The 1st N.Z. Honey Bee Research Symposium

September 7th 2020

Programme

Schedule

Session 1: Bee Health *Moderator: Phil Lester, Victoria University*

9:00	Welcome	Phil Lester, Victoria University
9:05	*The value of industry and research working together*	*Karin Kos, CEO, Apiculture NZ*
9:25	The ApiWellbeing Project	Richard Hall & Hayley Pragert, MPI
9:35	Bacteria in the honey bee gut	Michelle Taylor, Plant & Food Research
9:45	Do invasive Argentine ants affect viral infection dynamics in honey bee colonies?	Jana Dobelman, Victoria University
9:55	Diversity of viruses that infect a wide range of pollinators and associates is shaped by geographic origins	Antoine Felden, Victoria University
10:05	ABAtE, Active Bacteriophages for AFB Eradication: Citizen Science, Bacteriophage Hunting and Future Prospects.	Heather Hendrickson, Massey University
10:15	From soil to solution: isolating bacteriophages from the environment to combat AFB	Danielle Kok, Massey University
10:25	Aiding and ABAtE-ing: Alternative Host Bacteriophages to prevent American Foulbrood	Jo Turnbull, Massey University
10:35	Pandemic lessons: A future for varroa management in New Zealand	James Sainsbury, Plant and Food Research

10:45-11:10 Break (25 minutes)

Session 2: Fundamental Research *Moderator: Grant Fale, Plant and Food Research*

11:10	*Using science for regulation – bees and bee products*	*Fiona Thomson-Carter, Director Food Science and Risk Assessment, MPI*
11:20	Gene expression and brain function in bees exposed to QMP	Peter Dearden, University of Otago

11:30	Queen mandibular pheromone induces a starvation response in a non-eusocial insect	Mackenzie Lovegrove, University of Otago
11:40	Neonicotinoids and solitary ground-nesting bees: the missing link	Felicia Kueh Tai, Plant and Food Research
11:50	Genomic tools for honeybee breeding research	Tom Harrop, University of Otago
12:00	Rearing bumble bees for research and pollination	Theo Van Noort, Plant and Food Research

12:10-1:00 Lunch (50 minutes)

Session 3: Honey & Bee Products *Moderator: Claire McDonald, MPI*

1:00	*Te Pītau Science Programme*	*Victor Goldsmith, Terry Braggins, Te Pitau Ltd*
1:20	Bacteria on the mānuka (Leptospermum scoparium) leaf surface: a potential driving factor of mānuka honey quality?	Anya Noble, Waikato University
1:30	Honey bees and myrtle rust	Sacchi Shin-Clayton, Plant and Food Research
1:40	The secret lives of backyard bees: monitoring seasonal pollen sources of urban honeybees.	Andrew Cridge, University of Otago
1:50	Royal jelly production may be an indicator of colony pollen demand	Grant Fale, Plant and Food Research

2:00 *Workshop (45 minutes)* *Manager: Theo Van Noort, Plant and Food Research*

Breakout rooms to discuss the following:

- Collaboration and Funding Opportunities
- Gaps in NZ Apiculture and Honey Research
- Research to Support AFB Pest Management Plan

2:45-3:00 Break (15 minutes)

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

3:00	*Industry Research Perspectives*	*Jane Lorimer, NZ Beekeeping Inc*

3:10	Honeybee trait prioritisation by beekeepers help understand the economic impact of selection	Gertje Petersen, FutureBees / Abacusbio
3:20	Honey bee workplace stress	Heather McBrydie, Plant and Food Research
3:30	GIS analysis for apiary site selection and evaluation for different production systems	Jonah Duckles, AbacusBio
3:40	Chemical ecology of honey bees for improved pollination	Flore Mas, Plant and Food Research
3:50	Manipulating foraging dynamics of honey bee colonies with supplemental feeding	Sarah Cross, Plant and Food Research
4:00	Is bigger always better? Effects of population size on colony dynamics	Ashley N Mortensen, Plant and Food Research
4:10	Student prize awards and closing remarks	Ashley Mortensen / Claire McDonald

