2ND AUSTRALIAN Native Bee CONFERENCE

Integrating beekeeping, crop pollination,
hive products and research

Program Book

05·06·07 December 2019

St Leo's College, University of Queensland, St Lucia, Brisbane

Welcome

Conference

The organising committee warmly welcomes beekeepers, farmers, industry leaders and researchers to share knowledge at the first Australian Native Bee Conference, with the aim of discussing issues required to unlock the potential of our native bees, a valuable but under-utilized natural resource.

THURSDAY FRIDAY SATURDAY

Field Trip

A field trip will take us to a farm on the Sunshine Coast on the afternoon of Thursday 5th December. At the farm you will see hive shelters for communal housing of stingless bee hives. You will observe methods for hive propagation. We will discuss placement and management of hives on farms. The farmer will give his perspective on stingless bees for pollination. Lunch will be provided.

Hive exhibition

An exhibition of stingless bee hives will be held on the afternoon of Saturday 7th December, this event carries no extra charge to conference registrants.

Concurrent Event: Australian Bee Genomics Working Group

This working group will be held concurrently with the main program as a mix of parallel and shared sessions. The main goal of this synthesis group is to facilitate the assessment of Australia's bee diversity (taxonomy and systematics) and the creation of an action plan that will allow researchers to reach the goal of a unified national "bee dataset". Discussions will focus on how such a resource could assist studies on biodiversity, plant-pollinator interactions, spatial patterns, and which genomic tools can add the most value. Symposia and Workshops are generously sponsored by the Centre for Biodiversity Analysis (Australian National University/CSIRO), the Australian National Insect Collection (CSIRO) and Hawkesbury Institute for the Environment (Western Sydney University.

Shoulder event: Bee Identification Workshop

Are you interested in a half day bee ID workshop with Dr Tobias Smith, in the Goddard Building, University of Queensland, St Lucia, from 8am to 1pm on Sunday 8th December. It will consist of a lecture on diversity and anatomy, followed by lab based diagnostics with reference collections and keys.

Edited by Tim Heard • Designed by Glenbo

Organising Committee

Tim Heard ***(chair)*** Tim is an entomologist who works across disciplines to answer questions such as how to utilize stingless bees for economic purposes. He is an Honorary Associate with the University of Sydney and also runs Sugarbag Bees, which produces stingless bee hives and offers beekeeping, consulting and educational services.

Dr Romina Rader is a Senior Lecturer in Community Ecology at the University of New England, Armidale. Her research interests include the identity and performance of insect pollinators in crops, plant-animal interactions and the response of biodiversity to landscape and environmental change.

Assoc Prof Katja Hogendoorn from the School of Agriculture, Food and Wine, The University of Adelaide is a researcher who specialises in: foraging, nesting, and mating behaviour of solitary and primitively social native bees; taxonomy of native bees; revegetation strategies to enhance the resilience and quality of crop pollination services.

Prof James Cook, is a Professor of Entomology, Hawkesbury Institute for the Environment, Western Sydney University. He leads a research team studying the ecology and behaviour of native bees, focusing mainly on their roles in crop pollination, the floral resources they rely on for food, and their microbial diseases.

Dean Haley is a founding member of the Brisbane Native Beekeepers Club (The BNBC). He is interested in how to propagate and increase hive numbers with the minimum of stress, how to protect against some nasty natural enemies like phorid flies, and how our boxes and management techniques protect our bees in heat and cold.

Dr Ros Gloag
is a lecturer in evolutionary biology at the School of Life and Environmental Sciences, the University of Sydney. She researches the behaviour and genetics of bees in Australia, including invasive bees and native stingless bees.

Organising Committee

Prof Helen Wallace is Professor at Griffith University. Her research is focused on the science of plant reproduction and entomology. Her interests include bee biology, ecology, forestry, horticulture and conservation. Her research projects include topics in landscape ecology, pollination, bee ecology, fruit production, seed dispersal, agroforestry and natural products from plants and bees.

Prof Ben Oldroyd is a Professor at the University of Sydney, School of Life and Environmental Sciences where he leads the Behaviour and Genetics of Social Insects Laboratory. He and his group are interested in the population genetics and reproductive behaviour of honey bees and stingless bees.

Prof Saul Cunningham is currently Director of the Fenner School for Environment and Society at the Australian National University. Previously he spent 17 years with CSIRO. He has published papers on the importance of crop pollination to food production in the world's major science journals. His team works on pollination of crops interacting with farming industry groups and landholder groups.

Dr Tobias Smith is a bee researcher, educator and stingless bee keeper based on the Gold Coast. As a researcher Tobias is based at the University of Queensland. Tobias's research interests focus on wild bees in agricultural landscapes, crop pollination by native bee species, and native bee diversity and ecology. As an educator Tobias presents native bee and pollination workshops.

Dr Simon Tierney is an evolutionary ecologist who aims to understand the interplay between organisms, their environment and their genes, with a particular focus on social insect organisation, photic niche shifts and pollination. He is currently involved in a multi-disciplinary project aimed at understanding and safeguarding the pollination services provided by Australian bees (Western Sydney University).

VOLUNTEERS

Katina Heard was born amongst stingless bees in Cairns, and now lives amongst them more than ever in Brisbane.

Glenbo Craig is a passionate designer, photographer, publisher and son-of-a beekeeper. Oh, and an overly enthusiastic talker.

Trade Show

The Australian Native Bee Conference is complemented by trade tables which promote the businesses or interests of the exhibitors.

Sugarbag Bees is an innovative company based in Brisbane Australia which provides stingless bee hives, products, services, advice, information and education resources. Our primary activity is breeding and selling stingless bee hives. We also provide a variety of beekeeping products such as hive boxes, mounts and tools. We offer a range of beekeeping services including splitting or extracting honey from your hive, and hive buyback options. We present workshops and seminars on native bees in Queensland and New South Wales. We partner with universities to conduct pure and applied research on bees. We extend professional advice on crop pollination. We love what we do and feel privileged to spend our lives engaged with wonderful little masterpieces of nature. To share this love, we turn out a range of educational resources including The Australian Native Bee Book, a multi award winning and bestselling guide to keeping Australian native stingless bees. www.sugarbag.net.

Bugs and Beads is a small business founded in 2018 by Vivian Sandoval, an entomologist (insect scientist) living in Brisbane, to promote insects through handcrafted jewellery and collectables. The handmade pieces are delicate and intense at the same time. Her favorite materials are the tiny glass seed beads that resemble in size the minute tree-fungus beetles (Coleoptera: Ciidae) that she has been studying for more than ten years. Her best-sellers are the pieces made with recycled jewel beetle shells and 925 sterling silver. "Bugs and Beads" is also promoting local and international artwork and artists using nature as their source of inspiration and is supporting insect-fungi research through the donation of part of the profits to several non-profit organizations. "Bugs and Beads" has been exhibiting its insect-inspired handcrafts in several entomological and naturalists meetings in the past in Brisbane and overseas and it is very happy to be present this time in the 2nd Australian Native Bee Conference. Find out more at www.bugsandbeads.com

Brisbane Branch of the Australian Native Bee Association

The Brisbane native Beekeepers club was founded in 2016. It has grown steadily to become a home to nearly 500 native bee enthusiasts. The club has met every first Sunday of the month for three years, with few exceptions. In 2019, the organisers formed the Australian Native Bee Association and encouraged the formation of branches wherever there was an interest. The Brisbane branch of ANBA continues to meet at the same place and time. Our members are sharing information and displaying and selling products, and are largely responsible for the Hive Exhibition event at this conference.

Woodsman Bee Homes The Woodsman is a small father/daughter partnership that creates Solitary Bee Habitats from up cycled untreated timbers - thoroughly researched and well considered designs that are attractive to both bees and gardeners - we have also worked with local council to create habitats suitable for local native solitary bees. Operated by Libby Starrenburg and Sergio Ruggieri Deception Bay, Queensland, woodsmanaustralia@gmail.com.

The Wheen Bee Foundation is a not-for-profit organisation that promotes awareness of the importance of bees for food security, and raises funds for research that addresses the national and global threats to bees. In the past 12 months Wheen Bee Foundation has funded the establishment of online platforms to support events and activities that celebrate World Bee Day (20 May) and Australian Pollinator Week (2nd week in November). Visit our stand to find out how to register your 2020 events for free. Learn about our Bee Ambassador program and also, our newly established 'Rita Fund' for native bee research. Inquiries to info@wheenbeefoundation.org.au or 0427 354 457.

