

Chemical-free bees - a sustainable future for Irish beekeeping ? Think before you treat.

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Outline



Introduction



Mechanisms of VR



Do VR populations exist?



VR Breeding Programmes



Some Irish data & Observations

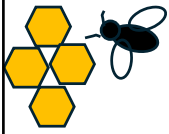


Conclusions



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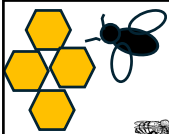
Introduction

-  Honey bee social immunity protects against a range of pests, parasites & pathogens.
-  Hygienic behaviour -a generalized response
-  Cues to determine that a larva/pupa is abnormal include; smells from the affected brood, lack of movement / vibrations within the cell, difference in heat, pheromones.
-  Rothenbuhler (1964) 2 recessive genes, Lapidge et al (2002) found 7 genes involved



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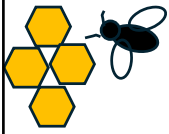
Introduction

-  HB – involved in resistance to American foulbrood and chalkbrood- they can detect, uncap and remove diseased brood from the nest before the organisms reach sporulating stage
-  HB traits could have been coopted to deal with Varroa
-  VR populations identified across the world
-  But are not yet commonly used in beekeeping



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Introduction

-  HB and other behaviours evolved as part of honey bee social immunity
-  They are heritable (although complicated and varying)- more research needed
-  Behaviours have evolved through natural selection and driven further/faster in some populations by beekeepers/scientists through artificial selection
-  Use of chemicals removes the selective pressure resulting in weaker, susceptible bees



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Introduction

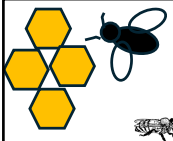
-  HB multiple benefits- active against multiple pathogens
-  Reduce dependance on chemicals, antibiotics, pesticides
-  Resistance to chemicals evolving in mites
-  Residues in products, impact on bees of chemicals
-  Can be selected for in *Apis mellifera* and hygienic queens produced for sale
-  Needs many beekeepers in area to join in the effort to be truly successful
-  Should be routine part of beekeeping



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Spivak & Gillam 1998; Grindod & Martin 2021; Mondet et al 2020

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Introduction



Host tolerance: the ability to reduce the effect of the parasite.

e.g. Mites present but with reduced damage to the colony even if the mechanism isn't understood.



Host resistance : the ability to reduce the fitness (*ability to survive*) of the parasite.

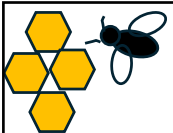
e.g. Reduced mite reproductive success due to VSH behaviour or drone entombing.

Schmid-Hempel, 2010



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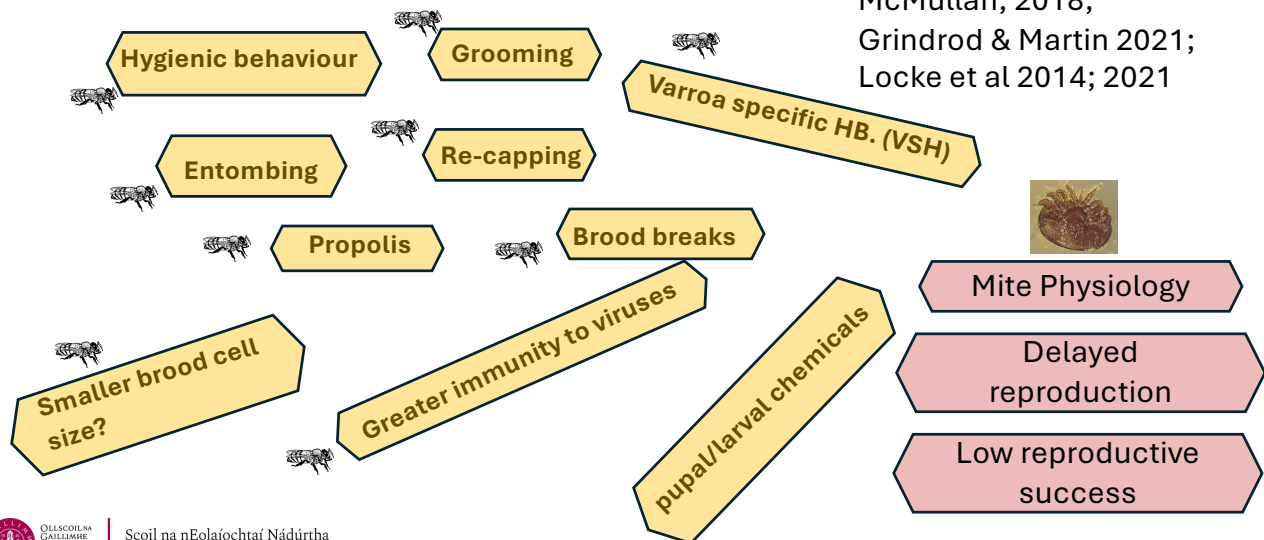
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Introduction