Abstracts

Session 1: Bee Health

The ApiWellbeing project

Richard Hall & Hayley Pragert
Ministry for Primary Industries, Biosecurity New Zealand

The ApiWellbeing project is a new three-year project at the Ministry for Primary Industries. We are developing new molecular tests for exotic organisms like IAPV, and developing better testing for endemic organisms. A deeper characterisation of deformed wing virus types is also planned. The project will sequence the genomes of 300 *Paenibacillus larvae* isolates collected from around New Zealand, to perform a molecular epidemiology analysis. The project will also create resources for beekeepers to enhance their knowledge of bee biosecurity. A national collection of bees and apiary data is being created to foster new opportunities for bee health research.

Bacteria in the honey bee gut

Michelle A. Taylor, Alastair Robertson, Patrick Biggs, & Shanthi Parkar
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

‘Rapid’ and ‘incremental’ colony loss may result from interactions among bee pathogens, environmental factors and beekeeping management. The gut, with its bacterial residents, assimilates nutrients, antibiotics and oral poisons, and is the ingress and potential reservoir for pathogens. Understanding these interactions may help mitigate losses. We characterised bacterial profiles of NZ honey bee guts from 21 apiaries; identified relative abundances of dominant bacteria; demonstrated that core bacteria are internationally widespread and have persisted within a population for > 60 years. Season and diet also influenced bacterial profiles. The family Rhizobiaceae, and genera Serratia and Acetobacter may indicate poor bee health.

Do invasive Argentine ants affect viral infection dynamics in honey bee colonies?

Jana Dobelmann, Antoine Felden, & Philip J. Lester*
School of Biological Sciences, Victoria University of Wellington, Wellington, New Zealand

Emerging viruses are threatening bee health. Evidence suggests that viruses initially described in honey bees can actually infect a wide range of insects. We tested whether invasive Argentine ants presence in apiaries can affect viral infections in honey bees. Eighteen beehives were placed in sites with and without Argentine ants and infections were monitored. Deformed wing virus accounted for up to 10% of RNA in bees and levels were increased with ant presence. Kashmir bee virus found in ants throughout the study but only in bees with ants. Exploring virus dynamics can improve understanding of virus infections disease management.

Diversity of viruses that infect a wide range of pollinators and associates is shaped by geographic origins

Jana Dobelmann, Antoine Felden, & Phil Lester
School of Biological Sciences, Victoria University

Emerging viruses have caused concerns about pollinator population declines, as multi-host RNA viruses may pose a health threat to pollinators and associated arthropods. In order to understand the ecology and impact these viruses have, we studied their host range and determined to what extent host and spatial variation affect strain diversity. Firstly, we used RT-PCR to screen pollinators and associates, including honey bees (Apis mellifera) and invasive Argentine ants (Linepithema humile), for virus presence and replication. We found a number of active viruses in a wide range of hosts and commonly co-infecting honeybees and other hymenopterans. Secondly, we use phylogenetic data to show strong geographic rather than host-specific clustering of KBV and DWV, suggesting frequent inter-species virus transmission. Transmission routes between hosts are largely unknown. Nonetheless, avoiding the introduction of non-native species and diseased pollinators appears important to limit spill overs and disease emergence.

ABAtE, Active Bacteriophages for AFB Eradication: Citizen Science, Bacteriophage Hunting and Future Prospects

Heather Hendrickson
Massey University, Auckland

Bacteriophages are the viruses that kill bacteria. Previous research abroad has demonstrated that *Paenibacillus larvae* bacteriophages can protect beehives against AFB infection by destroying the pathogen. The ABAtE project team has isolated 8 strains of P. larvae from across New Zealand and discovered 34 bacteriophages. We used a citizen science approach to sample NZ apiaries and we would like to expand this effort in the future. I will describe our progress in sequencing NZ bacteriophages and our next steps towards developing a protective bacteriophage cocktail for New Zealand apiaries.

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

Danielle Kok & Heather Hendrickson
School of Natural and Computational Sciences, Massey University, Auckland

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. Our research looks into the use of Bacteriophages as a preventative measure against AFB. We aim to isolate phages that are destructive to *P. larvae* and combine them into a bio-protective phage cocktail. We have isolated 34 native phages by establishing plaque formation on our pathogen. This project: ABAtE (Active Bacteriophages for AFB Elimination), provides the groundwork for an innovative approach to naturally protecting NZ beehives against AFB.