Beezotted is a stingless bee company based in Mooloolah Valley, Sunshine Coast, Australia. Beezotted provides stingless bee hives, products, services, advice and information, and facilitates educational workshops for schools and community groups across Australia and in Papua New Guinea. Our activities include breeding and selling several species of stingless bee hives. We also provide a variety of beekeeping products such as hive boxes, log hives, custom-made sculptured log hives and mounts. Our range of beekeeping services includes eduction set-ups and honey extraction. We partner with local business, organisations and international companies to achieve their stingless bee requirements. Beezotted feels the calling of the bees and is privileged to work with our national treasures. Beezotted.com.au, Matthew Middleton, middleton.beeman@gmail.com 0499 886 899

Beeright SB honey frames & extraction systems by Bob the Beeman
My lifetime of involvement with stingless bees has evolved from logs through box design to achieve durable boxes incorporating management systems to cope with high temperatures and leading to bio-ethically sound collection of clean SB honey of high purity. The quest is always to improve, putting the welfare of the bee first and foremost in all operations. Both current extractor designs allow direct bottling as part of the extraction process from the frames in which honey is stored in the bees own cerumen. The design allows SB honey to be extracted at very close to the condition in which it is stored by the bees without nest or pollen contamination. It achieved 2nd prize Sydney Royal with no treatment. It allows management in hive for natural aging to cope with the natural fermentation. Honey supers for my AusINPA box, and other box designs with be displayed. Bob Luttrell www.bobthebeeman.com.au

Thursday 5th December 2019

Hour	#	Event	Topic
900		Spirits of the Red Sand	Welcome to country and Native Bee Dance
930	1.1.1	*Plenary Speaker:* Eduardo Almeida	Australian bees: Ancient or young, but very attractive
1000	1.1.2	*Plenary Speaker:* Michael Batley	Diversity & ecology of Simpson Desert bees
1030		**MORNING BREAK**	

Bee Biology

Hour	#	Speaker	Topic
1100	1.2.1	James Dorey	Missing for almost 100 years: a case study of *Pharohylaeus lactiferus*
1115	1.2.2	Rachele Wilson	Solitary bee dependence on exotic plants identified through DNA metabarcoding of nest provisions
1130	1.2.3	Brittany Elliott	The pollen diets and niche overlap of honey bees and native bees in heathlands
1145	1.2.4	Alex Blackall	Reproduction of the buzz-pollinated *Hibbertia exutiacies* in a fragmented landscape.
1200	1.2.5	Ben Parslow	Are your larvae safe? Use of bee's as hosts in the wasp genus Gasteruption
1215	1.2.6	Matt Elmer	Modelling above and below ground climate for Homalictus bees: Hands on with NicheMapR
1230	1.2.7	Alan Dorin	A few things a computer scientist has learnt about bees through simulation, modelling and machine learning
1245		**LUNCH**	

Thu morning

Concurrent Event: Australian Bee Genomics Working Group

MORNING BREAK

Taxonomy & Systematics

Conv: Juanita Rodriguez

#	Speaker	Topic
1.3.1	Michael Branstetter	Ultraconserved element phylogenomics for native bee systematics, taxonomy, and identification
1.3.2	James Hereward	Which genetic markers are best for assessing stingless bee diversity?
1.3.3	Ros Gloag	Cryptic diversity in Australian Tetragonula & the mito-nuclear speciation hypothesis
1.3.4	Katja Hogendoorn	The need for a molecular barcode library for Australian native bees
1.3.5	Remko Leijs	Working towards a DNA barcode reference library for the Australian bee species
1.3.6	Tobias Smith	Making taxonomy more accessible to the growing community of Australian bee enthusiasts

LUNCH

Thu afternoon

AFTER LUNCH

Hour	Field Trip Event
1245	Field trip departs
	Field trip
1830	Field trip returns
1900	**DINNER**

This field trip will take us to a farm on the Sunshine Coast. At the farm you will see hive shelters for communal housing of stingless bee hives. You will observe methods for hive propagation. We will discuss placement and management of hives on farms. The farmer will give his perspective on stingless bees for pollination. Lunch will be provided.

Please note:

Wednesday 4th December 2019

Hour	Event
1800	**Welcome Reception**

Friday 6th December 2019

Fri morning

Hour	#	Plenary Speaker	Topic
900	2.1.1	Laurence Packer	Bees: What's in a Name
945	2.1.2	Margarita Lopez-Uribe	Lessons from population genomic studies of bees to detect recent demographic changes linked to agriculture
1030		**MORNING BREAK**	

Convenor: Helen Wallace

Community Engagement

Hour	#	Speaker	Topic
1100	2.2.1	Renae McBrien / Sarah Hamiltion	Native Bee Prescription-Patient rehabilitation outcomes with a therapy Native Bee Hive at Spinal Injuries Unit
1115	2.2.2	Judith Friedlander	The B & B Highway: Creating pollinator habitat corridors across Sydney to promote biodiversity and citizen science engagement
1130	2.2.3	Lena Alice Schmidt	Creating a floral banquet for native pollinators
1145	2.2.4	Kit Prendergast	What's the best method for monitoring bees?: an empirical test and review of the literature
1200	2.2.5	Dean Haley	Honey of stingless bees need for a standard
1215	2.2.6	Jenny Shanks	Food for thought for an emerging industry
1230	2.2.7	Fiona Chambers (5 mins)	Wheen Bee Foundation and the 'Rita Fund' for native bee research
1245		**LUNCH**	

Concurrent Event: Australian Bee Genomics Working Group

MORNING BREAK

Convenor: Saul Cunningham

Pollination ecology

#	Speaker	Topic
2.3.1	Saul Cunningham	How can genomics help pollination ecology?
2.3.2	Julian Brown	Global scale drivers of crop visitor diversity and the historical development of agriculture
2.3.3	Olivia Bernauer	Functional pollination traits of native bees
2.3.4	Liz Milla	Generalist pollinators as biomonitors of plant communities
2.3.5	Francisco Encinas-Viso	Effect of climate change in Australian alpine plant-bee communities

LUNCH

Fri afternoon

AFTER LUNCH

Hour	#	Speaker	Topic
Convenor: Katja Hogendoorn			**Crop Pollination**
1330	2.4.1	Helen Wallace	What is an effective pollination service? Why better understanding of bee behaviour is critical for crop production
1345	2.4.2	Chris Cannizzaro	Floral visitation rates of stingless bees in avocado orchards across transitional sexual phases
1400	2.4.3	O. P. Nzie	Australian stingless bees as crop pollinators for strawberries in protected cropping environments
1415	2.4.4	Scott Nacko	Small hive beetle infestation and cucurbit pollination in Australian stingless bees
1430	2.4.5	Claire Allison	Does the timing of stingless bee hive deployment impact foragers crop fidelity and resource use ?
1445	2.4.6	Tobias Smith	Buzz pollination in the Aust. bee fauna
1500	2.4.7	James Makinson	Stingless bees and other native pollinators on mango crops in the Northern Territory
1515		**AFTERNOON BREAK**	
Convenor: Tobias Smith			**Stingless Beekeeping & Management**
1600	2.5.1	Sunayana Sajith	Indian Beekeeping Practices: Photo-documentation
1615	2.5.2	Windra Priawandiputra	The selection of potential native stingless bees for beekeeping in South Sumatra, Indonesia
1630	2.5.3	Matthew Middleton	PNG native bee community development program
1645	2.5.4	Neil Fraser	Stingless beekeeping - wet tropics of FNQld
1700	2.5.5	Chris Fuller	Managing stingless bees in the commercial orchard environment
1900		**DINNER**	

Saturday 7th December 2019

Sat morning

Hour	#	Plenary Speaker	Topic
900	3.1.1	Cristiano Menezes	Nesting biology of stingless bees: applications for meliponiculture
945	3.1.2	Sandra Rehan	Behavioural genetics and social evolution of the small carpenter bees
1030		**MORNING BREAK**	

Convenor: Ben Oldroyd

Stingless Bee Biology

Hour	#	Speaker	Topic
1100	3.2.1	Tobias Smith	The mating system of *Tetragonula carbonaria* stingless bees
1115	3.2.2	Francisco Garcia Bulle Bueno	Sperm with wings: long-distance male dispersal in Tetragonula carbonaria
1130	3.2.3	Matthew Keir	Spatial Ecology and Queen Turnover Rates in a population of the Stingless Bees *T. carbonaria* and *T. hockingsi*
1145	3.2.4	James Hereward	Is there hybridisation between *Tetragonula carbonaria, T. hockingsii* and *T. davenporti?*
1200	3.2.5	Ros Gloag	How to find food fast: olfactory eavesdropping by Australian stingless bees
1215	3.2.6	Mark Hall	How will climate change affect stingless bee population dynamics and crop pollination potential?
1230	3.2.7	Flavia Massaro	Yeasts associated with nests of Australian stingless bees
1245		**LUNCH**	

Concurrent Event: Australian Bee Genomics Working Group

MORNING BREAK

Convenor: Simon Tierney

Functional Genomics

#	Speaker	Topic
3.3.1	Simon Tierney	Genomic evaluation of native bees as pollen-transport vectors
3.3.2	Kor-jent van Dijk	Pollen collection by bees, and the need for a molecular approach
3.3.3	Dona Kireta	Metabarcoding native bee pollen within restored landscapes
3.3.4	Lucas Hearn	Reproductive skew in the uniquely social colletid bee Amphylaeus morosus
3.3.5	Alexander Mikeyev	How to design a study using next-generation sequencing tools

LUNCH

Sat afternoon

AFTER LUNCH

Convenor: James Cook

Bee Diseases

Hour	#	Speaker	Topic
1330	3.4.1	Olivia Davies	Prevalence of a pervasive parasite across the Australian hylaeine bees
1345	3.4.2	Bronwen Roy	Exploring the virosphere of stingless bees in Eastern Australian
1400	3.4.3	Scott Groom	Susceptibility of Australian native bees to the Varroa-vectored Deformed Wing Virus
1415		Trevor Weatherhead	ANBA AGM
1500		**AFTERNOON BREAK**	
1530			Hive Exhibition Hive Exhibition Hive Exhibition
1700		Ben Oldroyd	Summary of conference: trends, themes, directions
1715		**FINISH**	

Sunday 8th December

Shoulder event: Bee Identification Workshop

There will be a half day bee ID workshop with Dr Tobias Smith, in the Goddard Building, University of Queensland, St Lucia, from 8am to 1pm on Sunday 8th December. It will consist of a lecture on diversity and anatomy, followed by lab based diagnostics with reference collections and keys.

Welcome to country smoking ceremony and Native Bee Dance

Spirits of the Red Sand will give a traditional Welcome to Country and native bee dance. This ritual is performed by the Elders and members of the Yugambir, Nunukul, Kombumerri, Yuggera tribes under the cultural expertise of Elder Eddie Ruska. Includes the following:

Smoking ceremony, a practice used to cleanse places and people of bad spirits and promote the well-being of our people and guests on Country.