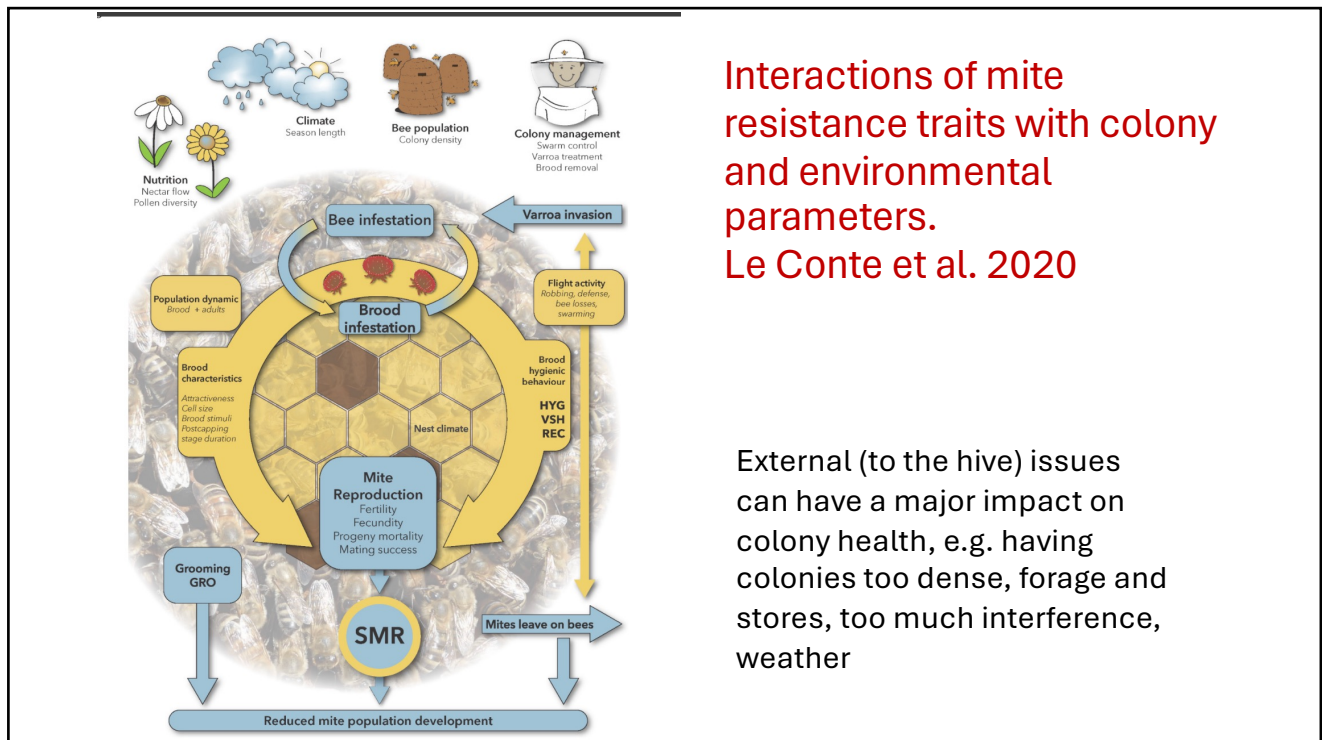
Possible Mechanisms

e.g. Mondet et al, 2020;
McMullan, 2018;
Grindrod & Martin 2021;
Locke et al 2014; 2021

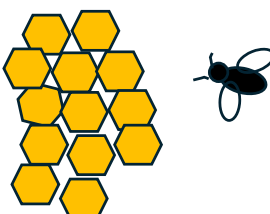


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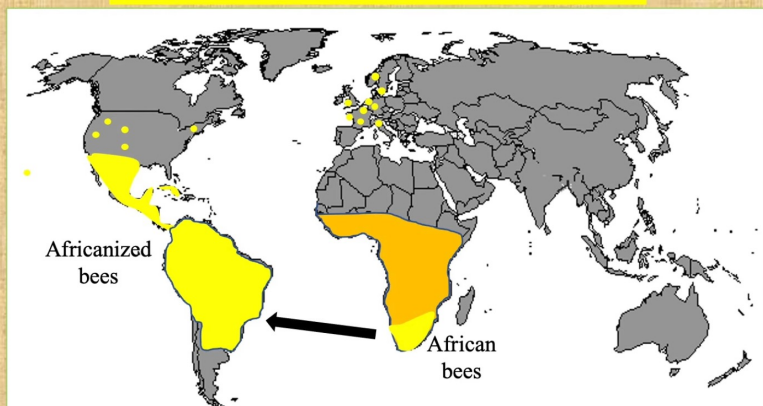


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Do VR populations exist? Yes.

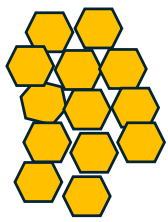
Varroa-resistant *Apis mellifera* have been around since the 1980's



By 2010's were very widespread

<https://www.youtube.com/watch?v=aa56mUJSApQ>: Stephen Martin: Understanding varroa resistance

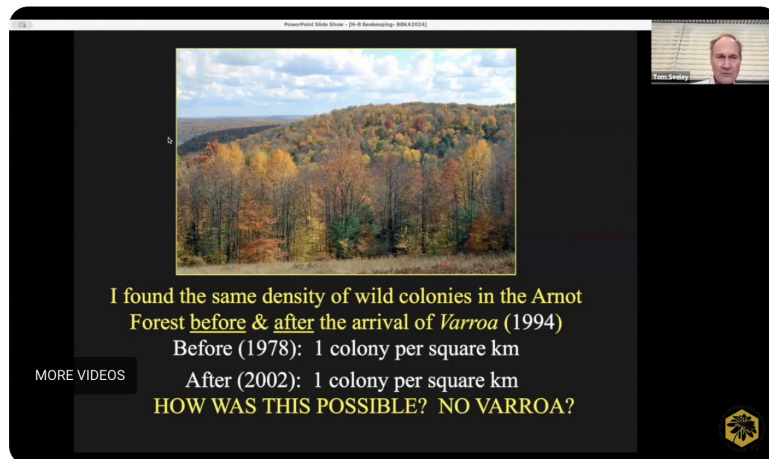
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Do VR populations exist? Yes.

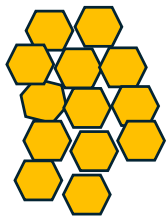
Surviving free-living colonies

Example 1: Arnott Forest, work by Tom Seeley



<https://www.youtube.com/watch?v=i8dNYnzvhlM>: Prof. Tom D Seeley: Nature-based beekeeping

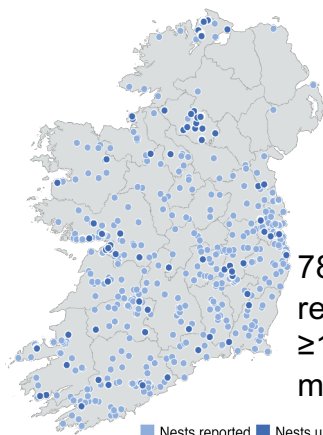
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Do VR populations exist? Yes.

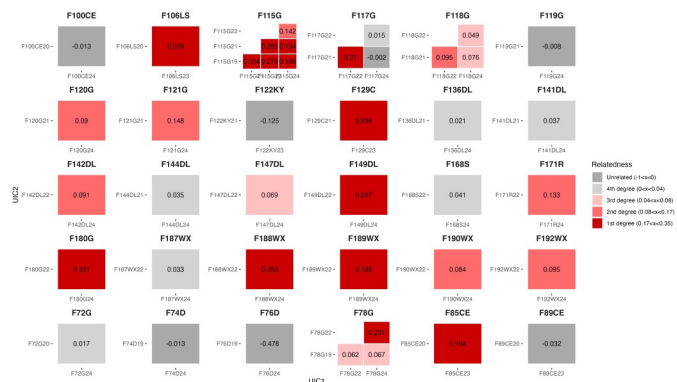
Surviving free-living colonies

Example 2: Irish FLCs



788 nests reported and ≥180 being monitored

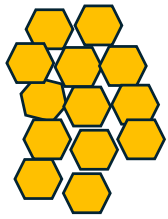
■ Nests reported ■ Nests under monitoring



17/32 colonies survived multiple years. Longest tracked so far ≥5yr

Monitoring & genomics

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Do VR populations exist? Yes.

