The 3rd N.Z. Honey Bee Research Symposium

June 29th 2022, Christchurch Convention Centre

Programme

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA
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Plant & Food Research Rangahau Ahumāra Kai
Ministry for Primary Industries Manatū Ahu Matua

Schedule

Session 1:Honey & Bee Products *Moderator: Phil Lester, Victoria University*

8:45	Welcome & Introduction of industry insights	Phil Lester *Victoria University*
8:55	*TBA*	Karin Kos, *CEO* *Apiculture NZ*
9:00	Discrimination of pollen of New Zealand mānuka and kānuka	Xun Li *GNS Science*
9:15	Bacteria on the mānuka (*Leptospermum scoparium*) leaf surface: a potential driving factor of mānuka honey quality?	Anya S. Noble* *University of Waikato*
9:30	Pollen analysis for New Zealand beekeepers	Linda Newstrom-Lloyd *NZ Trees for Bees Research Trust*
9:45	An investigation of low diastase activity in mānuka honey	Amber Bell* *University of Waikato*
10:00	Challenges and progress in honeybee pollination research	Madeleine Post *AbacusBio*

10:15-10:30 Break (15 minutes)

Session 2: *Moderator: Evan Brenton-Rule, Ministry for Primary Industries*

10:30	Division clusters: evidence for an unexpected mode of oogenesis in *Apis mellifera*	Georgia Cullen* *University of Otago*
10:45	Trees for Bees – developing practical tools to enable research uptake	Angus McPherson *NZ Trees for Bees Research Trust*
11:00	Water, water everywhere, but not a herbicide-free drop to drink: do the bees care?	Tessa Hiscox* *University of Canterbury*
11:15	Two new classical biological control agents of invasive Vespula wasps coming soon	Bob Brown *Manaaki Whenua*
11:30	Gene regulatory networks in the early honey bee embryo.	Erin Delargy* *University of Otago*
11:45	Land cover and pesticide use: how they affect abundance of ground-nesting bees across a range of horticultural intensities	Felicia Kueh Tai* *Plant and Food Research*
12:00	Apiculture training in NZ: now and in the future	David Woodward *Otago Polytechnic*

12:15-1:00 Lunch (45 minutes)

Session 3:Bee Health *Moderator: Anya Noble, Plant and Food Research*

1:00	*TBA*	Marco Gonzalez *AFB Management Agency'*
1:15	Viral communities in the parasite *Varroa destructor* and in colonies of their honey bee host (*Apis mellifera*) in New Zealand	Antoine Felden *Victoria University*
1:30	The role of drone honey bees in varroa mite dispersal	Erin Steed* *Plant and Food Research*
1:45	From soil to solution: isolating bacteriophages from the environment to combat AFB	Danielle Kok* *Massey University*
2:00	Genomic analysis of American foulbrood in New Zealand	Richard Hall *Ministry for Primary Industries*
2:15	The use of RNAi as a novel control method for the honey bee parasite *Varroa destructor*	Rose McGruddy* *Victoria University*
2:30	Using double-stranded RNA to control deformed wing virus in honey bees and *Varroa destructor* mites	Zoe E. Smeele* *Victoria University*
2:45	An investigation into varroa resistant New Zealand honey bees	Tessa Pilkington* *Victoria University*

3:00-3:20 Break (20 minutes)

Session 4: Management *Moderator: John Mackay, dnature*

3:20	Physiological indicators of stress in western honey bees	Revati Vispute* *Plant and Food Research*
3:35	Breeding a better bee in New Zealand	Damien Fèvre* *University of Otago*
3:50	Practical applications for data streams from remote hive monitoring systems	Gertje Petersen *AbacusBio*
4:05	Breeding for Varroa resistance and the attributes of the Mite Monitor App	Rae Butler *Bee Smart Breeding*
4:20	Parental meiotic contribution in honey bees	Astra Heywood *University of Otago*
4:35	*Industry insights, facilitated by John Mackay*	All attendees
4:55	Student Awards & Closing	Evan Brenton-Rule *Ministry for Primary Industries*

Abstracts

Session 1: Honey & Bee Products

Discrimination of pollen of New Zealand mānuka and kānuka

Xun Li[1], Joe Prebble[1], Peter de Lange[2], Ian Raine[1], Linda Newstrom-Lloyd[3]
1: GNS Science, PO Box 30368, Lower Hutt
2: School of Environmental & Animal Sciences, Unitec Institute of Technology, Private Bag 92025, Victoria Street West, Auckland
3: The New Zealand Trees for Bees Research Trust, PO Box 28104, Havelock North