Welcome to Country, in the traditional way of our people.

Corroboree, including Bee Dance & Didgeridoo. Our time of interpreting the Dreamtime through music & dance. The Didgeridoo is the oldest windpipe instrument in the world. The Bee Dance is a sacred ritual for which we have permission to perform, the dance is quite distinct from the light-hearted dancing that men, women and children could share.

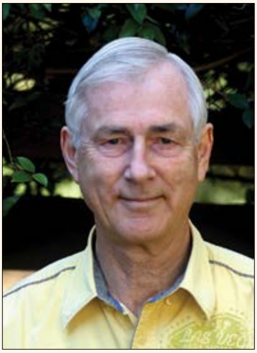
Fire lighting Ceremony, creating fire the traditional way.

spirits OF THE RED SAND

The Six Plenary Speakers

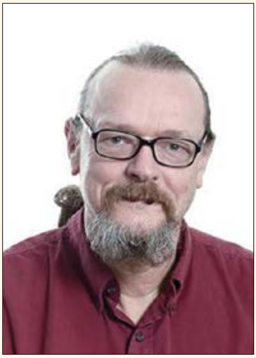
Eduardo Almeida

Michael Batley



Margarita López-Uribe

Sandra Rehan



Laurence Packer

Cristiano Menezes

A total of 60 speakers will present at the event.

The abstract and biography of each presenter follow in order of presentation.

1|1|1 Australian bees: Ancient or young, but very attractive

Plenary Address

Eduardo A. B. Almeida[1], Bryan N. Danforth[2], Diego S. Porto[1], Silas Bossert[2], Marcio R. Pie[3]

1 Universidade de São Paulo. Ribeirão Preto, Brazil. 2 Cornell University. Ithaca, USA. 3 Universidade Federal do Paraná. Curitiba, Brazil

Our growing understanding of how the wealth of bee diversity is connected by phylogenetic relationships has allowed for a refined appreciation of this diversity in the temporal and spatial dimensions. The Australian biota includes several interesting components that made it unique, whether in terms of its flora or fauna, which mainly relate to the history of connectivity to other landmasses. When focusing on the bee fauna found in the Australian region, we notice the absence of two families—Andrenidae and Melittidae—the presence of the endemic Stenotritidae, and a characteristically high diversity of a family that is not so ubiquitous elsewhere—Colletidae. Phylogenomic results will be used to discuss higher-level bee taxonomy and divergence times. These phylogenomic insights will be contrasted with and complemented by our morphology-based interpretations of bee phylogenetics. In this context of dated phylogenetic hypotheses, the placement of Australian bee lineages will be considered, emphasising their biogeographical connections that explain the singularity of the bee fauna in the region. Colletid and stenotritid bees will be discussed in greater detail: their initial diversification took place at the Late Cretaceous, followed by a period of trans-Antarctic connectivity with South America. Several lineage exchanges occurred between these continents until the end of the Paleogene period. The austral connection and posterior break-up of Antarctica, Australia, and South America resulted in a pattern of disjunct sister-lineages. Increased biome aridification coupled with floristic diversification in the southern continents during the Neogene may have contributed to the high rates of cladogenesis of colletid bees in the Oligocene and Miocene epochs.

Eduardo Almeida began his training in Biology in Brazil (Universidade Federal de Minas Gerais) and in 2007 received his PhD in Entomology from Cornell University. His research and teaching interests include insect comparative morphology, taxonomy, bee phylogenetics and biogeography. He is currently an Associate Professor in the Biology Department at the University of Sao Paulo, Ribeirao Preto, Brazil. Eduardo is also the curator of the entomological collection ("Coleção Entomológica Prof. J.M.F.Camargo" - RPSP) and the director of the Graduate Program of Entomology. His current research projects focus on the integration of comparative approaches to the description and interpretation of bee diversity.

1|1|2 Current knowledge about the diversity and ecology of Australian native bees: a case study from the Simpson Desert

Michael Batley[1], Tony J. Popic[2] & Glenda M. Wardle[2]

1 Australian Museum, 6 College Street, Sydney NSW 2010, Australia. 2 Desert Ecology Research Group, School of Biological Sciences, The University of Sydney, Sydney NSW 2006, Australia

Systematic programs for monitoring bee diversity and ecology in the diverse regions of Australia are yet to be developed. Such studies will be required for ecosystem conservation, sustainable management and assessment of possible responses to climate change. The results of an investigation of plant-pollinator networks in the north-eastern Simpson Desert has been used to evaluate possible survey methods and identify factors affecting the interpretation results. The bee fauna of spinifex grasslands in the northeastern Simpson Desert was examined and compared with those of other areas. Over a five year period 109 species and 18 genera (5 species of Apidae, 23 of Megachilidae, 22 of Halictidae and 61 of Colletidae) were recorded, but *Apis mellifera* was notably absent. Species rarefaction curves suggest that approximately 80% of species in the area were collected. Over 40% of the species had not formally been described.

Michael Batley is an honorary Research Associate of the Australian Museum who assisted with some of the species identifications. **Tony Popic** is currently resident on Thursday Island, and is an ecologist whose PhD study, supervised by **Glenda Wardle**, involved sampling the bee fauna of the Simpson Desert.

1|2|1 Missing for almost 100 years: a case study of *Pharohylaeus lactiferus*

Dorey, J.B. (1,2), M.S.Y Lee (1,2), M.I. Stevens (2,3) & M.P. Schwarz (1)

(1) Flinders University, Sturt Rd, Adelaide, SA 5042; (2) South Australian Museum, North Terrace, Adelaide, SA 5000; (3) University of South Australia, North Terrace, Adelaide SA 5000.

Insect biodiversity is threatened on a global scale, with reports of 40% of insect species threatened with extinction. Habitat loss, pollution, disease, invasive species and climate change are all associated drivers of diversity loss. Most insect species in Australia lack sufficient data to be assessed and yet assessments must be made before strategies conserving biodiversity can be developed. For ecologically and agriculturally important insect groups like bees there is a real need for assessments to begin. *Pharohylaeus lactiferus* (Colletidae: Hylaeinae) is one such species that is possibly threatened with extinction. *Pharohylaeus* contains only two species, one from New Guinea and *P. lactiferus*, endemic to Australia, and is therefore likely to have very high phylogenetic conservation value. *Pharohylaeus lactiferus* was last collected in 1923 near Atherton, and prior to this study, nothing was known of its ecology and it was feared extinct. A recent rediscovery indicates possible floral and habitat specialisation with specimens found in a single rainforest only visiting *Stenocarpus sinuatus* (Proteaceae), to the exclusion of other available resources. Sampling of nearby rainforest remnants with *S. sinuatus* and other flowering plants yielded no further specimens, suggesting population isolation and possible local extinctions. Mapping of Queensland rainforest, *Stenocarpus* and historical *Pharohylaeus* locations indicate a possible split distribution between the Cairns and Mackay regions. Highly fragmented habitat and host specialisation could explain the rarity of *P. lactiferus* and indicate extinction risk. Targeted sampling is required to assess the status of the species.

James Dorey is a PhD student at Finders University and the South Australian Museum. His work focusses primarily on Australian and Pacific wild bee diversity, phylogenetics and ecology. While the main thrust of James' PhD is regards the genus *Homalictus*, he collaborates where he can to include all Australian bee genera and other insect groups.

James is a professional photographer, who [of course] specialises on bees and other insects. He aims to increase understanding and appreciation of bees and other insects and to advocate for the protection of them and their habitats.

1|2|2 Solitary bee dependence on exotic plants identified through DNA metabarcoding of nest provisions

Wilson, R.S. (1,2), A. Keller (3,4) S.D. Leonhardt (5), C.J. Burwell (2,6,7), C. Fuller (8), T. Smith (9), A. Shapcott (1) & H.M. Wallace (2)

(1) GeneCology Research Centre, University of the Sunshine Coast; (2) Environmental Futures Research Institute, Griffith University; (3) Center for Computational and Theoretical Biology, Germany; (4) Department of Bioinformatics, University of Würzburg; (5) Department of Animal Ecology and Tropical Biology, University of Würzburg; (6) Biodiversity Program, Queensland Museum; (7) School of Environment and Science, Griffith University; (8) Kin Kin Native Bees; (9) School of Biological Sciences, University of Queensland.

Several studies have highlighted the importance of natural habitat to support bees in disturbed landscapes such as agroecosystems. However, little is known about the specific habitat requirements of solitary bees in such landscapes. We aimed to identify the plant sources of nest materials and brood provisions for cavity-nesting solitary bees in natural and agricultural landscapes. We applied dual-indexed amplicon sequencing of the ITS2 gene to pollens, pollen proxies (larvae and frass) and nest materials (resins, leaves and "cellophane") collected from trap nests over two years in Macadamia orchards and eucalypt forests of South-east Queensland. We identified more than 70 source plants of nests and provisions for five Australian solitary bee species: *Megachile mystacaena*, *Megachile simplex*, *Megachile deanii*, *Hylaeus nubilosus* and *Hylaeoides concinna*. Interestingly, half of all resources identified were introduced species, and exotics were among the three most used plants for all bees studied, excluding *M. deanii*. Common pollen sources were native trees such as *Lophostemon suaveolens, Corymbia* spp., *Eucalyptus racemosa, E. pilularis*, *E. crebra*, *E. tereticornis* and *Macadamia tetraphylla*, but also exotics like *Crotalaria lanceolata* and *Desmodium uncinatum*. Leaves used by *M. simplex* were dominated by *Passiflora* sp. and *Sida rhombifolia*, another naturalised weed. Resin nest caps were diverse, but most commonly included exudates from *E. racemosa*, *Lophostemon confertus* and *L. suaveolens*. The cellophane-like secretions of *H. concinna* consisted mostly of material from the herb *Modiola caroliniana* and *Passiflora* sp. This study highlights the utilization of exotic plants by solitary bees in both natural and agricultural landscapes. It also demonstrates the successful use of larvae and frass as proxies for molecular identification of provisions and is the first study, to our knowledge, to identify the plant origins of hylaeine cellophane. Resources identified in this study may be used to guide land management practices for the conservation and management of solitary bees in Australia.