Le Conte et al (2020) –survey- 7 countries Europe naturally selected VR populations (France, Italy, Ireland, Lithuania, The Netherlands, Norway and Sweden)

Country	Naturally Selected Resistant Populations Present	If Yes, How Many	Proven Examples of Survivor-Stock	If Yes, How Many	Are There Selection Programs for Varroa Resistance	If Yes, are Queens Commercially Available
Austria	none known		No		yes, two	Yes, but not marketed as 'resistant'
Belgium	none known		no		yes, starting: three	no
Bulgaria	anecdotal reports		no data available.		no; but selection on hygienic behavior carried out	
Croatia	anecdotal reports		no		yes	no
Cyprus	none known		no		no	
Czech Republic	none known		no		no, but selection on hygienic behavior	
Denmark	none known		no		Just initiated. No sale, no price.	
Estonia	none known		no		no	
Finland	none known		no		starting	
France	yes	3: Avignon, Sarthe, Tarn			yes, several initiatives	no

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Grindrod and Martin 2021

- >100 beekeepers & approx 500 colonies in Wales 11 years
- Swindon (Ron Hoskins) since 1995
- “Natural beedriven resistance to Varroa is a sustainable, long-term solution, prevents the constant usage of acaricides, will not weaken bees to any other maladies

Hoskins websites: 3 mechanisms identified: Grooming, uncapping and viral adaptation

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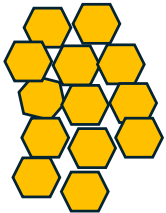
Important mite-resistant traits investigated in naturally occurring Varroa mite-surviving honeybee populations

	Brazil	South Africa	Fernando de Noronha	Primorsky, Russia	Gotland, Sweden	Avignon, France	Arnot Forest, NY, USA
Hygienic behaviour	✓	✓	✗	✓	✗	□	□
Grooming behaviour	✓	✓	✗	✓	✗	□	□
Small colony size	✓	✓	✗	✗	✓	□	✓
Reduced development time	✓	✓	□	□	✗	□	□
Reduced mite reproduction	✗	✗	✗	✓	✓	✓	□

- ✓ = Significant difference between resistant and susceptible population
 ✗ = No significant difference
 □ = Not investigated

Adapted from Locke, 2016

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VR Breeding programmes



HB acts against a range of pathogens so should be desirable but not yet common place amongst beekeepers (Spivak & Downey 1998)



Denmark: bees tested for HB, 4 generations of selection, 9% chalkbrood instead of 74%



Chile- selection programme



Australia: Oldroyd- evaluation 10 commercial stocks for HB

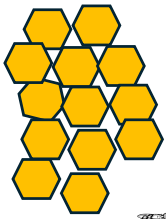


Argentina; selection started in 1992



USA: Minnesota, Baton Rouge

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VR Breeding programmes



queen supplies very limited & breeders very cautious about advertising their stock as “resistant”



Fifteen of the 28 breeders using selection (from Le Conte et al 2020 survey)- make their stock available to beekeepers.



Only 4 breeders produce VR queens (Finland, France, USA x2).
Finland- VR queens €500 ea. France, €10 per virgin queen.



So far attempts to bring honey bees bred from “natural selection” into beekeeping on a wider scale have failed Mondet et al 2020.



Breeding values seldom recorded

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What do beekeepers want?

Some beekeepers only interested in having colonies survive without treatment and not particularly interested in productivity.

Others seek commercially attractive traits such as honey production, gentleness and swarming.

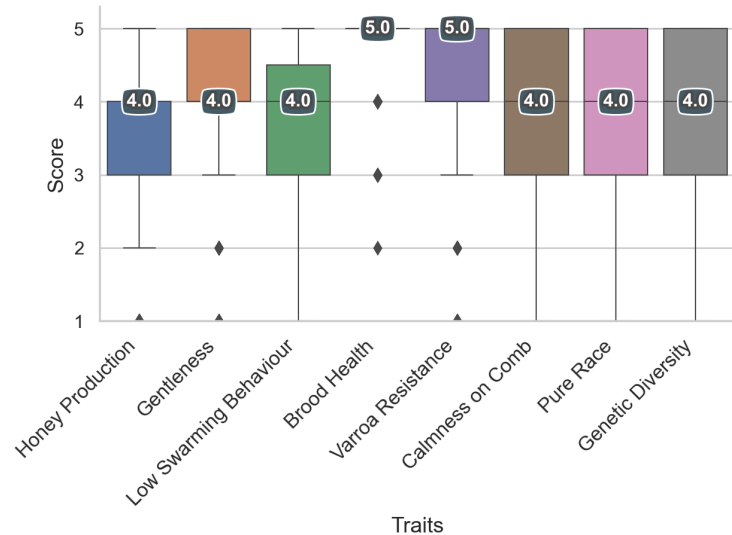
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Irish beekeeper opinion

Irish survey in 2023

- Traits of interest to Irish beekeepers
- Ranked 1 to 5; 5 = of most interest
- Varroa resistance ranked highest interest (5) along with brood health.

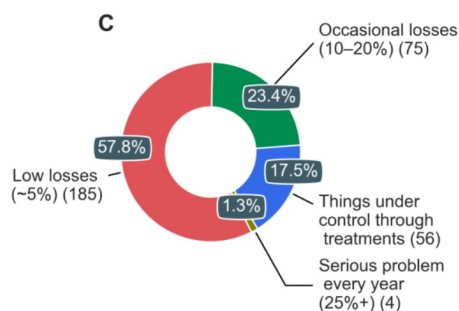


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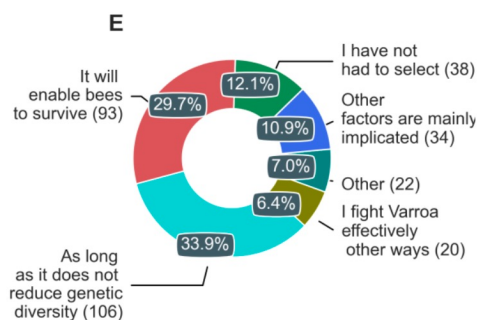


