

# Honey bee viruses and emerging pathogens

John Mackay, Richard Hall & Hayley Pragert



**Ministry for Primary Industries**  
Manatū Ahu Matua

---



# Bee diseases - **Viruses**

- Acute Bee Paralysis Virus (ABPV)
- Israeli Associated Paralysis Virus (IAPV)
- Kashmir Bee Virus (KBV)
- Black Queen Cell Virus (BQCV)
- Chronic Bee Paralysis Virus (CBPV)
- Deformed Wing Virus (DWV)
- Sacbrood Virus
- Lake Sinai Virus group  
..... and about 15 others known

# Before Varroa

- Few surveys
- Before varroa, following species detected (1985, 1996):
  - Acute Bee Paralysis Virus
  - Kashmir Bee Virus

# After Varroa

Apidologie 38 (2007) 354–367  
© INRA/DIB-AGIB/ EDP Sciences, 2007  
DOI: 10.1051/apido:2007021

Available online at:  
[www.apidologie.org](http://www.apidologie.org)

**Original article**

## **Incidence and molecular characterization of viruses found in dying New Zealand honey bee (*Apis mellifera*) colonies infested with *Varroa destructor*\***

Jacqui H. TODD<sup>a</sup>, Joachim R. DE MIRANDA<sup>b</sup>, Brenda V. BALL<sup>c</sup>

<sup>a</sup> Horticulture and Food Research Institute of New Zealand Limited, Private Bag 92169, Auckland, New Zealand

<sup>b</sup> School of Biological Sciences, Queen's University Belfast, Belfast BT9 7BL, Northern Ireland

<sup>c</sup> Plant and Invertebrate Ecology Division, Rothamsted Research, Harpenden, Herts, AL5 2JQ, UK

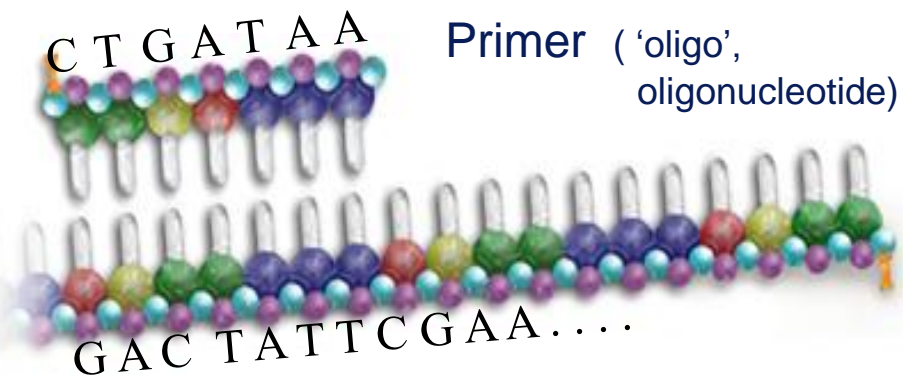
- Found      Chronic Bee Paralysis Virus  
                 Black Queen Cell Virus  
                 Kashmir Bee Virus

# After Varroa

- Deformed Wing Virus first detected in NZ in 2007
- Reported as major cause of overwintering losses