Rachele Wilson is a research assistant, PhD student and tutor at the University of the Sunshine Coast and holds a first class Honours degree in land, parks and wildlife management.

1 | 2 | 3 The pollen diets and niche overlap of honey bees and native bees in heathlands

Brittany Elliott (1), Rachele Wilson (1), Alison Shapcott (1), Ryan Newis (1), Chris Cannizzaro (1), Chris Burwell (3), Tobias Smith (4), Alexander Keller (6), Sara D. Leonhardt (2), Wiebke Kämper (1), & Helen Wallace (5)

(1) Genecology Research Centre, University of the Sunshine Coast; (2) Department of Animal Ecology and Tropical Biology, University of Würzburg; (3) Biodiversity Program, Queensland Museum and Griffith University; (4) School of Biological Sciences, University of Queensland; (5) Environmental Futures Research Institute, Griffith University; (6) Center for Computational and Theoretical Biology, Würzburg.

There are global concerns that honeybees have negative impacts on wild bees, i.e. by exploiting floral resources used by wild bees, resulting in competitive exclusion. European honeybees (*Apis mellifera*) were introduced to Australia in the 1820s, and feral populations are well established in all landscapes. However, there is little understanding of their floral resource use compared to native bees. Here we report on the pollen diets of wild bees in coastal heathlands in Queensland, an "of concern" ecosystem characterised by mass flowering in late winter and spring. Honeybees and native bees were sampled in three coastal heathland conservation areas and their pollen diets compared using DNA metabarcoding. We sampled bees once a week for 10 weeks during peak flowering and calculated niche overlap between honeybees and native bees within the network using Horn's Index. *A. mellifera* were the most common species across all locations, accounting for 42% of all bees collected (2772 in total). Other frequently recorded genera included native eusocial *Tetragonula* (37%), and semi-social *Braunsapis* (19.8%). *Braunsapis*, stingless bees and *Xylocopa* sp. had the highest niche overlap values with *A. mellifera*. Some distinct foraging preferences were revealed: *Tetragonula* were the only bee species that collected pollen from *Ludwigia, Spordanthus, Desmodium, Alyxia, Solanum, Burchardia, Amyema, Alysicarpus* and *Galium*. In contrast, *A. mellifera* were the only species that collected pollen from *Schoenus, Gazania, Leucopogon, Flagellaria, Playtsace, Elaeocarpus, Goodenia, Bossiaea, Empodisma, Apium, Ricinocarpos, Fontainea* and *Ageratum*. The niche overlap between honeybees and native bees could suggest exploitative competition by honeybees, however studies are needed where honeybees are rare or absent to better understand the foraging preferences of native bees.

Brittany Elliott has completed an Environmental Science degree with a Plant Ecology minor at the University of the Sunshine Coast. She has a strong interest in research, Brittany completed her BSc (Honours) studying the floral diets of bees in the heathlands of SEQ using DNA metabarcoding. She has been volunteering since she was 16 for various catchment care groups and zoos whilst completing her undergraduate studies. She is currently the Qld Frog Society Sunshine Coast coordinator. Brittany loves everything from frogs, birds, fungi and insects, but especially bees with her favourite being *Xylocopa*. When she is not at uni, she can be found out herping, bushwalking with a camera in hand and occasionally scuba diving off Mooloolaba.

1|2|4 Reproduction of the buzz-pollinated *Hibbertia exutiacies* in a fragmented landscape

Blackall, A. (1), D. Mackay (1) & M. Whalen (1)

(1) College of Science and Engineering, Flinders University, GPO Box 2100, Adelaide SA 5001.

Knowledge of the ecological interactions that link species within a community is critical for effective conservation. Given that the majority of the world's flowering plants are pollinated by animals, recent declines in important groups of pollinators are of conservation and economic concern. Both habitat loss and fragmentation are considered major drivers of declines in pollinator abundance and diversity. In turn, pollination and plant reproduction typically decline in such disturbed landscapes. Here, we use the common, bee-pollinated, sclerophyllous undershrub, *Hibbertia exutiacies*, to examine the impact of landscape disturbance on pollination and plant reproduction. The study was undertaken in conservation reserves within the fragmented landscape of the Adelaide Hills of the Mount Lofty Ranges, South Australia. Experimental manipulations and observations confirmed that *H. exutiacies* is dependent on floral visitors to reproduce. Effective pollination was performed by suitably sized native bees capable of buzz-pollination. Due to low levels of observed visitation by native bees to the flowers of *H. exutiacies* and apparent low levels of reproduction, pollen-limitation experiments were conducted. Fruit-set, but not seed-set, of *H. exutiacies* was significantly pollen-limited in the spring of 2017 but not 2018. Spring rainfall, and its potential influence on floral resource abundance, may explain the contrasting results between years. In terms of habitat loss and fragmentation, there was no trend for increased pollen-limitation of fruit-set within smaller conservation reserves in 2017. Thus, although plant production of fruit was typically low, access to effective pollination did not appear to decline with decreasing conservation reserve area.

Alex Blackall is a current PhD candidate at Flinders University. His research focuses on the spatial variability of pollination, reproduction, and levels of seed predation for selected plant species in the fragmented landscape of the Mount Lofty Ranges, South Australia.

1|2|5 Are your larvae safe? Use of bee's as hosts in the wasp genus *Gasteruption* (Gasteruptiidae: Evanioidea)

Ben A. Parslow (1,2,4), Michael P. Schwarz (1), Mark I. Stevens (2,3)
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(2) South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia.
(3) School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia

The life cycle of mass provisioning bee species provides a system where parasites are readily able to exploit dense aggregations of resources. Of all the villains of this story, the wasp genus *Gasteruption* are easily recognized wasps whose larvae are predator-inquilines in the nests of ground and stem nesting bees (Apidae, Colletidae, Halictidae and Megachilidae) with some records for solitary wasp hosts (Crabronidae, Vespidae and Sphecidae). They are regularly encountered at artificial 'bee hotels' and collected at floral resources with bees, but there is conflicting information about the biology and host associations for the genus with a lack of information for the majority of the world's biogeographical regions, particularly Australia. We have concatenated all available literature records pertaining to the biology of adults, host associations and larval development and conclude that bees hosts are more frequently utilized than wasp hosts (71 bee, 13 wasp species), with the majority of wasp observations without sufficient data to be confident of the host association. *Gasteruption* wasps have a preference for bee hosts nesting in stem and wood nests (76 species) over ground nests (8 species) with most species recorded from a single host. From data available, approximate rates of host nests with parasitised brood is low, between 4–7%. We also highlight the need for collaboration with Australian bee researchers to resolve the mysteries between bees and their villainous parasites.

Ben Parslow is a newly appointed collection manager for terrestrial invertebrates at the South Australian Museum. His primary research interests involve Hymenoptera (ants, bees and wasps) systematics and host-parasite interactions. His doctoral research has focused on the systematics of the wasp family Gasteruptiidae which are parasitoids of larvae in the nests of native bees and some wasps.

Gasteruption inferius,
by Jenny Thynne

Homalictus,
by James Dorey Photography

1|2|6 Modelling above and below ground climate for *Homalictus* bees: Hands on with NicheMapR

Elmer, M. (1), M. I. Stevens (2, 3) & M. P. Schwarz (1)

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Climate is one of the most important influences on species and ecosystems. It plays a major role in defining the distributions of species and can have significant impacts on evolution and diversification. To understand the influence of climate on a species it is important to know what climate it is actually experiencing. Although there are now many excellent global climate resources such as WorldClim and CHELSA the resolution of these layers is ~1km at the equator. This may be a sufficient resolution for many studies, but climate can vary on much finer scales. For species that have small ranges, live in topographically complex areas or live near or beneath the ground surface, finer resolution climate data might be more suitable. This high-resolution climate modelling can be achieved with the use of NicheMapR. This recently released R package can account for the interaction of climate with terrain features such as elevation, slope, aspect and horizon angles, in addition to various soil properties, to accurately predict both above and below ground climate conditions. This can be useful to a vast array of scientific investigations such as correlative and mechanistic distribution modelling, agent-based modelling, broad scale ecology and investigations on evolution and development. It can be used for any location around the world and is completely free. Because NicheMapR can model both above and below ground conditions it is especially useful for investigating the ecology and evolution of ground nesting bees. Here, I outline the basics of how to use NicheMapR, and how we have used it in combination with evolutionary genetics to study the ecology and evolution of Fijian *Homalictus* bees- a species-rich group of ground nesting bees that are important pollinators. With the growing threat of climate change, research into the influence of climate on species biology has become increasingly important.

Matt Elmer grew up around Brisbane and has always had a passion for science and nature. After graduating from the University of Queensland in 2015 with a Bachelor of Science majoring in Ecology and Genetics, he has spent time volunteering and working in a range of scientific fields, research groups and locations. This included research in ecology, entomology and agriculture with multiple labs at UQ and the Pest Suppressive Landscapes team at CSIRO. Most recently, Matt completed an Honours project at Flinders University under the supervision of A/Prof Mike Schwarz and A/Prof Mark Stevens. Here he was able to combine evolutionary genetics and climate modelling to research the *Homalictus* bees of Fiji - a fascinating group of bees that display remarkable species diversity and unusual distribution patterns.