Many respondents did not have significant losses

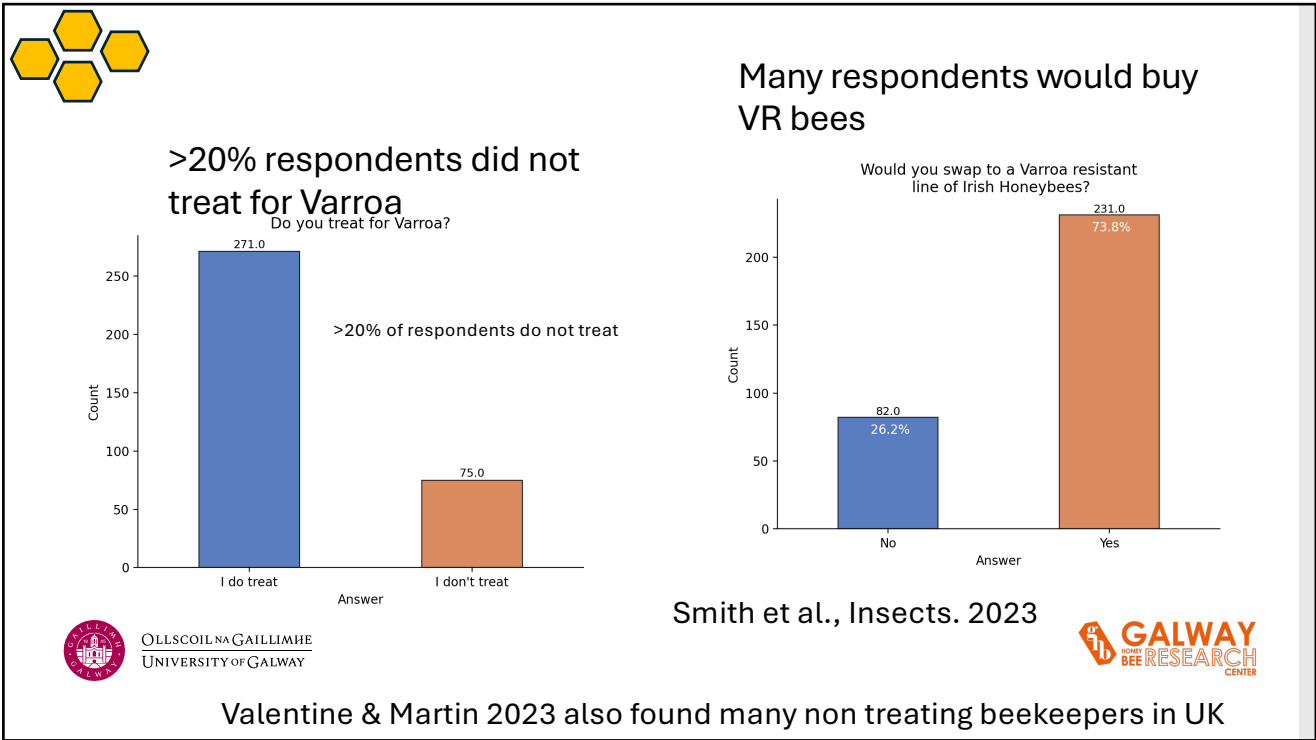


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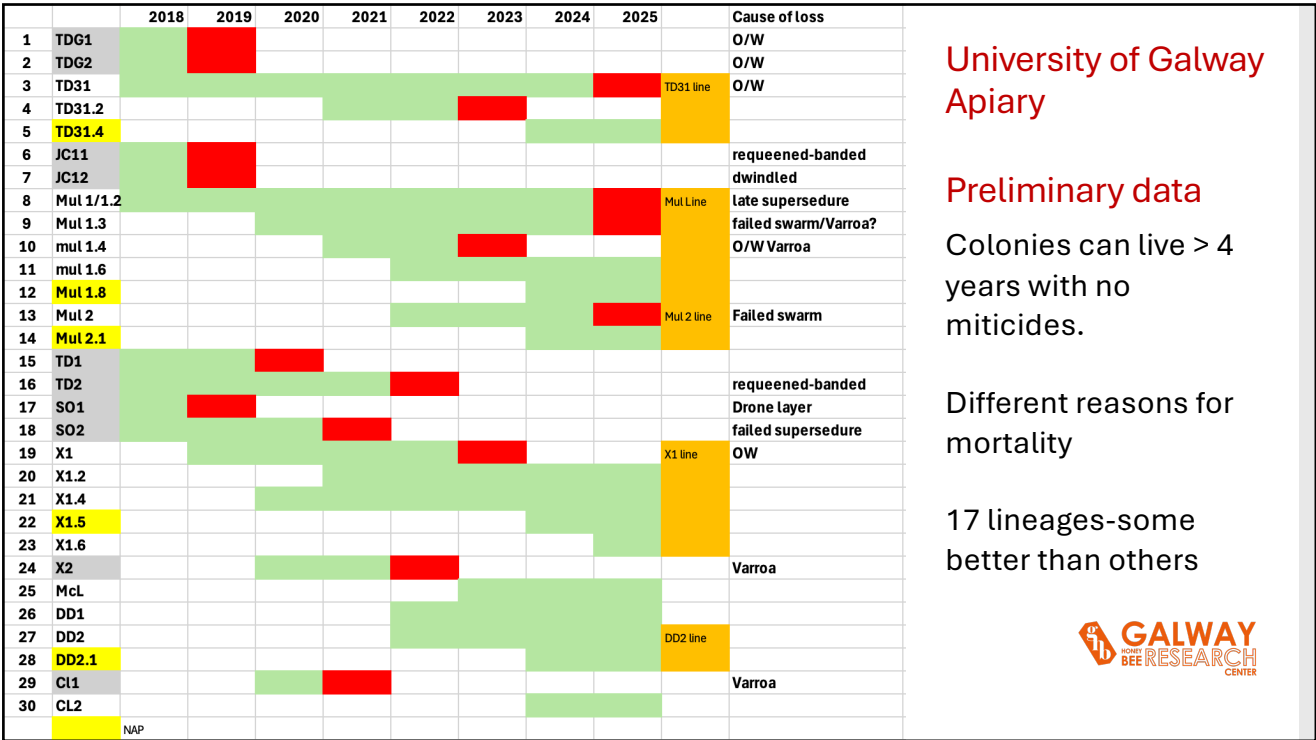
Many respondents approve of selection for VR



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Department of Agriculture, Food and the Marine

**Ireland's
National Apiculture Programme
(2023-2027)**

Open Call for Proposals

Programme Proposal Form

PROBEE:
protecting Irish
bees through field
trials and
metagenomics-
informed
strategies



An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine



Funded by the Department of Agriculture, Food and the Marine and the European Union

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- TASK 4 = PILOT STUDY
- Monitor treatment free colonies and treated colonies to assess their performance.
- Ten apiaries across Ireland with experienced beekeepers.
- Three years study to determine their viability for beekeepers.



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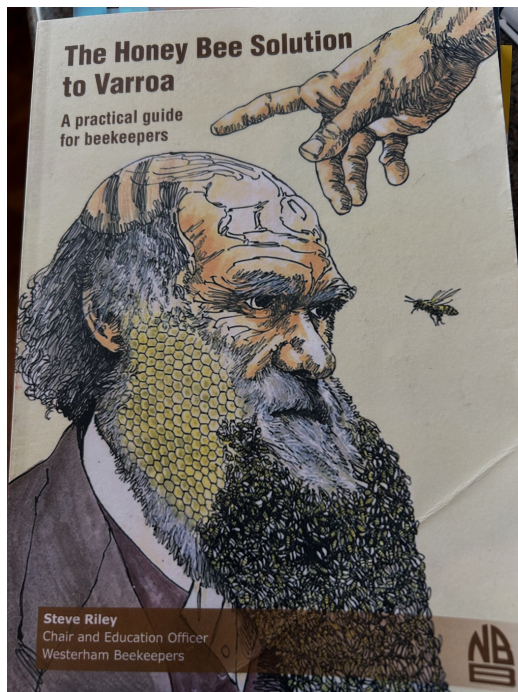


Apiary
Sites

MacGiollacoda- Louth, Neary & Mooney- Mayo, Faherty & UoG-Galway, Forskitt-Tipperary; O'Neill- Kildare and Verspuij- Donegal

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Rationale for current approach

Previous varroa resistance breeding programme unsuccessful.
Sought a method easily followed by busy beekeepers