Pollen of mānuka (*Leptospermum scoparium* agg.) and kānuka (10 *Kunzea* spp.) are similar and have previously been combined in melissopalynological analyses. We examined pollen of plants collected throughout New Zealand, using light microscopy, SEM, and the Classifynder automated microscope system. We found that, at a generic level, mānuka and kānuka pollen can be readily differentiated on size, shape, and surface texture. Differences at subgeneric level are more subdued. Software to differentiate pollen using images captured by Classifynder had a prediction accuracy of ~95%. This study is a step towards future melissopalynological differentiation of honeys using automated pollen image capture and classification.

Bacteria on the mānuka (*Leptospermum scoparium*) leaf surface: a potential driving factor of mānuka honey quality?

Anya S. Noble, Michael J. Clearwater, Megan Grainger, Charles K. Lee
School of Science, University of Waikato, Hamilton, New Zealand

A growing body of evidence demonstrates the importance of leaf-associated microorganisms on plant physiology. However, little is known about microorganisms that associate with New Zealand's unique honey sources, such as mānuka. The first study of the mānuka leaf surface microbiome revealed a unique group of bacteria persisting across geographically distinct populations. This finding suggests mānuka recruits specific microorganisms that are functionally significant for the host. We now investigate the specificity of these microorganisms by comparing the mānuka leaf surface microbiome with other species, such as kānuka. We anticipate these results will permit the identification of mānuka-specific microorganisms and provide a foundation for future studies to investigate the relationship between these microorganisms and commercially desirable physiological traits, such as nectar DHA.

Pollen analysis for New Zealand beekeepers

Ian Raine[1], Xun Li[1], Linda Newstrom-Lloyd[2]
1: GNS Science, PO Box 30368, Lower Hutt
2: The New Zealand Trees for Bees Research Trust, PO Box 28104, Havelock North

To encourage beekeepers and others to take up pollen analysis, we published a manual demonstrating how to sample, prepare, and identify pollen. We describe laboratory preparation of pollen from bee loads, hive pollen traps, bee bread, and honey, including an introduction to microscopic study. We link this to the online NZ Pollen Catalogue with an identification key to pollen of over 120 nectar and pollen source plants. At the level of a local area, usually only a small number of different plant species are used by bees. These will comprise the bulk of pollen encountered, so the analyses are simplified.

An investigation of low diastase activity in mānuka honey

Amber Bell[1], Dr. Megan Grainger[1], Sunil Pinnamaneni[2]
1: The University of Waikato
2: The Experiment Company

Diastase enzyme activity is used as an indicator of poor storage or excessive heat treatment for honey export to some countries. Despite careful treatment, mānuka honey with high methylglyoxal content often fails the diastase assay, decreasing export volume. We hypothesised notable compounds in mānuka honey (methylglyoxal, mānuka marker compounds) were inhibiting diastase. Clover honey spiked with compounds of interest and fresh honeys (44 mānuka, 23 non-mānuka) were stored (20-34°C) and analysed periodically to determine correlations to diastase activity over time (198 days). Diastase activity was predominantly influenced by time and temperature, however the presence of some compounds accelerated activity loss.

Challenges and progress in honey bee pollination research

Madeleine Post[1], Gertje Petersen[1], Cherokee Walters[1], Peter Dearden[2], Steve Wooten[3]
1: AbacusBio
2: University of Otago department of Biochemistry
3:Taylor Pass Honey co.

Bees provide vital pollination in the horticultural sector but there are large gaps in our understanding of the factors contributing to pollination success. AbacusBio has partnered with Taylor Pass Honey and cherry growers in Central Otago to investigate honeybee activity and pollination using advanced monitoring tools and observational data. The objective is to improve understanding of the relationships between pollination, bee activity, orchard conditions and fruit yields, and to improve pollination through hive and orchard management. The presentation will discuss progress made in developing standardized methodology along with the challenges and the anticipated outcomes.