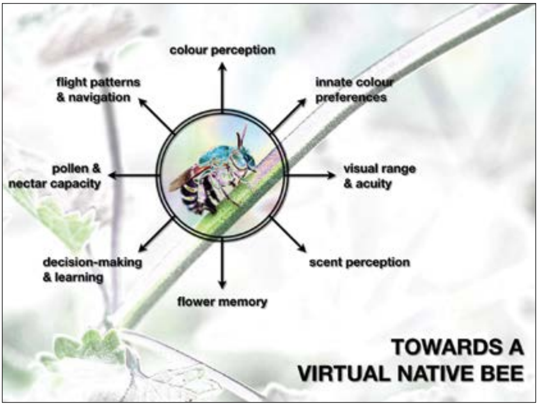
1|2|7 A few things a computer scientist has learnt about bees through simulation, modelling and machine learning

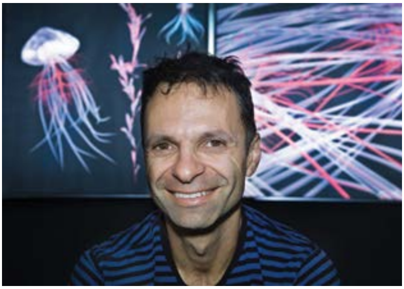
Dorin, A.

Faculty of Information Technology, Monash University, Wellington Road. Clayton VIC 3800

Interdisciplinary research has many benefits. Among them is that the researchers involved have the benefit of discovering whole new fields. In this way they can learn new (and amazing) things that are common knowledge to those based in the other discipline, and contribute fresh perspectives to solve important global problems. In this talk I'll present a few things I've learnt about bees. I'll describe some simulations and software my team has built in collaboration with ecologists, evolutionary biologists, botanists, entomologists, fruit/vegetable growers and seed producers. These simulations help us understand how to preserve the bees and flowering plants of our native ecosystems, and to secure our human food supply under a changing climate. In addition, the need to parameterise and calibrate simulations raises questions for we which require specific answers for our native Australian bees. What do they perceive? How do they learn? What strategies do they use when they forage? How do they make decisions? How do they navigate in complex environments? Answers to these questions will enable us to tailor simulations specific to the Australian pollination context.

Alan Dorin is an academic in the Faculty of Information Technology at Monash University. He is an Artificial Life researcher, a Computational Ecologist, and a generative artist working in electronic media. His interests include ecosystem simulation and agent-based modelling, artificial chemistry, self-assembling systems, the evolution of complexity, the history and philosophy of science, technology and art, and the links that bind all fields together. His major applied research focus addresses the global insect crisis by developing new simulations to improve agricultural and natural ecosystem pollination, and to better understand the relationships between insects and plants under a changing climate.





1|3|1 Ultraconserved element phylogenomics: A one-stop shop for advancing native bee systematics, taxonomy, and identification

Michael G. Branstetter

USDA-ARS, Pollinating Insects Research Unit, 5310 Old Main Hill, Utah State University, Logan, UT 84321, USA

Next-generation sequencing and genomic laboratory methods have driven a revolution in molecular systematics, with average dataset sizes growing from tens to hundreds or thousands of genetic loci in relatively short time. Among competing genomic approaches being used in systematics research, the targeted enrichment of conserved genetic elements, especially ultraconserved elements or UCEs, has become a favored tool for answering questions at all phylogenetic time depths. In this talk, I present an overview of the UCE approach to phylogenomics, outline the development of the method in Hymenoptera, and detail how it has been customized and applied to native bee systematics research. I will then present several examples of how I have used UCE data to address unresolved questions in bee systematics and evolution, from relationships among families to uncertainties in species boundaries, and I will discuss how UCE data can be used in bee species identification. Given the relatively low cost and broad applicability of UCE data, I argue that focused, collaborative efforts to generate UCE data for national or global bee diversity projects would be of lasting value for bee systematics and conservation long into the future.

Dr. Michael Branstetter is currently a Research Entomologist for the U.S. Depart. of Agriculture, Agricultural Research Service, and works in the Pollinating Insects Research Unit in Logan, Utah. His research aims to integrate the use of modern molecular methods into bee systematics research in order to improve upon knowledge of bee classification, phylogeny, and taxonomy. A major goal of his work is to create new resources and methods for bee identification in an effort to speed up the identification process and to make it easier to survey and monitor bees in the U.S. Dr. Branstetter received his Ph.D. from the University of California in Davis and held two postdoctoral positions, one at the Smithsonian's National Museum of Natural History in Washington, DC and one at the University of Utah in Salt Lake City, UT. For most of his career, Dr. Branstetter studied the molecular systematics of Neotropical ants, but over the last five years, he has helped to develop novel phylogenomic methods for use in insect and especially Hymenoptera phylogenomics. He is currently applying these new phylogenomic methods to help resolve taxonomic issues in the bees of the United States and the World.

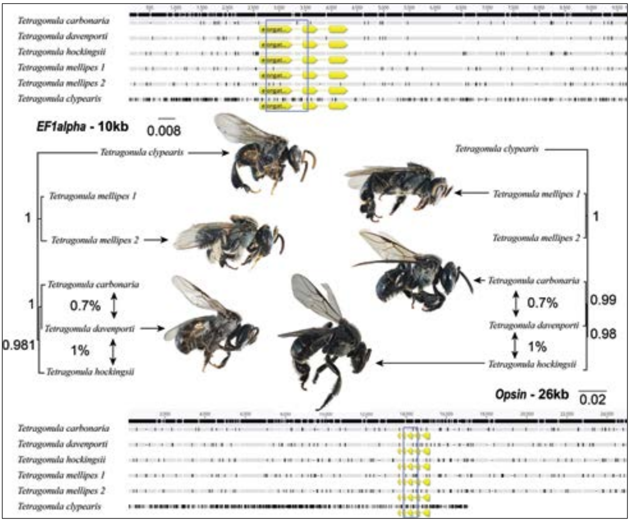
1|3|2 Which genetic markers are best for assessing stingless bee diversity?

James Hereward[1], Tobias Smith[1], D. Brookes[1], M. Finlay-Doney[2] & G. Walter[1]

1 School of Biological Sciences, The University of Queensland, St Lucia, Brisbane, 4072.
2 Berrimah Agricultural Laboratory, Northern Territory Department of Primary Industry and Resources, GPO Box 3000 Darwin NT 0801

Stingless bee genetic studies have mostly relied on a couple of short mitochondrial gene sequences and a couple of short nuclear gene sequences. We sequenced the genomes of *T. carbonaria, T. hockingsii, T. davenporti, T. mellipes* and *T. clypearis*, *Austroplebeia australis* and *A. cassiae*. We assembled the complete mitochondrial genomes of these bees and find that the commonly-used 16S region is highly conserved compared to the rest of the mitogenome, which is highly divergent across species. We also find evidence for two species within what is currently known as *T. mellipes* from Darwin. One often-used nuclear gene, EF1alpha, is invariant across *T. carbonaria*, *T. davenporti*, and *T. hockingsii*. We extracted 10,000bp of sequence from around this gene from the genome assemblies and found that there are differences across the species, but the divergence in the nuclear genomes is much lower than in the mitogenomes. Our results provide the resources from which well-designed markers (both nuclear and mitochondrial) can be developed for biodiversity studies in stingless bees.

James Hereward is a research fellow in the School of Biological Sciences at the University of Queensland in Brisbane. He is interested in using genetics and genomics to better understand ecology and evolution, and insect-plant interactions in particular. James runs a bioinformatics discussion group, and is interested in taking new genomics approaches developed in humans and applying them to plants and insects.



1|3|3 Cryptic diversity in Australian *Tetragonula* and the mito-nuclear speciation hypothesis

Ros Gloag 1, Brock Harpur 2, Ben Oldroyd 1

1 School of Life and Environmental Sciences, The University of Sydney. 2 Department of Entomology, *Purdue* University

Stingless bees are the only eusocial bees native to Australia, and among the most tractable of our native bees for use as managed crop pollinators. They are also experiencing a huge surge in popularity as pets, making them important ambassadors to the public for all Australian native bees. The *Tetragonula* species of the "*carbonaria* species complex" are particularly widely propagated. Despite all the outsized attention, the diversity and population structuring of this cryptic group remains poorly resolved, particularly in northern Australia. Current evidence indicates much higher divergence of mitochondrial genes than nuclear genes both within and between species as currently-defined. I propose that Australian *Tetragonula* may represent an example of speciation driven by mito-nuclear coadaptation. Under this hypothesis, high substitution rates lead mitogenomes to rapidly diverge in isolated populations, followed by compensatory changes in associated nuclear genes to maintain optimal cellular energy production. When populations come back into contact, hybrids suffer disruption of these coadapted mito-nuclear gene complexes, which reinforces population isolation. Several key aspects of the geographical distribution and behaviour of Australian *Tetragonula* would contribute to this process as a key driver of speciation. I will discuss how this hypothesis could be tested, and propose ways in which *Tetragonula* offer useful lessons on cryptic species diversity. I will also preview the recently sequenced *T. carbonaria* genome, a valuable resource for future work on stingless bees

Ros Gloag is a lecturer in evolutionary biology at the School of Life and Environmental Sciences, the University of Sydney. She researches the behaviour and genetics of bees in Australia, including invasive bees and native stingless bees.