= Westerham Beekeepers Monitoring

Three main approaches

- Mite levels
- Uncapping/recapping
- Evidence of chewed out pupae

Year 1- 2024 establish colonies with new queens from untreated stock

Year 2- 2025, first year of data

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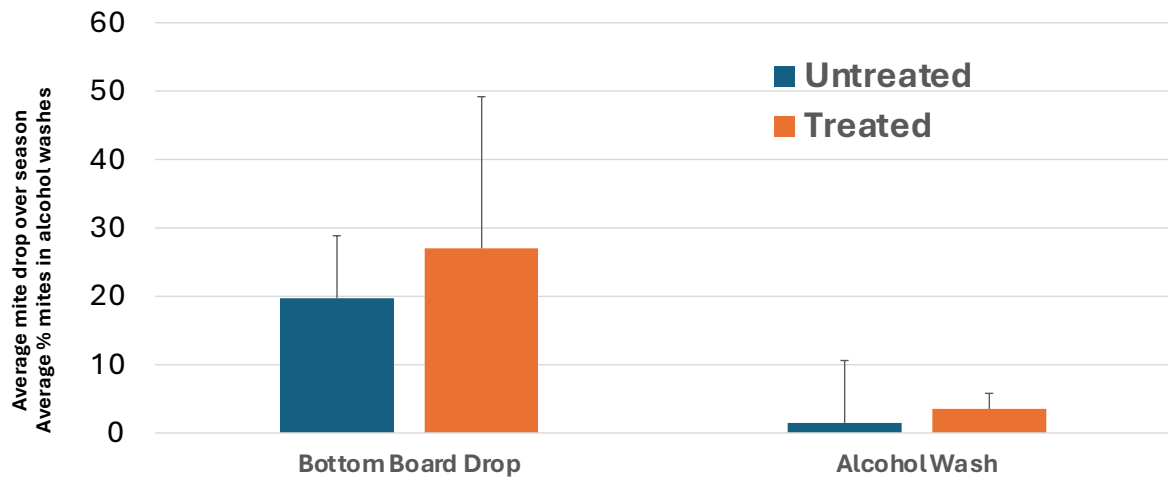
Bottom board samples 1-3days $\geq 1/\text{mo}$. Alcohol wash x2
Brood photographs, also disease sample to Bee Diagnostics lab in DAFM



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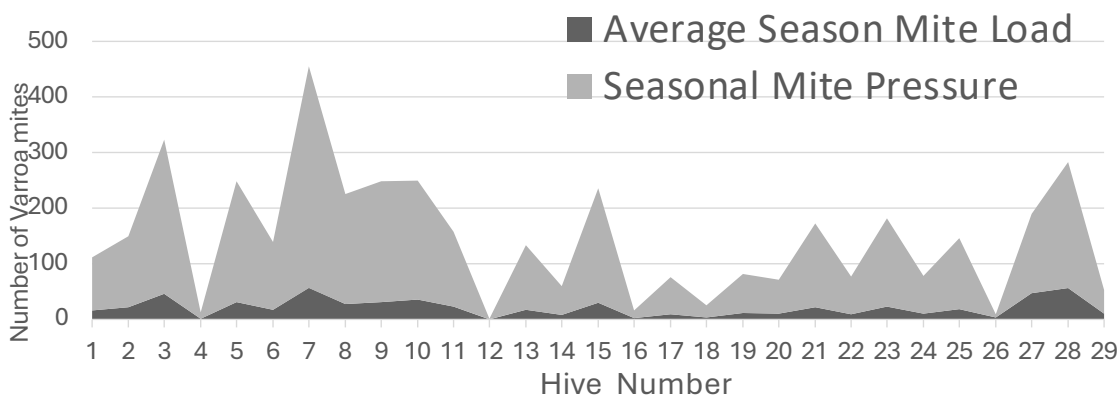
Varroa in Untreated Versus Treated Colonies



Average mite drop /day from June-December and alcohol washes (June & September) in treated (n=20) and untreated colonies n=6

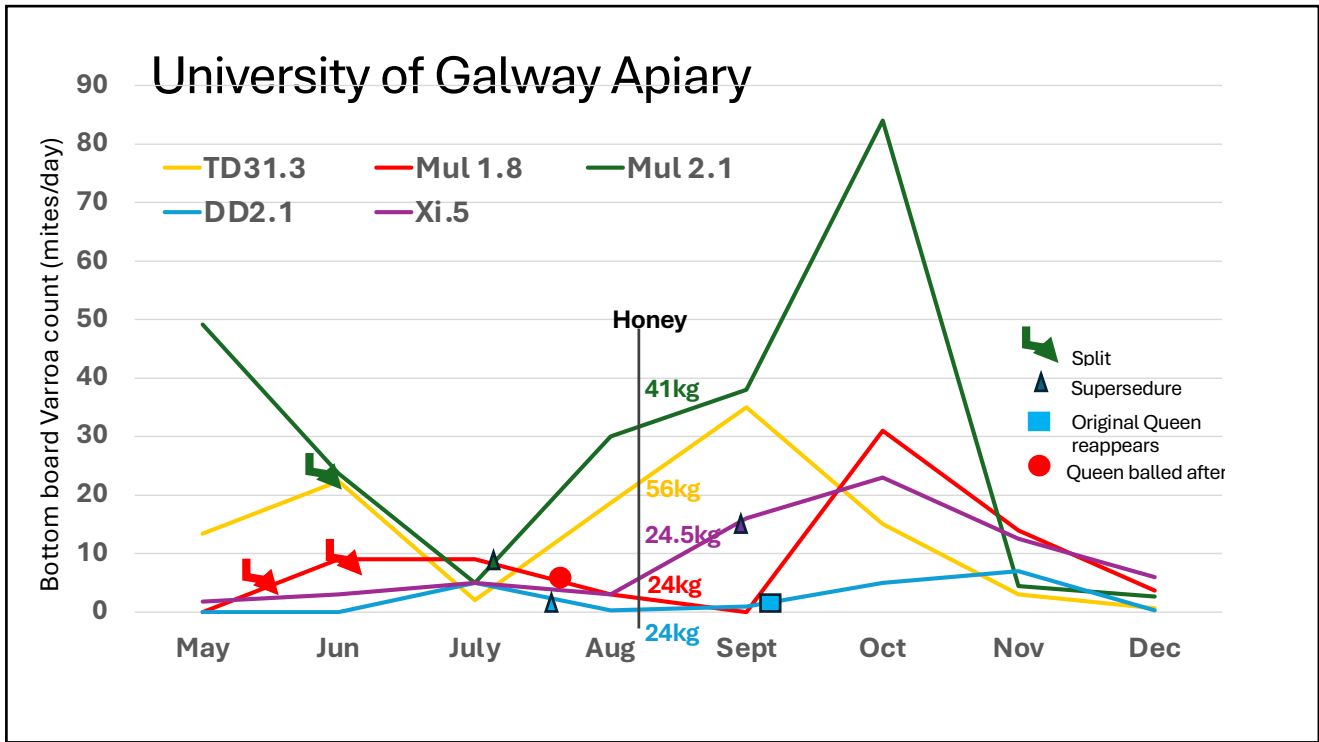
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Overview of Colony Varroa Load