Aiding and ABAtE-ing: Alternative Host Bacteriophages to prevent American Foulbrood

Joanne Turnbull, Danielle Kok, & Heather Hendrickson
Massey University School of Natural and Computational Sciences

The ABAtE project at Massey University is developing a treatment to protect healthy beehives from American foulbrood (AFB), using bacteriophages (phages) that kill the causative bacterial pathogen *Paenibacillus larvae*. I have evolved *P. larvae* phages to be more effective at infecting and killing *P. larvae*, observing a significant increase in phage particles produced per infection. I am also screening related non-pathogenic bacterial hosts to identify an alternative for propagation of *P. larvae* phages; this will enable the use of a citizen science approach to isolate phages that can kill *P. larvae*, and phage amplification without use of the pathogen.

Pandemic lessons: A future for varroa management in New Zealand

James Sainsbury, Ashley N Mortensen, Nico Bordes, & Toni White
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

Over the last couple of years there have been increasing colony losses attributed to Varroa, reports of existing treatments no longer being fit-for-purpose, and rapid rates of re-infestation. There has also been a willingness to exchange views and an acknowledgement that high rates of Varroa control benefit everyone. In response, Plant & Food Research recently hosted a meeting of Varroa management end-users and stakeholders. The purpose of the workshop was to clarify and align the gains, pains, research areas and outcomes that New Zealand is looking for when it comes to varroa management.

Gene expression and brain function in bees exposed to QMP

Ann-Kathrin Glosch, Laura Upton, Josh Gilligan, Mackenzie Lovegrove, Shannon Taylor, Tom Harrop, & Peter Dearden
University of Otago

Queen mandibular pheromone is expressed by queen bees and induces physiological and behavioural changes in workers, including repression of reproduction. When QMP is removed, however, worker bees can begin to reproduce, laying haploid eggs. This is an accessible model to understand the mechanisms of plasticity in animals. We have investigated gene expression changes in worker bee brains as they activate their ovaries, and identify brain cell types that are expanded as worker bees begin reproducing.

Queen mandibular pheromone induces a starvation response in a non-eusocial insect

Mackenzie R. Lovegrove, Elizabeth J. Duncan, & Peter K. Dearden
Biochemistry Department, University of Otago

Queen honeybees produce a highly specialised pheromone (QMP) which represses reproduction in workers. This specific blend of chemicals has not been found in any other species. Despite this, QMP can repress reproduction across a wide range of arthropod species, up to 560 million years diverged. This suggests that QMP is acting on ancient, conserved mechanisms of regulating reproduction. This study has investigated these ancient pathways by identifying how QMP is acting in a non-target species. This aids in our understanding of QMPs evolutionary trajectory, by showing how it represses species which may be reflective of a more ancestral state.

Neonicotinoids and solitary ground-nesting bees: the missing link

Felicia Kueh Tai[1,2], Jacqueline Beggs[2], Ashley N Mortensen[1], & David Pattemore[1,2]
1: The New Zealand Institute for Plant and Food Research Limited
2: School of Biological Sciences – University of Auckland, New Zealand

Pesticide exposure is hotly debated as one of the key drivers for bee population decline in both managed and wild bees. The neonicotinoid class of neurotoxicant insecticides has received considerable attention in recent years and has been widely studied for its negative impacts on honey bees. However, considering the difference in life trait histories, buffering capacity and routes of exposure, the impact of neonicotinoids on solitary ground-nesting bees may not mirror those on Apis bees. We therefore aim to assess the risk of neonicotinoids to these ground-nesters in New Zealand.

Genomic tools for honeybee breeding research

Tom Harrop
University of Otago

As part of the FutureBees project, we're doing a lot of second- and third-gen sequencing for honeybee genomics. I'll talk about some of the methods and assays we've developed and how we are applying them to honeybee breeding research.