1|3|4 The need for a molecular barcode library for Australian native bees

Katja Hogendoorn[1], Scott Groom[1], Mark Stevens[2], Remko Leijs[1,2]

1 The University of Adelaide, School of Agriculture, Food and Wine. 2 South Australian Museum

Identification of Australian native bee species is no easy task. This is due to four main impediments: (a) only about 55 % of known Australian bee species covered by keys; (b) many species are as yet undescribed; (c) a wealth of species are morphologically very similar; and (d) there is only a handful of experts that can check identifications. Due to these issues, students of bee ecology and pollination often place morphological identification of Australian native bees into the 'too hard basket'. Development of a DNA barcode library can help to resolve several of these issues. This library will provide key benefits, such as: (a) empowering ecologists to reliably and cost effectively identify their specimens; (b) help in the recognition of cryptic species; (c) assist in the recognition of species that are new to science; (d) provide more accurate species range distributions; and (e) free up the time of specialists. Of crucial importance in the development and the use of such a library is that the specimens are reliably identified, that voucher specimens of barcoded bees are entered into a national insect collection, that obtaining barcodes is straightforward and simple and that the library is publicly accessible. We will discuss our approach in the creation of such a publicly available library that is currently well underway.

Katja Hogendoorn Assoc Prof from the School of Agriculture, Food and Wine, The University of Adelaide is a researcher who specialises in: foraging, nesting, and mating behaviour of solitary and primitively social native bees; taxonomy of native bees; revegetation strategies to enhance the resilience and quality of crop pollination services.

1|3|5 Working towards a DNA barcode reference library for the Australian bee species

Remko Leijs[1,2], Mark Stevens[2], James Dorey[2,3], Olivia Davies[2,3], Kit Prendergast[4], Katja Hogendoorn[1]

1 The University of Adelaide, North Terrace, Adelaide, SA, 5000. 2 South Australian Museum, North Terrace, Adelaide, SA, 5000, 3 Flinders University, Sturt Road, Bedford Park, SA, 5042.

4 Curtin University, Kent Street, Bentley, WA, 6102

Seven years ago we started the open access AUSBS (Australian native bees) project in the Barcode Of Life Data system (BOLD), which contained circa 290 barcodes and 98 species among which were several species new to science. Here, we report on a large scale addition to the AUSBS project, which aims to initiate a DNA barcode reference library of reliable identified Australian bee species. All five Australian bee families (Apidae 102, Colletidae 1540, Halictidae 268, Megachilidae 369, Stenotritidae 31) were represented in the 3770 specimens submitted for barcoding. Specimens were collected from all over Australia, mainly from 11 Bush Blitz surveys, private collection trips as well as fieldwork associated with PhD projects. Specimens are sequenced using high-throughput PacBio sequel system that also detects nuclear paralogues, as well as non-host DNA such as Wolbachia. The generated DNA barcode data will help future bee researchers with the identification of bee specimens, and the wide geographic and taxonomic sampling will inform about the spread of Wolbachia and aberrant genetic traits (e.g. nuclear paralogues) across taxa.

It will help in identifying undescribed species and it may help with placement of species in species groups. Resolving systematic problems at higher level (genus level and above) might only be possible using a multigene approach. A DNA-barcode reference collection will be housed at the SA-Museum and WA-Museum.

1|3|6 Making taxonomy more accessible to the growing community of Australian bee enthusiasts

Tobias Smith[1,2]

1 School of Biological Sciences, University of Queensland, St Lucia, QLD, Australia. 2 Bee Aware Brisbane, Brisbane, QLD, Australia

Australia has a growing community of native bee enthusiasts, numbering in their thousands. Enthusiasm in this community is high, and as such provides a potential reservoir of citizen scientists and future native bee professionals. Most native bee enthusiasts, however, have little or no training in bee identification and usually rely on direct assistance from professionals to perform reliable identifications. In addition, most resources for identifying bee species are tricky to use without guidance, and these resources are not often freely available to people outside of universities or other research institutions. Here I present the case that Australia's extensive community of native bee enthusiasts offers great potential for furthering our understanding of Australian bees, but that this community must be actively nurtured by bee researchers and bee taxonomists to become fully engaged and to be able to make reliable identifications and useful contributions. Steps that can be taken to work toward this includes making taxonomic keys more accessible to non-scientists, providing formal bee taxonomy training opportunities to non-university students and researchers, and encouraging taxonomists and researchers to publish resources outside of the traditional publishing system.

Tobias Smith is a bee researcher, educator and stingless bee keeper based on the Gold Coast. As a researcher Tobias is based at the University of Queensland. Tobias's research interests focus on stingless bee biology and ecology, wild bees in agricultural landscapes and native bee diversity and ecology. As an educator Tobias presents native bee and pollination workshops to community groups and schools, primarily through his business Bee Aware Kids. In addition, Tobias teaches full-day stingless beekeeping training workshops on behalf of Sugarbag Bees. As a beekeeper Tobias keeps native stingless bee hives around south-east Queensland and northern New South Wales, and helps to manage many more as a stingless beekeeping consultant.

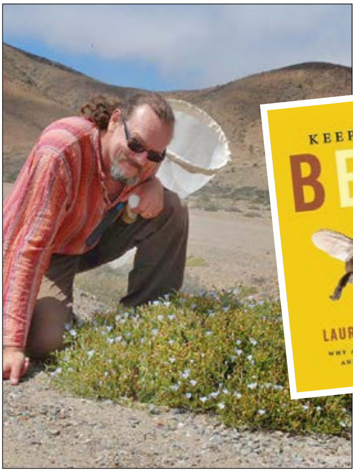
2|1|1 Bees: What's in a Name

Laurence Packer

Department of Biology, York University, Toronto, Canada

To a rough approximation, bees do not make honey, are solitary and do not live in hives. Furthermore, many of them either do not sting or do not work (some do neither). This will come as a surprise to almost everyone except melittologists. The reason for these misconceptions is obvious – the domesticated western honey bee possesses all of these properties, but it is just one of over 20,400 described bee species, of which over 1650 are found in Australia. Most people would not recognize most bees as being bees: even the average melittologist would not recognize some of the more unusual bees as being bees (and the most unusual ones are Australian). In this talk, I will survey bee diversity and then turn to problems associated with bee identification. What is in a name? What does it mean when a researcher identifies something as *Euryglossina leyburnensis*? A survey of over 900 entomological papers published in 2016 showed that taxonomic information is almost always treated in a way that is unscientific – impossible to replicate. I will explain how to make identifications replicable. I will then summarize the results of the campaign to obtain DNA barcodes for the world's bees. Approximately 30% of the world's bee species have DNA barcodes (assuming that total to be 21,000). For Australia, the figure is less than 20%. While it is not a panacea, this approach certainly helps, and I will provide some examples. Finally, I will discuss some issues that preclude progress in bee identifications.

Laurence Packer is a passionate melittologist and Professor of Biology at York University - well versed in the taxonomy, behaviour and ecology of bees. He aims to inform biologists and the wider community of the global diversity and importance of bees beyond commonly known managed bee species. Laurence completed undergraduate studies at Oxford University and undertook his PhD at the University of Toronto.



2|1|2 Lessons from population genomic studies of bees to detect recent demographic changes linked to the expansion and intensification of agriculture

Margarita M. López-Uribe

Department of Entomology, Center for Pollinator Research, Pennsylvania State University, University Park, 16802 USA

The development of effective conservation strategies to mitigate the negative impacts of environmental stressors on bee populations requires an understanding of key evolutionary and ecological processes. As populations of both managed and unmanaged bee species decline in different parts of the world, molecular tools can be used to estimate the time and severity of reductions in population sizes and the potential causes for these reductions. However, the suitability of genetic markers to detect demographic changes in historic and contemporary time scales remains to be tested for bees. In this talk, I will present a summary of the literature of population genetic structure and demography of bees. In addition, I will show empirical datasets for two case studies where population genomic markers were used to detect recent changes in bee population demography linked to the expansion and intensification of agriculture. Results from these studies highlight the power and limitations of genomic markers to investigate changes in demography in the context of bee conservation.

Margarita López-Uribe is an Assistant Professor of Entomology and the Lorenzo L. Langstroth Early Career Professor at Penn State University. She received her BS in Biology from Universidad de los Andes (Colombia), her MS in Genetics and Evolution from Universidade Federal de São Carlos (Brazil), and her Ph.D. in Entomology from Cornell University (USA). Before joining Penn State, Margarita was an NSF postdoctoral fellow at North Carolina State University (USA). Margarita is broadly interested in understanding how environmental changes associated with crop domestication, cultivation and agricultural intensification affect demography, health and long-term persistence of bee pollinator populations. In her research program, Margarita aims to promote science that incorporates the needs and views of an increasingly pluralistic society and globalized world.

2|2|1 Native Bee Prescription - Patient rehabilitation outcomes and experiences with a therapy Native Bee Hive at the Spinal Injuries Unit

R McBrien (1) & S Hamilton (2)

(1) Princess Alexandra Hospital, Woolloongabba. (2) Bee Yourself, Brisbane

Hospitals are stressful places in our community where we disconnect from Nature and enter the sterile field of the modern health service. Native Bees are a metaphor for many of the patient issues and experiences in hospital life. Our relativity to the natural world reflects our relationship with ourselves and others. The Spinal Injuries Unit is a 30 bed facility for patients who have suffered a catastrophic and devastating injury to their spinal cord. Patients stay in the spinal unit for anywhere between 6-18 months as they learn to rehabilitate mentally and physically back into life with permanent paralysis. Spinal patients often suffer an acute phase of care where they are bed bound for 24 hours a day with no connection or stimulation to the outside world. This presentation will outline the powerful effects of daily and seasonal interaction of patients with a native bee hive to spinal patients as a part of their rehabilitation. We will provide evidence of the measurable impact a native bee hive has had on spinal patient goals, wellbeing, quality of life and positive mental health outcomes. Integrating bee observations into a patient's daily therapy adjunct to traditional treatment has proven to have vast medical effects on the body. Prescribing time with native bees will improve cardio-vascular and sensory retraining, enhance cognitive and physical development and develops positive psychology outcomes. This humble native bee hive has had a huge impact on patient community, stress reduction and vast improvement in patient quality of life and purpose.