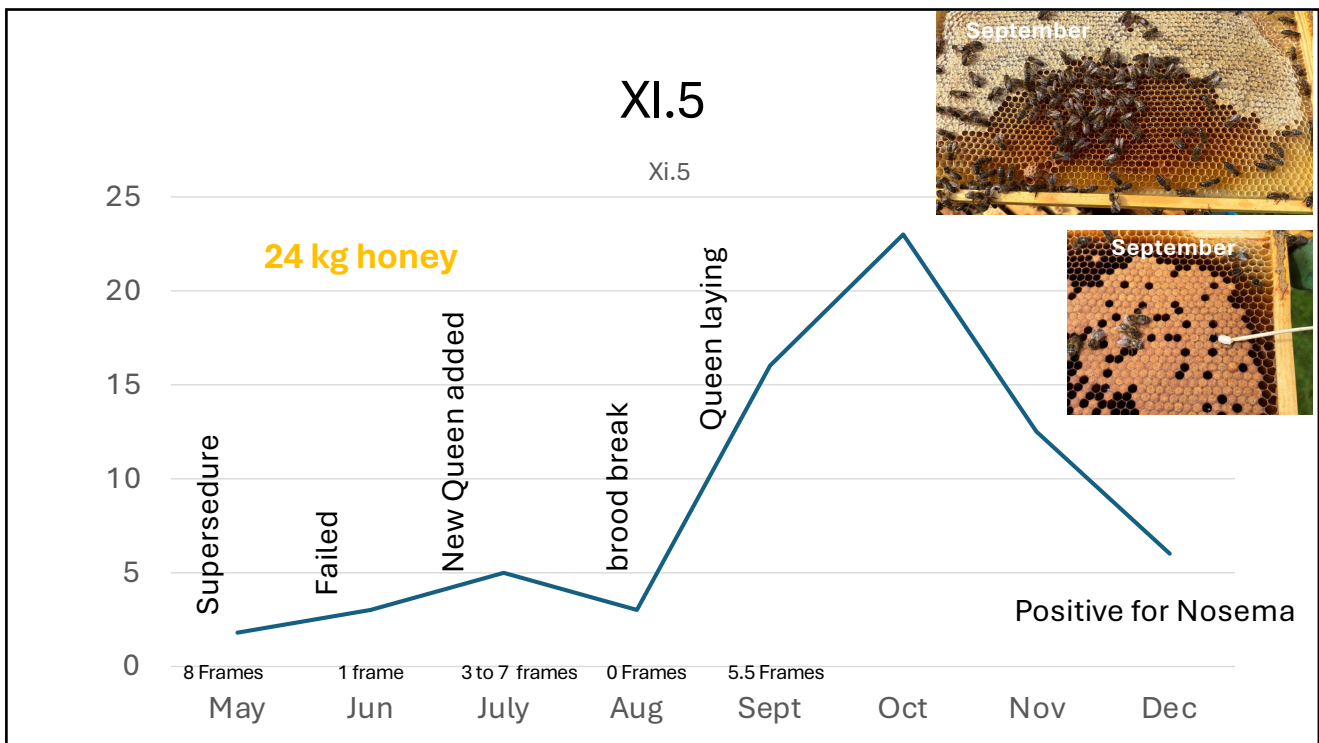


Chalkbrood present in all colonies, Nosema in some only

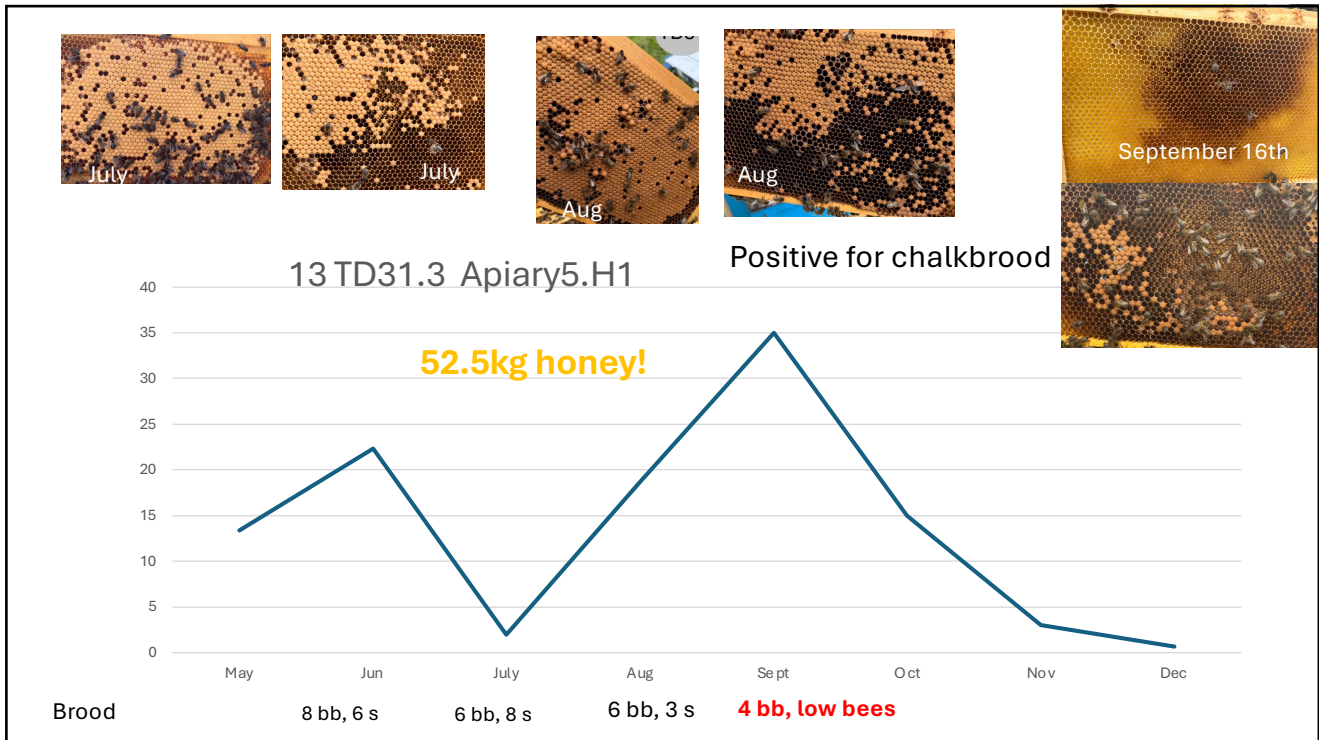
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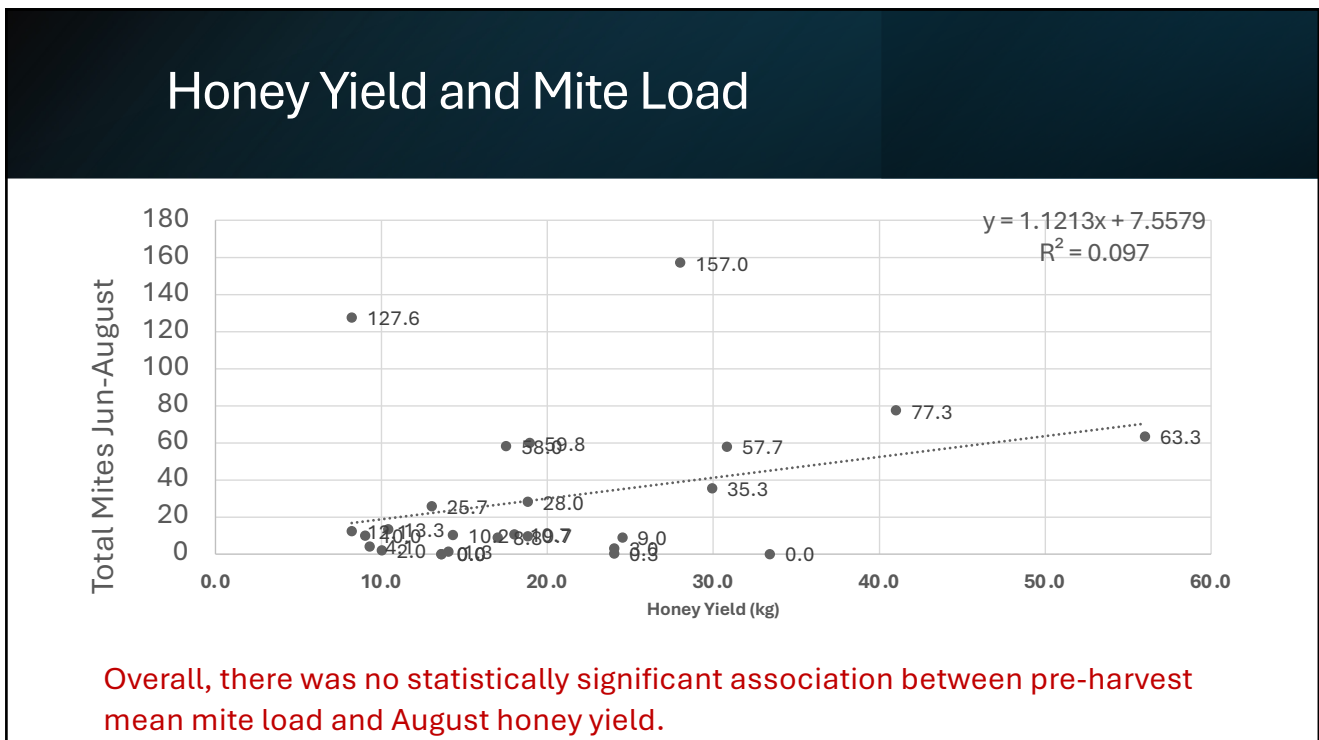
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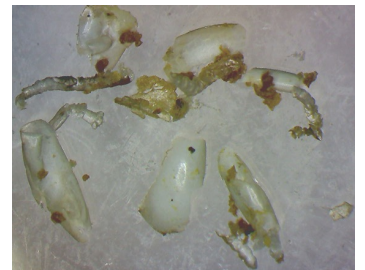
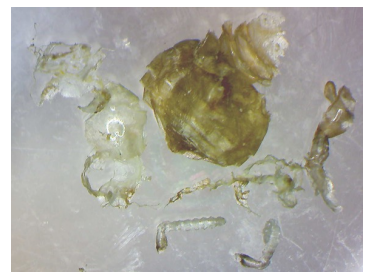
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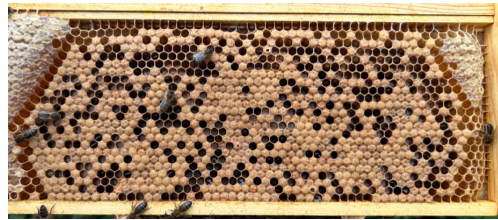
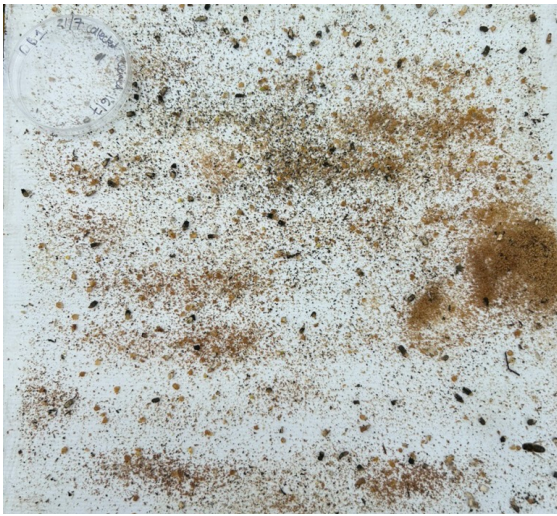
DD2.1 UNCAPPING
PURPLE STAGE
PUPAE