# PCR and qPCR



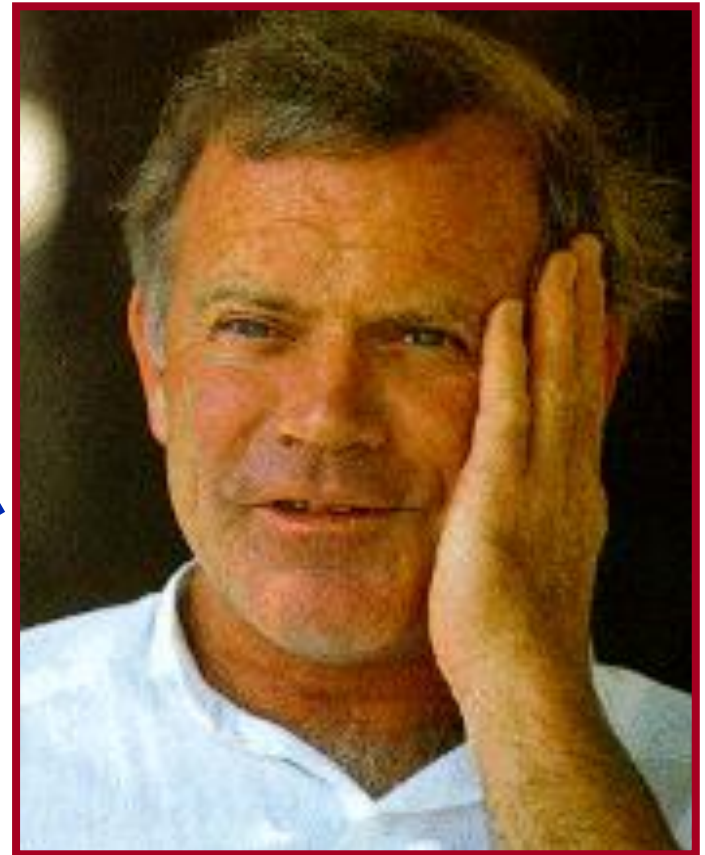
DNA template strand

DNA template strand

Primer 1

Primer 2

DNA template strand

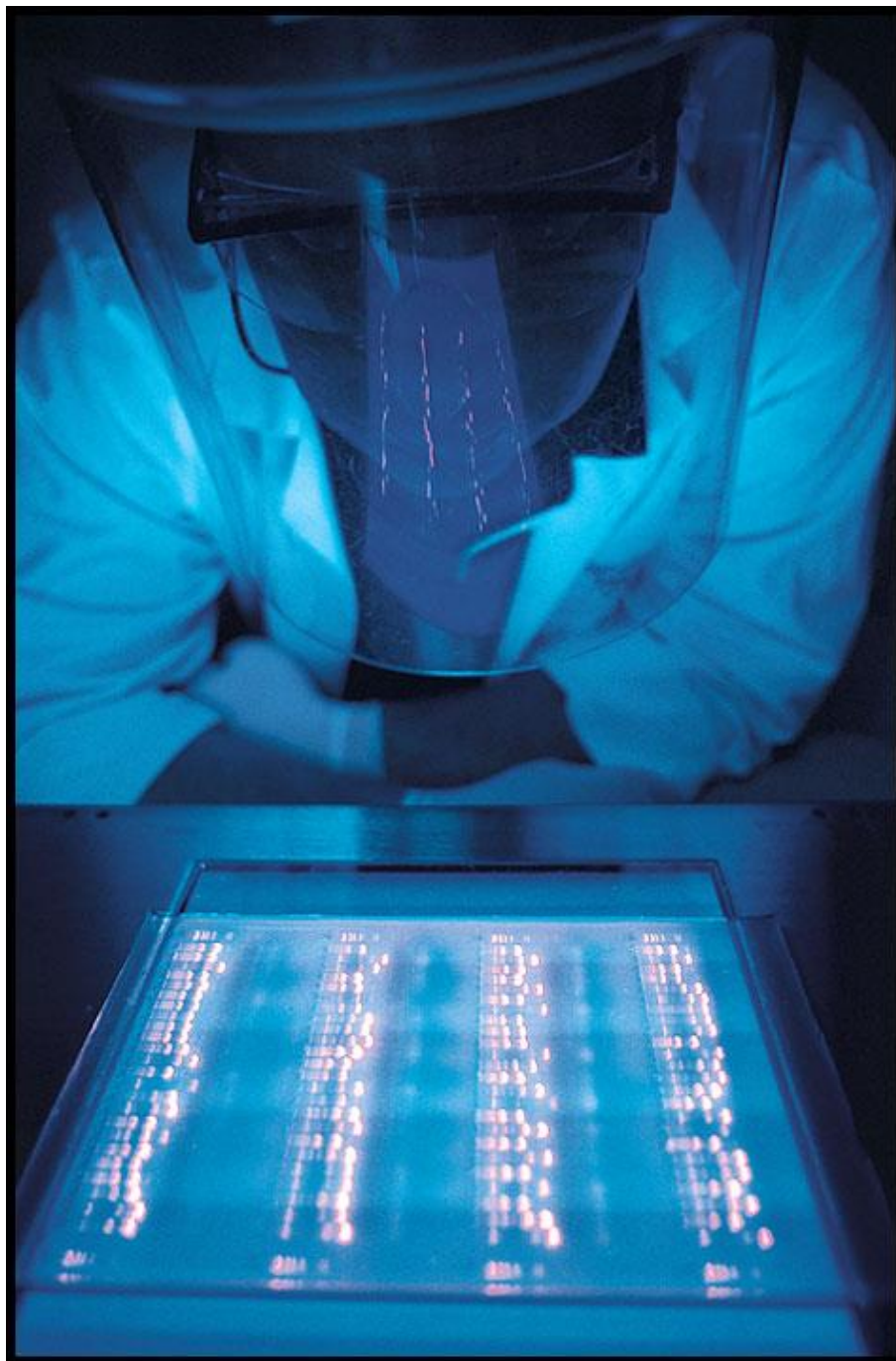


Dr Kary Mullis

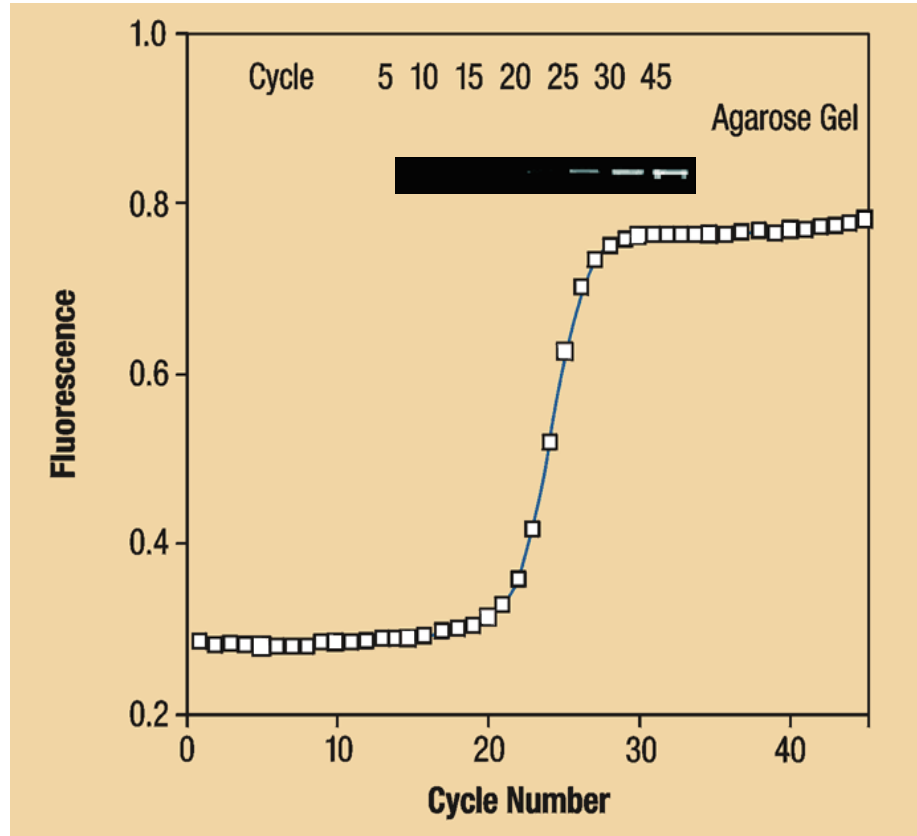




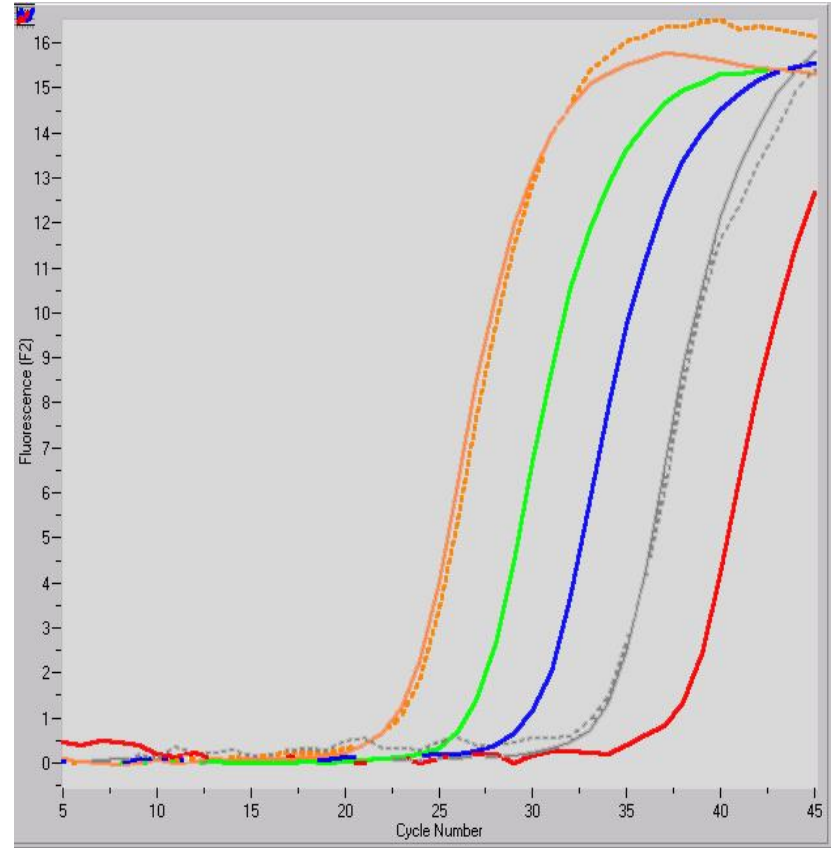




# Monitoring of PCR Reactions

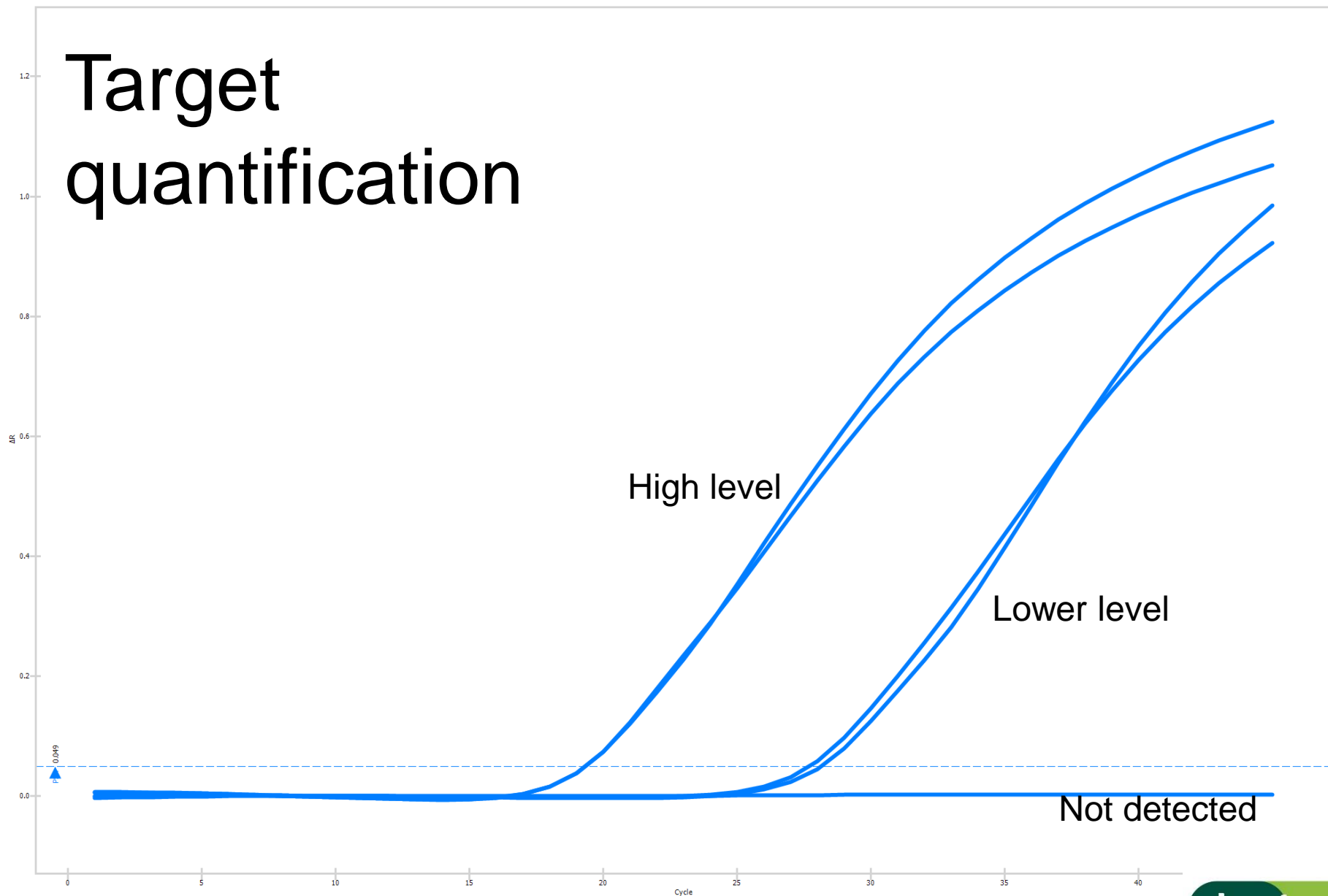


Agarose Gel Blotting



Real-time PCR

# Target quantification



# 2014

OPEN  ACCESS Freely available online

 PLOS | PATHOGENS

## On the Front Line: Quantitative Virus Dynamics in Honeybee (*Apis mellifera* L.) Colonies along a New Expansion Front of the Parasite *Varroa destructor*

Fanny Mondet<sup>1,2,3\*</sup>, Joachim R. de Miranda<sup>4</sup>, Andre Kretzschmar<sup>5</sup>, Yves Le Conte<sup>2</sup>, Alison R. Mercer<sup>1</sup>

<sup>1</sup> Department of Zoology, University of Otago, Dunedin, New Zealand, <sup>2</sup> INRA, UR 406 Abeilles et Environnement, Avignon, France, <sup>3</sup> AgroParisTech, Paris, France,

<sup>4</sup> Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden, <sup>5</sup> INRA, UR 546 Biostatistique et Processus Spatiaux, Avignon, France

# Acute Paralysis Virus / Kashmir Bee Virus / Israeli Associated Paralysis Virus\*

- Closely related genetically
- Carried into hives by varroa
- Quickly fatal when artificially injected into bees
- Needs high mite levels to majorly affect hives
- Only KBV typically seen now