Sarah Hamilton is a horticulturalist, has specialised in native stingless bee keeping for more than six years and is a passionate advocate for the important pollination role that bees play in the environment. Her primary focus is on raising awareness, providing education and consultation services, and supplying hives and accessories for new bee custodians.

Renae McBrien is a Radiographer, Horticultural Therapist and Recycling Consultant for Queensland Health. She is a passionate about connecting the community with nature and has created over 6 Community Gardens in Brisbane. She uses native bees to deliver meaningful care to our patients and community by allowing them to engage with their senses and rhythms of nature while being more active in our community and environment. Her work has been captured by the ABC War on Waste and has been viewed over 3.7 million times. She has received multiple awards for her work.

2|2|2 The B & B Highway: Creating pollinator habitat corridors across Sydney to promote biodiversity and citizen science engagement

Friedlander, J.

Institute for Sustainable Futures, University of Technology Sydney

The 'B & B Highway' – 'Bed and Breakfasts for Birds, Bees, Butterflies' and other pollinators – was launched in January 2019 by the Planting Seeds (FoodFaith) organisation in response to the alarming research into pollinator decline and research indicating that cities can be biodiversity hotspots. By year-end the 'Highway' will host 30 'pollen booths' across Sydney, located primarily at schools. These B & Bs or pollen booths feature a range of pollinating plants and a stingless native beehive or insect hotel. With the backing of the NSW Department of Education, school children will utilise a citizen science app, the Pollinator P.I. (Private Investigator), to feed data on pollinators and plants at their local B & B into a national biobank of data. The app will enable users to take images of pollinators and plants through a mobile device, upload the data into a repository and receive identification information. The data will contribute to further knowledge and research relating to the state of biodiversity in Australia and contribute to research conducted by the CSIRO. The NSW Department of Education is also developing curriculum materials to complement and respond to the B & B Highway initiative. It is anticipated that more schools will 'join the dots' on the B & B Highway on an ongoing basis.

Judy Friedlander is an academic, journalist and the founder of Planting Seeds (FoodFaith), an organisation that works to promote sustainability through pollinator and community gardens. With a background in newspapers (Sydney Morning Herald and The Sun-Herald), television (Channel Nine producer) and web media, Judy currently works as a postgraduate researcher at the Institute for Sustainable Futures at the University of Technology Sydney. She has this year submitted her PhD on the 'how to' of switching people on to sustainability in the age of the infoglut and eco-anxiety and brings a wealth of experience to the subject.

2|2|3 What's the buzz all about? - Creating a floral banquet for native pollinators

Schmidt, L.A. (1), A.-M. Gilpin (1), J.M. Cook (1), P. Rymer (1), P. Gibson-Roy (2) & S.A. Power (1)

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Within agroecosystems, large-scale, mass-flowering monocultures associated with many crop species offer wild bees only a short-term bountiful floral resource in an otherwise florally depauperate landscape. Outside of this floral window, resources may be scarce, with negative implications for native bee populations and consequently pollination services to both native flora and agricultural crops. Particularly protein-rich pollen is crucial for bee nutrition and colony viability, and a varied diet of diverse pollen and nectar sources ensures bee health and longevity. Wildflower strips have been shown to support pollinator populations within intensively managed agricultural areas in the Northern Hemisphere. Targeted plantings of locally adapted, native flowering plants can increase floral resources for resident pollinator communities, especially outside of crop flowering times. However, in Australia relatively little is known about the extent to which different pollinator groups exploit and benefit from the floral resources in vegetation adjacent to crops, and how plant species differ in their relative contributions to resource provisioning throughout the year. Our project will provide valuable insights into the efficacy of native floral enhancements in maintaining and supporting pollinator populations in Australian cropping systems, specifically the economically and locally important apple industry. Selected native and exotic plant species will be established as on-farm floral enhancements in apple orchards to support wild insect pollinators, potentially reducing dependence on introduced, managed honeybees. The information obtained will help identify Australian native plant species for on-farm floral enhancements that successively flower throughout the year, and which attract a diverse array of native pollinator species. These data will inform decisions for the development of an Australian native wildflower seed mix for use by growers to support healthier bee populations in Australian agroecosystems.

Lena Alice Schmidt is a PhD candidate at the Hawkesbury Institute for the Environment, Western Sydney University. She is interested in research at the interface of plant-pollinator interactions and landscape ecology, and how pollinators respond to floral resource availability within disturbed (e.g. burned) or highly transformed (e.g. agriculturally intensified) landscapes. Her current project is focused on selective floral enhancement of native flora for healthy and diverse pollinator populations in Australian agro-ecosystems under climate change.

Lena Schmidt

Kit Prendergast

2|2|4 What's the best method for monitoring bees?: an empirical test and review of the literature

Prendergast, K.S. (1), M.H.M Menz (2), K.W. Dixon (1), and P.W. Bateman (1)

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Many bee species are declining globally, but to detect trends and monitor bee assemblages, robust sampling methods are required. Numerous sampling methods are used, but a critical review of their relative effectiveness is lacking. Moreover, evidence suggests the relative effectiveness of sampling methods depends on habitat, yet efficacy in urban areas has yet to be evaluated. This study compared the bee community documented using observational records, targeted netting, mobile gardens, pan traps (blue and yellow), vane-traps (blue and yellow), and trap-nests in the urbanised region of the southwest Australian biodiversity hotspot. Our results were compared to a comprehensive literature review of studies where two or more bee sampling methods was conducted. Observational records exceeded all other methods in terms of abundance of bees, but was unable to distinguish finer taxonomic levels. Of methods that captured individuals, targeted sweep netting vastly outperformed the passive sampling methods, yielding a total of 1,324 individuals, representing 131 taxonomic units - even when deployed over a shorter duration. Analysis of the literature revealed high variability in relative effectiveness, but targeted sweep netting and blue vane traps tended to be most effective. Results from our study differed from most studies in the extremely low catch rates in pan traps. Species using trap-nests represented only a subset of all potential cavity-nesters, and their relative abundances in the trap-nests differed from that in the field. Mobile gardens were ineffective at attracting bees. For this urbanised yet biodiverse region, targeted sweep netting is indispensable for obtaining a comprehensive indication of native bee assemblages; passive sampling methods alone recorded only a small fraction of the native bee community. Overall a combination of methods should be used, as each have their own biases, and certain taxa were well-represented in some methods, but poorly represented in others.

Kit Prendergast is a native bee researcher from Western Australia. She is currently doing a PhD at Curtin University, under a Forrest Scholarship. Her thesis is titled "Determinants of native bee assemblages in urban habitat fragments in the southwest Australian biodiversity hotspot and interactions between honeybees *(Apis mellifera)* and native plant-pollinator communities." Kit has a passion for the natural world and gets a real buzz when going out in the field to conduct native bee surveys. Her surveys have underscored the incredible diversity of Australia's native bees that occur within the urban milieu of the southwest Western Australian biodiversity hotspot. Kit aspires for her research to lead to science-based actions for conserving thriving native bee assemblages.

2|2|5 Honey of Stingless Bees – Need for a standard

Dean Haley
Team leader – Australian Native Bee Association – Honey subcommittee

The honey of stingless bees is collected in large quantities, and marketed in beautiful packaging throughout South East Asia and the Americas. Despite a deep history of use and a thriving industry, stingless bee honey throughout the world resists attempts to define it using modern Food Standards. In fact, only Malaysia has successfully created a stingless bee honey standard (in 2017). In Australia, we also have a deep history of using stingless bee honey, and our modern bee-keepers are creating a market for this unique Australian product, and finding better ways to extract our honey. But our fledgling industry has a problem; we cannot label our product "honey" as it may confuse the consumer, who might think its European Bee "honey" for which a food standard already exists. One solution to this, is to create an Australian food standard that defines our honey, and gives it a new official name (such as "Native Honey" or "Stingless Bee Honey"). My talk will discuss the reasons and efforts so far, in creating a food standard for our honey.

Dean Haley lives in Brisbane, and runs a "large hobby" breeding and selling native bees. Dean is a founding member, and current President of the Brisbane Native Beekeepers Club (ANBA – Brisbane Branch). Dean also helped to set up and organise the Australian Native Bee Association, and was an organiser for last year's (and this years) Australian Native Bee Conference. I think it's fair to say that Dean likes bees. During the work week, Dean works at a successful Brisbane Biotech company, where he has held roles as senior Production scientist, Facilities and Engineering leader, and in Work Health & Safety. Dean is passionate about sharing his love of our Australian Stingless Bees, and likes working in harmony with nature and community.

2|2|6 Food for thought for an emerging industry

Taylor, S. & J. Shanks
Plant Health Australia, Phipps Close, Deakin, ACT 2600

Emerging animal and plant industries play an important role in the development of the Australian agricultural landscape. They contribute to the national economy, plant and animal diversity, and will assist in meeting changing global food demands. Australia's native bee industry is considered an emerging industry. In the last 10 years there has been considerable enthusiasm and growth in rearing native bees for personal interest and commercial use such as pollination and sugar bag production. Much of this interest stems from broad concerns about global bee decline, the impacts from honey bee pests such as varroa mite, environmental impacts on availability of bee food resources, increase chemical usage, lower food security and questions on feeding a growing population. The native bee industry has already been supported by the formation of the Australian Native Bee Association, the development of native bee honey standards, improvements to market accessibility and the ongoing pollinator awareness through community and school educational programs. It is a timely opportunity to reflect on the benefits of this growing enthusiasm. But also identify gaps for future research, as well as collaboration opportunities with government and other industry stakeholders to meet the service demands for healthy native bees. This talk will introduce the broad considerations, 'food for thought', for an emerging industry with particularly focus on bee health and management.