Session 2

Division clusters: Evidence for an unexpected mode of oogenesis in *Apis mellifera*

Georgia Cullen[1], Josh Gilligan[2], Peter K. Dearden[1]
1: Genetics Department, University of Otago
2: Biochemistry Department, University of Otago

The Western honeybee is worth billions of dollars worldwide annually, from contributions to crop yield and growth, and bee products. A single hive can increase crop yields to over 1000kg/ha per year, per each added hive/ha. Despite *Apis mellifera*'s importance to agriculture and pollination, knowledge of their oogenesis is deficit. Using in situ Hybridisation-Chain-Reaction, immunohistochemistry, and EdU injection experiments, we identify two germline cell markers (Vasa, Nanos), two novel somatic cell markers (Castor, MAD6), and have found no evidence of individual germline stem cells in the origin of oogenesis. This is in direct contrast to the best studied model insect – Drosophila melanogaster. We hypothesize that they are found earlier in development, and are specified germ cell clusters by adulthood. Our findings support research on reproduction and supporting declining honeybee populations, and highlight a potentially novel reproductive system among insects. Improving our ability to understand reproduction will allow for better management of managed honeybees.

Trees for Bees – developing practical tools to enable research uptake

Angus McPherson

The New Zealand Trees for Bees Research Trust

Trees for Bees NZ is developing a range of practical tools to assist beekeepers and landowners to plant superior bee forage. These online tools include pollen analyses, flowering calendars, and bee forage plantation designs. The tools are intended to provide practical resources to make incorporating bee forage on farms simple, realistic, and sustainable in the long term. These tools are underpinned by extensive field and laboratory research and demonstrations to identify and validate the best bee forage. We show how end-user engagement was conceived, developed, and implemented to ensure maximum research uptake by the end-users the research was designed for.

Water, water everywhere, but not a herbicide-free drop to drink: do the bees care?

Tessa Hiscox, Brigitta Kurenbach and Jack A Heinemann

School of Biological Sciences, University of Canterbury

Antimicrobials found naturally in plant nectar or made by bees or their microbiota help protect bees from disease. We are testing whether agrichemicals such as herbicides undermine this protection. Herbicides are used at scale in Aotearoa and residues in honey confirm bee exposure. We report measurements of the effects on icon bee gut bacteria following exposure to antimicrobials and herbicides alone and in combination. Furthermore, we are measuring bee drinking preferences. Do bees selectively forage for or away from herbicides?

Two new classical biological control agents of invasive Vespula wasps coming soon

Bob Brown

Manaaki Whenua Landcare Research

Two biological control agents of Vespula wasps, *Volucella inanis* and *Metoecus paradoxus*, have recently been approved for release by EPA. My talk will describe the journey through searching for potential new biological control agents in the native range, how we narrowed down the list of agents and finally how we plan to go about releasing the selected agents in New Zealand.

Gene regulatory networks in the early honey bee embryo.

Erin Delargy

University of Otago

Honeybees are one of the world's most important pollinator species and are on the decline. investigation into the reproduction, evolution and development of the honeybee is becoming more vital as a way to support this important species. An as yet not fully understood part of honeybee development is early embryo segmentation; we know lots about Drosophila and are starting to understand more about Nasonia but for such an ecologically important creature we know little about honeybee development. My research aims to glean some insights that we may be able to leverage to our advantage for honeybee management in the future.

Land cover and pesticide use: how they affect abundance of ground-nesting bees across a range of horticultural intensities

Felicia Kueh Tai(1,2), Jacqueline Beggs (2), Ashley N Mortensen(1), David E Pattemore(1,2)*
1.Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited
2.School of Biological Sciences, University of Auckland, New Zealand

Among the major drivers of wild bee decline is agriculture expansion and intensification, which is often associated with increased pesticide input and loss of natural and semi-natural habitats. We collected ground-nesting bees, using pan traps, from eight avocado orchards in the Bay of Plenty, NZ, across a gradient of intensities. We then tested the relationship of pesticide use, natural habitat, and other landscape factors on their abundance. Total bee abundance was negatively associated with pesticide use, habitat slope and soil hardness. The abundance of different bee species was influenced differently by the proportion of the natural habitat around orchards.

Apiculture training in NZ: now and in the future

David Woodward
Otago Polytechnic

Apiculture qualifications are available at Level 2 to 4 on the NZQA framework and are currently delivered throughout NZ by the polytechnic and industry sector. There are also postgraduate qualifications available for research students, however an educational gap lies at the diploma (5-6) and degree (7) level. Information will be presented on the current qualifications and what future qualifications might look like

Session 3: Bee Health

Viral communities in the parasite *Varroa destructor* and in colonies of their honey bee host (*Apis mellifera*) in New Zealand

Antoine Felden, Phillip J. Lester, James W. Baty, Mariana Bulgarella, John Haywood, Ashley N. Mortensen, Emily J. Remnant, Zoe E. Smeele
School of Biological Sciences, Te Herenga Waka-Victoria University of Wellington

Varroa destructor is a leading cause of mortality for Western honey bee colonies around the globe. We sought to describe the viral community within both Varroa and the bees that they parasitise. The most prevalent and abundant virus in bees was the Deformed wing virus A (DWV-A) strain. In Varroa, $>99.9\%$ of viral reads from DWV-A and *Varroa desctructor* virus 2 (VDV-2). Interestingly, where high levels of VDV-2 occurred in mites, reduced DWV-A occurred in both mites and bees within the same hive. Where there were high loads of DWV-A in mites, there were typically high viral loads in bees.