Positive for chalkbrood

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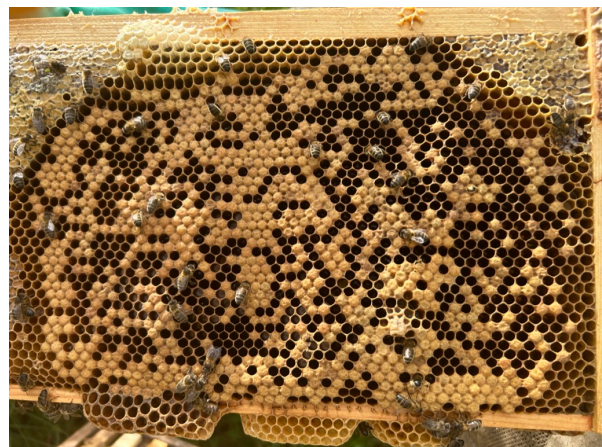
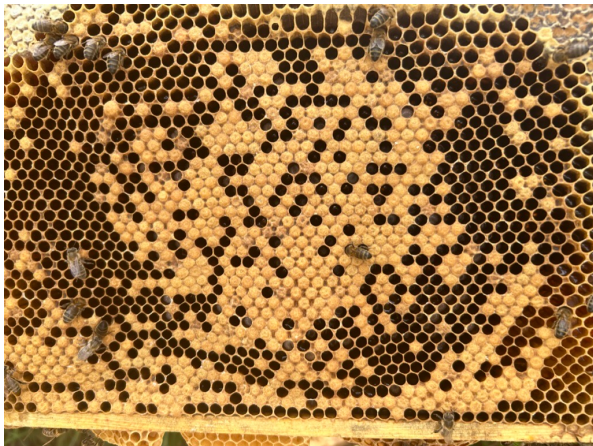
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DD1: significant chalkbrood infection
Mummies dropped on bottom boards

June 2024

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CL2: significant chalkbrood infections. No mummies on the bottom boards,
bees observed bringing mummies out the entrance

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Observations:

1. Recapping rare	2. Grooming present	3. Uncapping common	4. queen issues (low mite levels)
5. Pupal parts present but not abundant	6. molted Vs chewed out ?	7. Chalkbrood differences	8. DW rare
9. Density of hives	10 Thriving vs not	11. Other pathogens	12. Young queens- honey. Old queens- bees.

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FREE-B

Survivor stock
Pilot
Started 2025

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Should we all be trying integrated pest management?

