Deformed wing virus (DWV) and Varroa

Is DWV the last man standing?

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With Emily Remnant, Niklas Mather, Thomas Gillard and Boris Yagound

Behaviour and Genetics of Social Insects Laboratory

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Bee Viruses

- ~24 known viruses
  – Australia has ~5
- Seasonal outbreaks, usually mild
- Normally transmitted by feeding, trophallaxis

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T. M. Fraser
H. Hellmann

Deformed wing virus
Sacbrood virus
Black queen cell virus
Deformed wing virus

DWV

- Not known to occur in Australia
- Almost always mentioned in the same sentence as ‘Varroa’
- While a generalist insect virus, named after its effect on bees

Viruses have changed

Varroa destructor

Jumped from A. cerana → A. mellifera
Impact of *Varroa*

- **Wounding**
  - Damage to the cuticle
  - Suck haemolymph (bee blood)

- **Vector for viruses**
  - Spread viruses
  - Viruses increase in mites

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**Island-hopping Varroa**

- **Hawaii, 2009:**
  - *Varroa* mite distribution limited;
  - Deformed wing virus (DWV) levels low
  - Multiple Deformed wing virus strains present

- **Hawaii, 2012:**
  - *Varroa* spread, colonies collapsing
  - Rapid increase in Deformed wing virus levels
  - Only one Deformed wing virus strain present

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*Global Honey Bee Viral Landscape Altered by a Parasitic Mite*

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Island-hopping Varroa

- New Zealand
  - North Island: 2000
  - Spread over 10 years
  - Deformed wing virus levels dramatically increased

Host- virus- vector interaction

Vectors can change virus infections

Virus needs bee to be alive to be transmitted

Virus can kill bee and still be transmitted
Host- virus- vector interaction

Vectors can change virus infections

More deadly

Wherever Varroa arrives, DWV increases

Global distribution of Varroa

© UNEP 2010 - UNEP Emerging Issues: Global Honey Bee Colony Disorder and Other Threats to Insect Pollinators
Wilfert et al. (2016) Deformed wing virus is a recent global epidemic in honeybees driven by Varroa mites. Science 351(6273), pp. 594-7
What exactly is the relationship?

Pretending to be a Varroa mite
Serial transmission experiment

Transmission Cycle 1

Transmission Cycle 2

x 20 Cycles

Measure of amount of virus present

A

Black Queencell Virus
Immediate increase

Sacbrood Virus
Increase after cycle 1

Injecting haemolymph from bee to bee increases the virus levels of two common honeybee viruses

Measure of amount of virus present

B

Relative expression (log10 normalized data)
Serial transmission experiment - DWV

Importation of frozen bees permitted under our Department of Agriculture and Water Resources import permit number 0000917783

Serial transmission experiment - DWV

Transmission Cycle 1

Transmission Cycle 2

x 30 Cycles

(2 colonies)
DWV rapidly decreases

As the others increase
Survival assay – serial transmission experiment

Survival assay

Control pupa

Day 0  Day 1  Day 2  Day 3  Day 4  Day 5  Day 6  Day 7

Developed by Thomas Gillard (then an Honours student)
Survival assay

Control pupa

Day 0 Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

Haemolymph injected pupa

Day 0 Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

Control
Buffer
‘Pure’
DWV does not have an effect on mortality. Bees are killed by BQCV and/or SBV.

But how do you explain the association between DWV and Varroa everyone is talking about?

- Well, perhaps everyone else is wrong!
- The beauty of doing experiments......
DWV may well be an innocent bystander

• With the arrival of Varroa virulent viral strains emerge

• When they kill the brood before it emerges, the mites will be killed too

Because DWV is benign, it remains present after the other viruses have disappeared. As a result, we see an association between Varroa and DWV.
DWV may well be an innocent bystander

- With the arrival of Varroa virulent viral strains emerge
- When they kill the brood before it emerges, the mites will be killed too
- This stops the spread of the viruses

DWV: the last man standing

- Once the nasties are gone, DWV can pop up
DWV: the last man standing

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- Because DWV is benign, it doesn’t kill the bees

Therefore it remains present in the colonies
DWV: the last man standing

• Once the nasties are gone, DWV can pop up
• Because DWV is benign, it doesn’t kill the bees
• Therefore it remains present in the colonies
• As a result, we see an association between \textit{Varroa} and DWV

To be continued….Emily will talk more about our work at 4:30pm today
Thank you