The role of drone honey bees in varroa mite dispersal

Erin Steed[1,2], Chrissie Painting[2], James P Sainsbury[1], Ashley N Moretensen[1]
1: Bee Biology & Productivity Team, The New Zealand Institute for Plant and Food Research Limited
2: Te Aka Mātuatua School of Science, University of Waikato, Hamilton, New Zealand

Honey bee mating sites, known as drone congregation areas (DCAs), are areas where drones from colonies in the surrounding area gather in large numbers to mate with queen honey bees. Preliminary work has demonstrated a potential correlation between the prevalence of *Varroa destructor* on drones at DCAs and the *V. destructor* infestation rates of nearby managed colonies. We have also investigated by looking at varroa preference for different castes of honey bee, and by collecting more data from DCA's and apiaries in the Waikato over summer. This presentation will detail the current findings, and their implications for varroa dispersal.

From soil to solution: isolating bacteriophages from the environment to combat AFB

Danielle Kok[1], Heather Hendrickson[1,2]
1: School of Natural Sciences, Massey University, Albany, NZ.
2: School of Biological Sciences, University of Canterbury, Christchurch, NZ.

American Foulbrood (AFB) is a disease of honeybee larvae caused by the bacterial pathogen *Paenibacillus larvae*. Using antibiotics in hives infected with P. larvae is prohibited under NZ law. The ABAtE project aims to discover and develop bacteriophages as a preventative measure against AFB. I will present recent progress in sequencing and annotating 26 novel *Paenibacillus* bacteriophages from NZ. I have also assembled and tested a set of effective bacteriophage cocktails. I will discuss the results of testing cocktails in-vitro and in honeybee larvae. This project provides the groundwork for an innovative approach to naturally protecting NZ beehives against AFB.

Genomic analysis of American foulbrood in New Zealand

Richard Hall[1], Barbara Binney[1], Jonathan Foxwell[1], Edna Gias[1], Meredith Birrell[1], Luciano Rigano[3], Oliver Quinn[1], Michael Taylor[2], Hye Jeong Ha[1], Ben Phiri[2] & Hayley Pragert[2]
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3: Plant Health & Environment Laboratory, Biosecurity New Zealand, Ministry for Primary Industries, 231 Morrin Road, St Johns, Auckland 1072, New Zealand

We sought to determine the genomic variation of *Paenibacillus larvae* (American foulbrood) circulating in New Zealand between 2019 and 2022. We generated 163 whole genome sequences of P. larvae from hives with symptomatic AFB, from 163 apiaries covering 22 subregions across New Zealand. Using multi-locus sequence typing we identified three main sequence types: ST18, ST5 and ST23. Each ST was the centre of a clonal cluster with limited variation. All three sequence types belong to the ERIC I genogroup. No coherent geographic structure was observed for ST18 or ST5. The ST23 type was restricted to Central Otago.

The use of RNAi as a novel control method for the honey bee parasite *Varroa destructor*

Rose McGruddy
Victoria University of Wellington

Varroa is one of the biggest threats to apiculture worldwide. Results from last years NZ COLOSS survey showed Varroa to be the biggest cause of colony loss. The most effective Varroa control methods currently on the market are synthetic or organic miticides. These treatments can have negative impacts on the environment and non-target species, including the bees. RNA interference (RNAi) has potential as a next-generation control method for pests like Varroa. Our research this far has found RNAi to be effective in controlling Varroa numbers, providing a species-specific mite management alternative.

Using double-stranded RNA to control deformed wing virus in honey bees and *Varroa destructor* mites

Zoe E. Smeele
Victoria University of Wellington

Together, *Varroa destructor* and the Deformed wing virus represent a severe threat to the beekeeping industry globally. Currently, the effects of DWV are mitigated through controlling V. destructor levels using miticides, which varroa may be increasingly developing resistance towards. The application of pathogen-specific double-stranded RNA (dsRNA) molecules has been widely proposed as a pesticide treatment. We assessed the effectiveness of using dsRNA to control for DWV by feeding mini-hives of honey bees dsRNA specific to DWV. Results from this experiment aid in determining the effectiveness of dsRNA as a next-generation treatment strategy for pests and pathogens of honey bee colonies.