\* not in NZ currently

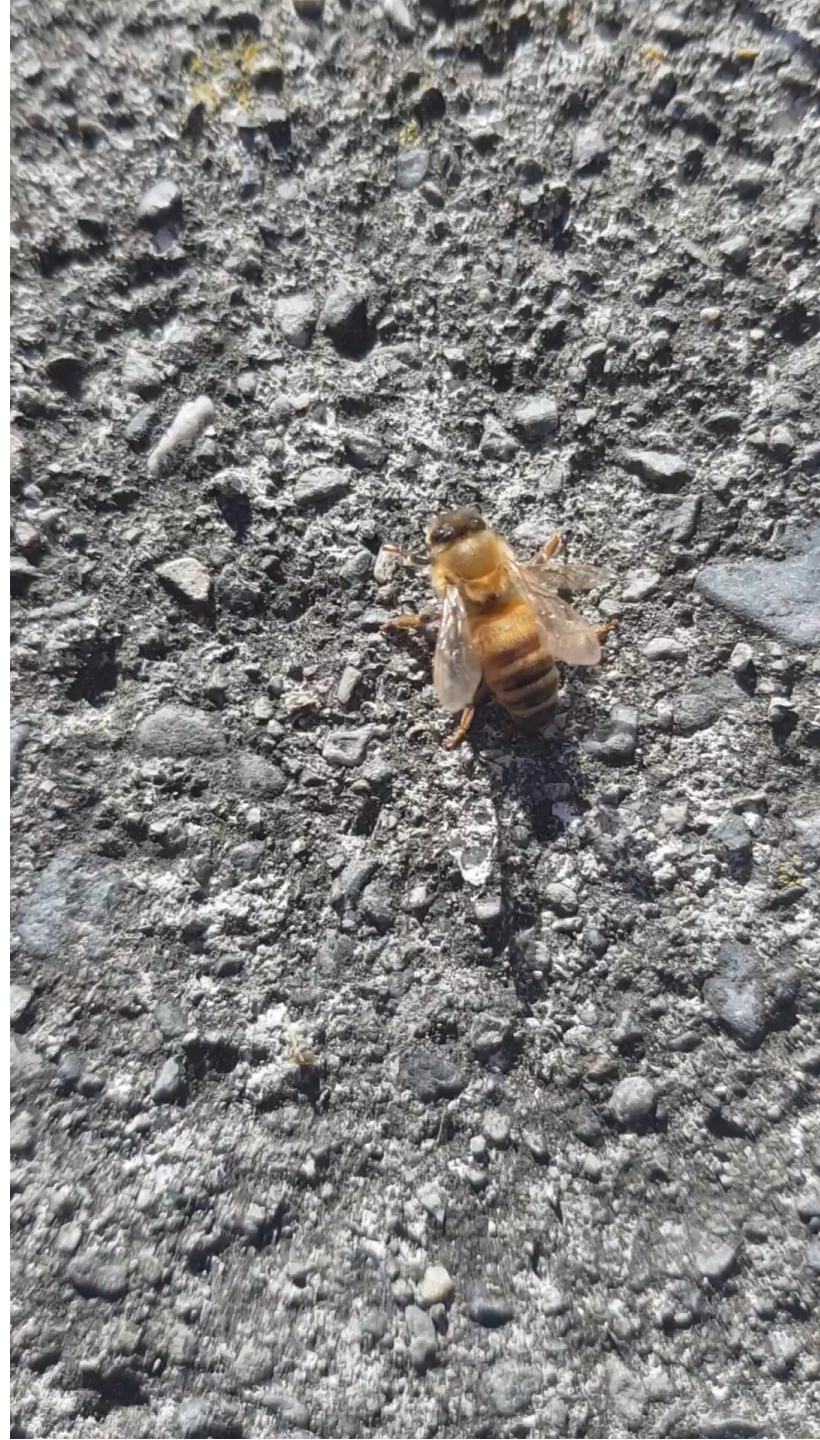
# Chronic Paralysis Virus

- Bee trembling
- Hairless (“little blacks”)
- Dead bees in front of hive
  - Can’t fly / ejected





# Chronic Paralysis Virus



# ~~Deformed Wing Virus~~

**HIVE KILLER 1**

- Closely associated with varroa
  - “control varroa / control the virus” ?
  - Virus replicates in bees after varroa gone
- Major issue with hive loss over winter
- In USA, varroa selecting for more damaging strains of DWV = very high levels of virus.
- Same in NZ?
- **Usually present without symptoms**