Cameron & Ellis 2021. Varroa difficult to manage under IPM due to complexity

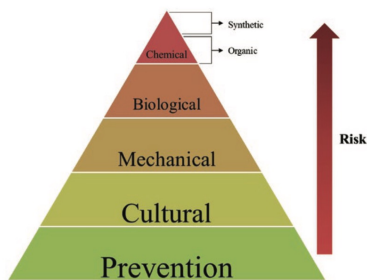
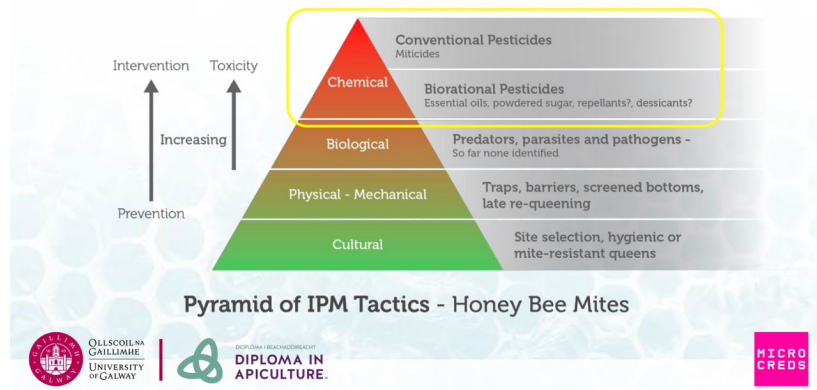


Fig. 3. IPM Treatment Pyramid. Beekeepers should employ non-chemical or low-risk control methods at the bottom of the pyramid first and move up the pyramid to chemical or high-risk methods as the situation requires.

1. Position of miticides on the Integrated Pest Management scale



Mooney, H. 2025

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Summary



Natural hygienic behaviours have evolved in *Apis mellifera* to deal with disease and parasites



Their frequency has been increased by selecting colonies that express the traits.



Colonies showing traits do not have to be treated with chemicals.



The Irish population contains cohorts that display these traits and many beekeepers that select for them.

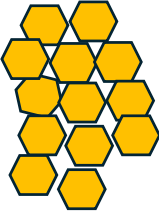


There is a fear around claiming VR -not enough beekeepers involved.

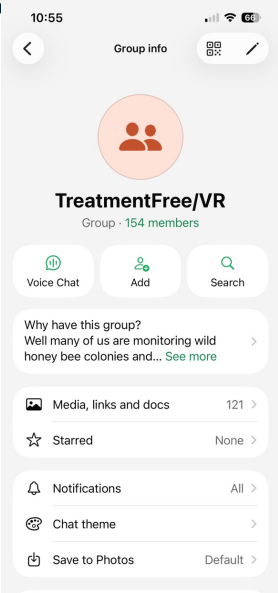


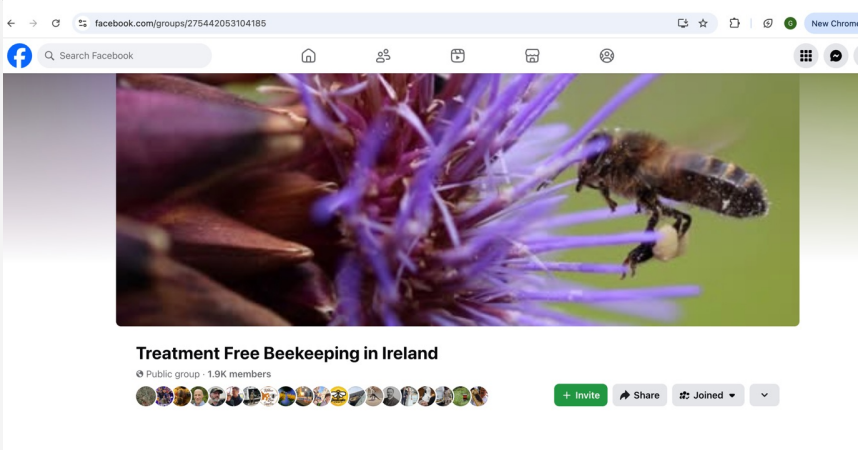
There is huge potential: needs infrastructure, coordination and cooperation

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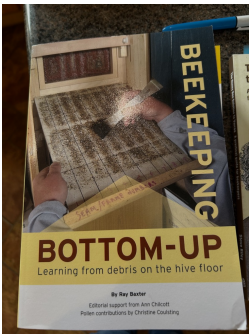

If interested.....



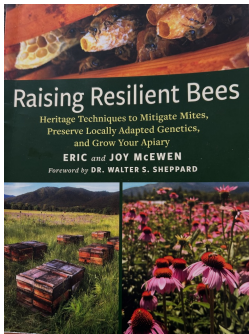


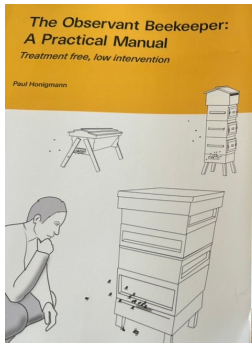
Grace.mccormack@universityofgalway.ie
 0860227227

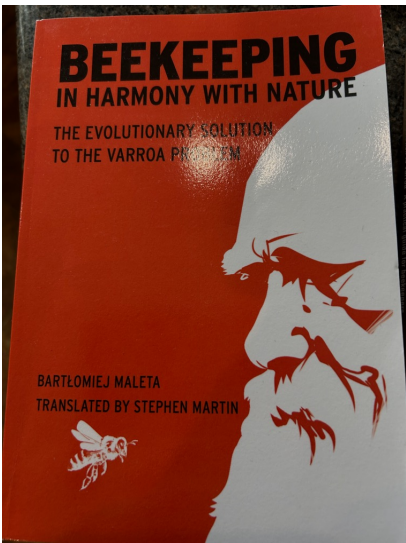
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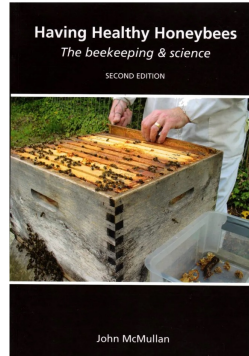


Lots of books out there to introduce and inform.









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Some references

- Spivak M, 1996. Honey bee hygienic behavior and defense against *Varroa jacobsoni*. *Apidologie* 27. 245-260
- Kulin JM et al. Seasonality and colony variation of reproducing and non-reproducing varroa females in western honey bee worker brood. *Apidologie* 20 173-180
- Le Conte Y et al 2007. Honey bee colonies that have survived *Varroa destructor* *Apidologie* 566-572
- Spivak & Reuter. 1999. www.sare.org/project-reports
- Dyrbye-Wright I, Simone-Finstrom M, Walsh EM, Spivak M (2025) Honey bees bred for Varroa sensitive hygiene trait demonstrate resistance to chalkbrood disease. *PLoS One* 20(8): e0329739. <https://doi.org/10.1371/journal.pone.0329739>
- Valentine A, Martin SJ (2023) A survey of UK beekeeper's Varroa treatment habits. *PLoS ONE* 18(2): e0281130.
- Smith S et al. 2023. *Insects*.
- Le Conte et al. 2020. *Insects*. Geographical Distribution and Selection of European Honey Bees Resistant to *Varroa destructor*.
- Mondel F et al. 2020. *Insects*. Evaluation of Suppressed Mite Reproduction (SMR) Reveals Potential for Varroa Resistance in European Honey Bees (*Apis mellifera* L.)
- Cameron & Ellis 2021. IPM for Varroa
- Locke et al 2014. Increased Tolerance and Resistance to Virus Infections: A Possible Factor in the Survival of Varroa destructor -Resistant Honey Bees (*Apis mellifera*). *PLoS ONE* 9(6): e99998.
- Grindrod & Martin. 2021. Parallel evolution of Varroa resistance in honey bees: a common mechanism across continents? *Proc. R. Soc. B* 288: 20211375.

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