An investigation into varroa resistant New Zealand honey bees

Tessa Pilkington
Victoria University of Wellington

Varroa is the leading cause of mortality of beehives in New Zealand. I've been working on a strain of bees that appear to show a level of mite resistance. Preliminary results indicate that this strain does offer a degree of resistance, and that this resistance may be associated with a slightly shorter developmental time of the juvenile bees. A reduced bee developmental time could limit the number of mite progeny able to be developed from any individual cell, slowing parasite population growth. My work in future summers will seek to confirm these results.

Physiological indicators of stress in western honey bees

Revati Vispute[1,2], Tony Hickey[2], James Sainsbury[1], Ashley Mortensen[1], David E Pattemore[1,2]
1: Bee Biology & Productivity Team, The New Zealand Institute for Plant and Food Research Limited
2: School of Biological Sciences, University of Auckland, New Zealand

Inter-colony competition due to over-population at apiary sites may lead to stress in honey bees. Over-population may have a negative effect not only on the honey bee colonies but also on the surrounding environment. To determine markers of stress in honey bees, we investigated increased energetic costs as a physiological indicator of stress. We exposed hives to varying degrees of intra-apiary competition, and measured glycogen stores and respiration rates of workers to assess the effects of this stress on energetics. This study aims to define a physiological marker that helps in the early detection of density-related stress in honey bees. This will offer beekeepers a way to recognize stress early and help improve the well-being of the colonies and maximize honey production.

Breeding a better bee in New Zealand

Damien Fèvre
University of Otago; AbacusBio. Ltd

Honeybee colony assessment is essential for selection and breeding in beekeeping operation. Therefore, it is necessary to better understand the influence of the different factors that influence honeybee colony phenotype. The nutritional status and the genetic effect are of primary importance. To address this question, small colonies kept in innovant cages under laboratory conditions have been fed with different diets. The study of the genetic expression through RNA sequencing performed on collected eggs and qRT-PCR on workers will allow to differentiate queen and nutritional effect.

Practical applications for data streams from remote hive monitoring systems

Gertje Petersen[1,2], Maddi Post[1], Peter Fennessy[1] and Peter K. Dearden[3]
1: AbacusBio Ltd
2: FutureBees NZ Ltd
3: University of Otago, Department of Biochemistry

Continuous hive monitoring has been hailed as a source of valuable information for honeybee research and is often portrayed as a game changing technology in practical beekeeping. However, there are currently few practical applications for cost-effective use of hive telemetry. As part of the MBIE-funded honeybee genetic improvement project “Selecting Future Bees”, AbacusBio and the University of Otago have worked with commercial beekeeping partners and Auckland-based tech company Apiary Solutions on defining specific patterns of bee activity and hive weight that can find practical application in the field, transforming data into actionable information for beekeepers.

Breeding for varroa resistance and the attributes of the Mite Monitor App

Rae Butler
Bee Smart Breeding

For the last 6 years Bee Smart Breeding has been working on breeding Varroa Sensitive Hygienic (VSH) bees, at the same time maintaining all the other desirable traits.
Bee Smart Breeding's vision is to incorporate VSH Production Line (Pro-Line) queens into beekeepers Varroa Pest Management Plans with the aim of minimising varroa treatments which in turn will have a positive economic impact to the beekeepers' bottom line.
Bee Smart Breeding will demonstrate this is being achieved by intertwining research with practical beekeeping. With particular emphasis on the attributes of the Mite Monitoring App Project.

Parental meiotic contribution in honey bees

Astra Heywood[1], Gertje Petersen[2], Cherokee Walters[2], Tom Harrop[1], Reuben McKay Vercoe[1], Peter Fennessy[2] and Peter Dearden[1]
1: University of Otago
2: AbacusBio Ltd

Honeybee pedigree is not able to be readily recorded due to their reproductive behaviours of inflight mating and polyandry. However, genotyping of queens and linking queens to breeding stock observations is extremely valuable as queen management in beekeeping operations often leads to the granddaughters of breeder queens being placed in the field. Here we investigated a closed mating scheme of five pedigree lines across five generations and compared the paternal and maternal contributions in queen and drone offspring. We further identified genetic regions that demonstrate higher maternal contribution across all maternal lines and trace their genetic contribution back five generations.