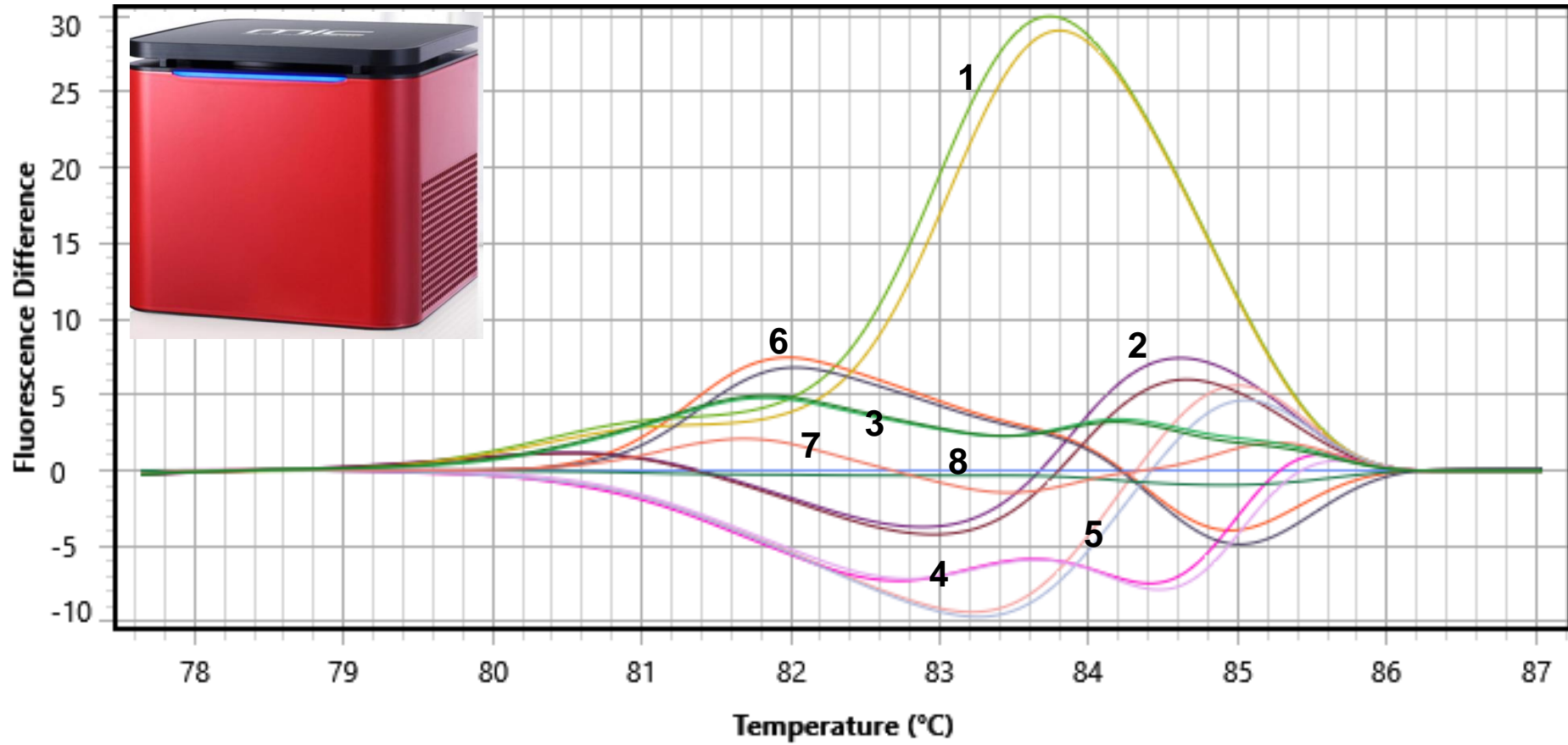
# In 2016

- Discovery of new group of viruses in NZ
  - Lake Sinai Viruses (8!)
  - Suspect 4 in NZ
  - LSV2 associated with dwindling hives
- Do we have the one strain? Or multiple?

