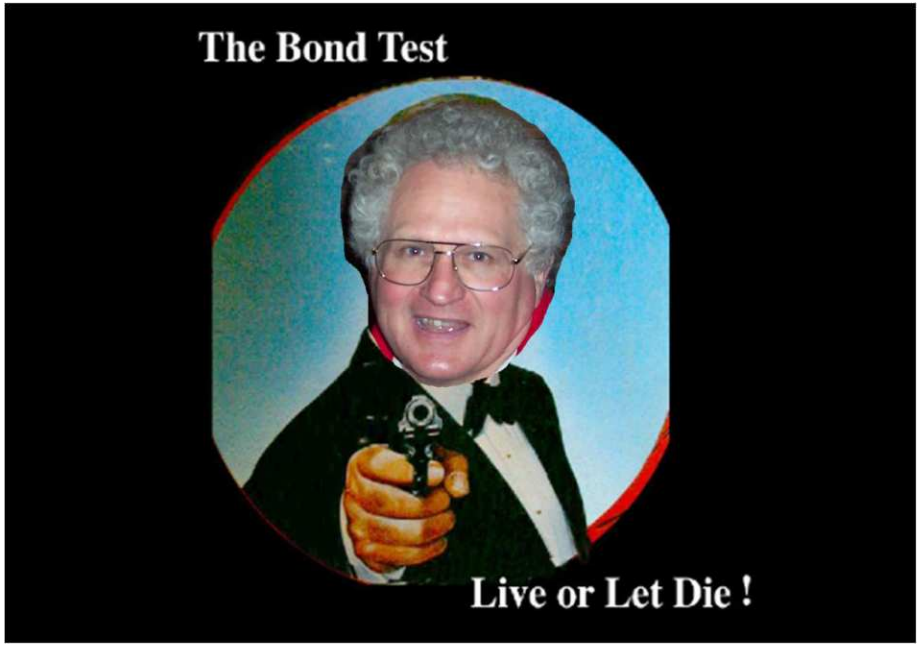
1. The Good Strategy

2. The Bad Strategy

and 3. The Ugly Strategy



3. The Ugly Strategy



First developed by John Kefuss

Results in heavy bee losses

Likely to produce mites and bees
that live happily together

Likely to be unacceptable to beekeepers

2. The Bad Strategy

This is the main stream strategy

Consists of various effective chemical treatments

Removes selective advantage of being tolerant/less virulent

Results in resistant mites and contaminated products

The Bad Strategy resembles the ostrich philosophy


The Bad Strategy gets you hooked forever…..

1. The Good Strategy

This strategy combines the Bad Strategy and the Ugly Strategy

The Good Strategy allows selection pressure on host <u>and</u> parasite, without severe bee losses

”Bad” mites are punished by only treating heavily infested colonies

”Bad” bees are punished by requeening heavily infested colonies

Time will tell if the Good Strategy is suicide…..

or heaven…..

Thank you for your attention !!