Rearing bumble bees for research and pollination

Theo Van Noort[1], *Ashley N Mortensen*[1], *Aran Sisley*[1], *& David Pattemore*[1,2]
1: The New Zealand Institute for Plant and Food Research Limited
2: School of Biological Sciences – University of Auckland, New Zealand

Plant and Food Research's Productive Biodiversity & Pollination group have been developing technology – "BumbleBox", to make bumble bees more accessible to crop growers for pollination. The same technology can be utilised by researchers to study bumble bees in a variety of contexts. Our group and collaborators reared more than 5000 *Bombus terrestris* colonies in 2018 and 2019 for pollination of crops including kiwifruit, avocados, blueberries, and passionfruit. Our research has focused on improving in-orchard bumble bee colony management, refining rearing techniques, and assessing bumble bee pollination effectiveness.

Overview of the Te Pītau PGF Science Plan

Terry Braggins
Te Pītau Ltd

The Mānuka Charitable Trust has been set up to undertake the kaitiakitanga (guardianship) protection of the term Mānuka Honey as a Certified Trade Mark (CTM) with Geographical Indications (GI) protection. The Trust is the recipient of a Provincial Growth Fund (PGF) for underpinning research on the authenticity and provenance of mānuka honey. The Trust has set up Te Pītau Ltd to support and advance the activities of the Trust which include filing for CTMs and GIs and managing the PGC Science Plan. This presentation will further explain the structure and functions of Te Pītau and overview the projects within the PGF Science Plan.

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 and productivity. However, little is known about microorganisms that associate with New Zealand's mānuka (*Leptospermum scoparium*). We conducted the first characterisation of microorganisms that live on the surface of mānuka leaves and revealed a unique group of bacteria persisting across leaf surfaces of distinct and geographically distant mānuka populations. This finding suggests important mānuka-bacteria interactions exist and paves the way for future studies that will investigate the relationship between these microorganisms and important physiological traits such as nectar DHA and honey MGO.

Honey bees and myrtle rust

Sacchi Shin-Clayton[1,2], Ashley N Mortensen[1], Jacqueline Beggs[2], & David Pattemore[1,2]
1: The New Zealand Institute for Plant and Food Research Limited
2: School of Biological Sciences – University of Auckland, New Zealand

Western honey bees (*Apis mellifera sspp.*) were seen foraging on the yellow spores of the fungal pathogen *Austropuccinia psidii* (myrtle rust), that develop on Myrtaceae plants and bear a resemblance to pollen on flowers. Does this represent a co-incidence in visual traits, an adaptation to use honey bees as dispersal agents, or mutualism with bees gaining nutrients from the pathogen? It was found to be mutualistic, and provides strong evidence against current theories in plant pathology and honey bee nutrition: firstly, that rust pathogens, including myrtle rust, are predominantly wind-dispersed; and secondly, that natural bee diets are exclusively pollen and nectar.

The secret lives of backyard bees: monitoring seasonal pollen sources of urban honeybees

Andrew G Cridge, Otto Hyink, Karen F. Armstrong, Tom W. R. Harrop, & Peter K Dearden
Laboratory for Evolution and Development, Department of Biochemistry, University of Otago

To identify on which flowers backyard honeybees (*Apis mellifera*) forage, we collected pollen from approximately 20 hives located across Dunedin during the 2019/2020 season. Hives sites included residential, semi-rural, and town belt locations. Pollen samples were collected over a two-day window at three weekly intervals across the season using internal pollen traps. Pollen samples were identified and quantified using DNA barcoding and microscopy. We will present some early results from this study, indicating the variation in the types of pollen collected across colonies, even from hives sited in the same location.

Royal jelly production may be an indicator of colony pollen demand

Grant Fale, James Sainsbury, Sarah Cross, & Ashley N Mortensen
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

The environmental and physiological stimuli around royal jelly production are not fully understood, although pollen is the primary source of proteins, lipids, and minerals to a colony, and is presumed to be a key component of royal jelly production. Variable royal jelly production between colonies has been reported, and it is logical to expect the pollen demand (and thus their contribution to pollination as a consequence) is similarly variable. We attempted to streamline an image capture protocol using one-day-old worker larvae with the potential for in-the-field assessment of royal jelly production by beekeepers. Results will be presented.