# Lake Sinai Virus group

## High Resolution Melting Analysis

Consensus primers – 1 strain or many?



# Report

dnature #	4548/4552	4549/4553	4550/4554	4551/4555
<b>Pathogen</b> <i>N. ceranae</i> <i>N. apis</i>	High Moderate	High Very High	Low Moderate	Very High Very High
<b>Viruses</b> DWV Tri-Panel CBPV BQCV	Very High Moderate N Moderate	Moderate Low N Moderate	N Very Low N Low	Low N N Very High

Questions? Feedback? Email: [support@dnature.co.nz](mailto:support@dnature.co.nz)

0800 DNATURE (0800 362 887)



# New Viruses

- Bee Macula-like Virus (2015)
  - Bees and varroa
  - Tymovirus (typically infect plants)
- Moku Virus (2016)
  - New assays developed (dnature)
  - Not detected in NZ bees/varroa to date
- NZ Bee Pathogen Program (Dr Richard Hall / Hayley Pragert)



# *Nosema apis* / *Nosema ceranae*

- ***Nosema apis*** around >100 years
- Bee dysentery on outside of hive
- A bit of poo – big deal?
- **Reduced life-span of bees**
- **Overwintering losses**
- **May also vector Black Queen Cell Virus**



# *Nosema apis* / *Nosema ceranae*

- ***Nosema ceranae*** discovered in honeybees in 2005
- Discovered in NZ in 2010
- No dysentery observed
- Associated with colony collapse disorder ??
- Lower brood rearing, reduced colony size and no honey !
- Hive dwindling

# Nosema apis / Nosema ceranae

Journal of Invertebrate Pathology 125 (2015) 9–15



Contents lists available at ScienceDirect

Journal of Invertebrate Pathology

journal homepage: [www.elsevier.com/locate/jip](http://www.elsevier.com/locate/jip)



## Comparative virulence and competition between *Nosema apis* and *Nosema ceranae* in honey bees (*Apis mellifera*)



Meghan O. Milbrath<sup>a,1</sup>, Toan van Tran<sup>a,b,1</sup>, Wei-Fong Huang<sup>c</sup>, Leellen F. Solter<sup>c</sup>, David R. Tarpy<sup>d</sup>, Frank Lawrence<sup>e</sup>, Zachary Y. Huang<sup>a,\*</sup>

<sup>a</sup>Department of Entomology, Natural Science Building, 288 Farm Lane Room 243, Michigan State University, East Lansing, MI 48824, USA

<sup>b</sup>Bee Research and Development Center, N° 19 Truc Khe, Lang Ha, Dong Da, Ha Noi, Viet Nam

<sup>c</sup>Illinois Natural History Survey, Prairie Research Institute at the University of Illinois at Urbana-Champaign, 1816 S. Oak St, Champaign, IL 61820, USA

<sup>d</sup>Department of Entomology, North Carolina State University, Raleigh, NC 27695-7613, USA

<sup>e</sup>Center for Statistical Training and Consulting, 178 Giltner Hall, Michigan State University, East Lansing, MI, USA

### ARTICLE INFO

### ABSTRACT

*N. ceranae* to become dominant in most geographical areas. We demonstrated that mixed *Nosema* species infections negatively affected honey bee survival (median survival = 15–17 days) more than single species infections (median survival = 21 days and 20 days for *N. apis* and *N. ceranae*, respectively), with median survival of control bees of 27 days. We found similar rates of infection (percentage of bees with active

honey bee, *Apis mellifera*

*Nosema apis*

*Nosema ceranae*

Disease transmission, infectivity

ian survival of control bees of 27 days. We found similar rates of infection (percentage of bees with active infections after inoculation) for both species in mixed infections, with *N. apis* having a slightly higher rate (91% compared to 86% for *N. ceranae*). We observed slightly higher spore counts in bees infected with *N. ceranae* than in bees infected with *N. apis* in single monoxenidia infections, especially at the midpoint of