Honeybee trait prioritisation by beekeepers help understand the economic impact of selection

Gertje Petersen, Peter Fennessy,& Peter Dearden
AbacusBio Ltd, FutureBees NZ

Understanding the economic impact of selection decisions is challenging in any production system, but becomes even more difficult where there are other factors (such as social or historic ones) influencing individual producer preferences. Beekeepers tend have economic rationalisations for queen selection decisions, but these strongly depend on their individual situation and are generally poorly reflected in the decisions made by queen breeders.Using the prioritisation software 1000minds, we have surveyed NZ beekeepers to generate preference values which can form the basis of an economic evaluation of queen bee selection candidates for different production systems (e.g. pollination and pure honey production).

Honey bee workplace stress

Heather McBrydie, Ashley N Mortensen, Sacchi Shin-Clayton, Purak Patel, & James Sainsbury
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

Heat shock proteins (HSPs) can be used to assess stress in honey bees. New Zealand's beekeeping industry has identified "overstocking" as a key challenge to sustainability and growth. HSP concentrations may aid understanding of the implications of changing beekeeping practices. PFR have funded establishment of stressed (exposed to vibrations or acetone during development) and unstressed honey bee larvae "standards" in an in vitro rearing system. These standards are being assessed using commercially available HSP antibodies to monitor changes in honey bee stress proteins. Once proof-of-concept is demonstrated, this capability can be used to assess the stress implications of apiary formats/densities.

GIS analysis for apiary site selection and evaluation for different production systems

Jonah Duckles & Gertje Petersen
AbacusBio Ltd, FutureBees NZ

The success of beehives in a particular environment depends strongly on the correct selection of apiary sites. By using geospatial information (contour, land coverage) as well as long- and short-term climate data, a basis for hive placement decisions can be created in silico to in turn be used as a guideline for physical surveys. With this approach, the accessibility (i.e. cost of transportation) of particular areas can be taken into account as well as the factors impacting on production capacity (e.g. floral resources, hive density) to create a snapshot of the expected economic outcomes of hive placement decisions.

Chemical ecology of honey bees for improved pollination

Flore Mas, Rachael Horner, & Taylor Welsh
Chemical Ecology & Behaviour Team, Biosecurity group, The New Zealand Institute for Plant and Food Research Limited

We will give an overview of the work carried out by our team for the last five years on the chemical ecology of honey bees and how it can influence crop pollination success. Combining chemical analysis, electrophysiology and behavioural methods, we now have a better understanding of what bees smell and learn from our major crops. Based on this knowledge, we will discuss how cross-pollination among hybrids or varieties can be promoted or limited; and how we can influence honey bees foraging decision via manipulating their associative olfactory memory for better pollination outcomes.

Manipulating foraging dynamics of honey bee colonies with supplemental feeding

Sarah Cross, Ashley N Mortensen, Grant Fale, Lara Mills, Georgia Woodall, & James Sainsbury
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

Honey bee colonies adjust their foraging behaviour in response to their environment. Supplemental feeding of protein and/or carbohydrates can alter the internal demands of a honey bee colony, thus modifying their foraging efforts in the field. This trait is exploited by beekeepers and orchardists during spring pollination where pollen foragers are in high demand. We present results of a trial designed to determine how readily, and to what degree, protein and/or carbohydrate supplementation alters the foraging efforts of honey bee colonies. We also assessed the degree of intercolonial variation in latency and degree of response to supplemental feeding treatments.

Is bigger always better? Effects of population size on colony dynamics

Ashley N Mortensen, Grant Fale, Lisa Evans, & James Sainsbury
Bee Biology & Productivity Team, Productive Biodiversity & Pollination Science Group, The New Zealand Institute for Plant and Food Research Limited

Both the population of workers within a honey bee colony and the population of honey bee colonies in the environment affect colony dynamics. Several research programmes at Plant & Food Research have identified counter intuitive correlations between colony size and colony function. Furthermore, colony density at the landscape scale affects colony physiology and behaviour. We present ongoing research and potential future programmes to directly investigate the relationships between population size and colony behaviour and physiology.