Jenny Shanks has an honours degree in horticultural science from the Western Sydney University, and completed her PhD in 2015 investigating stingless bee behaviour and disease control. Jenny started working at PHA in 2016. Her current role, as Bee Pest Surveillance Coordinator, involves managing the national surveillance program for exotic honey bee pests and diseases at Australia's ports of entry. She is also involved in the interim committee for the Australian Native Bee Association and continues to encourage activities which promote and support healthy populations of stingless bees, other native bees, and honey bees.

2|2|7 Wheen Bee Foundation and the 'Rita Fund' for Australian native bee research

Fiona Chambers

Wheen Bee Foundation, 96 Harbours Rd, Yendon, Vic 3352

Wheen Bee Foundation is Australia's only registered charity for bees. It manages a Deductible Gift Recipient Fund for research into the causes, prevention and cure of diseases in bees as well as into plant health as much as it is impacted by pollination. During Australian Pollinator Week, 10-17 November 2019, Wheen Bee Foundation launched a tax deductible fund exclusively to support native bee research in Australia. The fund has been named the 'Rita Fund' in honour of the Australian Pollinator Week mascot, Rita the reed bee. The Australian Green Carpenter Bee project provides an example of the kind of research the Rita Fund can support and the way Wheen Bee Foundation can work in collaboration with other funding partners to raise funds for specific causes. Donations to the Green Carpenter Bee Project will be matched dollar for dollar by Flow until 25th December 2019. The aim is to replicate this funding model across a range of projects and help raise awareness and much needed funds to enable more native bee research in Australia. For more information or to make a donation to the Rita Fund for native bee research

https://www.australianpollinatorweek.org.au/donate/

Fiona Chambers, CEO of The Wheen Bee Foundation has studied and worked in agriculture for more than 30 years as a farmer, business manager, consultant, lecturer and leadership development trainer. She has a keen interest in farm livestock, genetic conservation, sustainable agriculture, good food and how they interconnect. Fiona is a Churchill Fellow, ISS Fellow and a graduate of the Williamson Community Leadership Program.

WHEEN BEE FOUNDATION

2|3|1 How can genomics help pollination ecology?

Saul A Cunningham

Fenner School of Environment & Society, ANU

Over the past twenty years we have seen intense research interest in issues related to bees as pollinators (especially of food crops) and environmental pressures on their populations. This activity is reflected in a rapidly growing research literature. Our understanding has grown accordingly and we have a good understanding of high level patterns, such as the pattern of species richness responses to configuration of natural habitats and the relative dependence of many different crops on pollinators. In some parts of the world this is matched by good levels of knowledge regarding species-level ecology. But in much of the world, including Australia, it is remarkable how thin our ecological knowledge is regarding anything but quite general phenomena. One of the main impediments to progress is our capacity to efficiently determine at minimum how many species are present, and then to identify individuals to species level using an approach that is consistent across multiple studies. Our hope is that genomic methods can solve this problem. Using these tools we could then ask, with confidence, how much do bee assemblages differ from place to place (beta diversity)? How do bee assemblages respond to floral community composition? And for crops, how does the contribution of the many low abundance species compare to the few abundant ones?

Saul Cunningham is currently Director of the Fenner School for Environment and Society at the Australian National University. Prior to this role he spent 17 years with CSIRO in Canberra. Pollination has been a major theme in his research. He has published papers on the importance of crop pollination to food production in the world's major science journals. His research team has worked on pollination of a range of crops in Australia, including Almonds, Apples, Faba beans and Canola. Along the way he has worked with farming industry groups, local landholder groups, and a wide network of international colleagues with shared interests. He was a contributor to the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) assessment report on Pollination and Food production, 2016.

2|3|2 Global scale drivers of crop visitor diversity and the historical development of agriculture

Julian Brown

Fenner School for Environment & Society, Australian National University, Canberra, ACT, Australia

Understanding diversity in crop-visiting bee assemblages helps us improve pollination of crops and support better biodiversity conservation outcomes. Much recent research has focused on drivers of crop-visitor diversity operating over spatial scales from fields to landscapes, such as pesticide and habitat management, while drivers operating over larger scales of continents and biogeographic realms are virtually unknown. Flower and bee traits influence attraction of bees to flowers, and evolve in the context of associations that can be ancient or recent. Plants that have been adopted into agriculture have been moved widely around the world and thereby exposed to new flower visitors. Remarkably little is known of the consequence of these historical patterns for present day crop-visiting bee diversity. We test three hypotheses: 1) crops will attract more bee taxa in their regions of origin compared to other realms, 2) crops will attract more bee taxa in regions where their family has had the longest evolutionary history with local bees, and 3) suites of native crops will collectively support more bee taxa than suites of exotic crops grown in each region. The best available data to test these hypotheses were lists of bee genera recorded visiting crops in published journal articles from around the world. In this talk I describe the findings from this analysis, and how it might be improved with bee genomics.

Julian Brown completed his PhD in fire and pollination ecology at the University of Melbourne in 2016. Since 2017 he has been a post-doctoral research fellow at the Australian National University where he is studying wild bees in agricultural landscapes.

2|3|3 Functional pollination traits and phylogenetic relatedness: linking native Australian bee communities to fruit yield and quality

Olivia M. Bernauer, James M. Cook, Simon M. Tierney

Hawkesbury Institute for the Environment, Western Sydney University, Richmond, NSW Australia

Many studies of biodiversity focus on species richness to measure biodiversity - this data is often simple to collect and informative because species richness positively correlates with ecosystem health. Alternatively, taking a trait-based 'functional diversity' approach to evaluate a pollinator community, we can generate both species richness data and provide more useful insights as to how a community of bees behaves and facilitates pollination services in different environmental settings. Functional traits include morphological, behavioural, biochemical, physiological, structural, or phenological characteristics of individual organisms. Closely related species are likely to share traits, so pairing functional diversity with a phylogenetics approach links evolutionary relationships with functional traits. This study aims to use both trait-based and phylogenetic evolutionary approaches to understand Australian bee communities visiting apple flowers in a region where fruit orchards are surrounded by pristine national parklands (Blue Mountains NSW), compared with a region where orchards are located in a highly agricultural landscape (Central West NSW). Further comparisons will be made between the pollinator communities found on crop flowers and on other floral resources within 100m of the crop to understand similarities and differences between the functional and phylogenetic diversity in these communities. Ultimately, this research aims to link the natural history of bee community characteristics to apple fruit set and fruit quality.

Olivia Bernauer is a second year PhD student at the Hawkesbury Institute for the Environment at Western Sydney University. Her current research focuses on understanding apple pollination in NSW, specifically: pollinator foraging behavior, pollinator effectiveness, and the functional diversity of apple pollinator communities. She is also investigating the life cycle, nesting biology and social organization of a common apple pollinator species in the lower Blue Mountains.

2|3|4 Generalist pollinators as biomonitors of plant communities

L. Milla, A. Schmidt-Lebuhn, J. Bovill, F. Encinas-Viso

Centre for Australian National Biodiversity Research, CSIRO, Canberra ACT, Australia

The detection and monitoring of changes in plant community composition is becoming an increasing concern, as climate change begins to impact the occurrence and distribution of many plant species. Plant identification from pollen carried by pollinators is an approach that could be employed to monitor vegetation changes in a landscape. Pollen DNA metabarcoding, a novel genomic method, has been recently demonstrated to improve detection and identification of plant species from a mixed pollen sample compared to traditional microscopy. We applied pollen DNA metabarcoding in the identification of plant species from pollen collected by European honeybees (*Apis mellifera*), a widely-distributed generalist pollinator, from managed beehives located within an urban reserve. Using two metabarcoding markers, trnL and ITS2, we analysed the plant composition of three different pollen sources associated with honeybees: pollen from the bodies of individual bees, pollen collected in pollen traps and honey produced by the hive. Pollen metabarcoding from individual bees was able to detect up to 50% of the species observed flowering in the study area, but also many other species initially undetected by our vegetation survey. We compare how each of the pollen sources (individual bees, honey and pollen traps) reflects the composition of the surrounding plant community, with each substrate representing a different time window or level of resolution. We discuss the potential of using bees as biomonitors of plant diversity, and the potential role of pollen DNA analysis in the long-term monitoring of plant community structure, including the reconstruction of historical plant distributions through the use of museum pollinator specimens.

Liz Milla is a postdoctoral fellow at CSIRO with the Environomics FSP Mapping Pollinator Networks project. Liz's current research uses ecological and genomic tools to reveal interactions between plants and their insect pollinators. Her research on pollinator networks will contribute to biodiversity identification and help detect keystone plant and insect species for targeted conservation and management strategies.

2|3|5 Effect of climate change in Australian alpine plant-bee communities

Francisco Encinas-Viso

Centre for Australian National Biodiversity Research, CSIRO National Facilities and Collections, Canberra ACT, Australia

Alpine ecosystems around the world are threatened due to climate change. The presence of pollinators is critical for the reproduction of many alpine plant species, however the shrinking of alpine ecosystems and changes in species phenologies might drive a rapid decline of plant-pollinators interactions that we are unaware. In this study, we aim to investigate the effects of climate change in alpine plant-pollinator communities. We have analysed changes of a plant-bee pollinator community in the Australian Alps using as a baseline plant-pollinator community data collected 30 years ago and comparing it to recent data. We have used traditional methods (flower-visitor observations) and novel approaches (pollen DNA metabarcoding) to quantify plant-bee pollinator network structure, as well as changes in phenology and community composition. We found changes related to network structure (e.g. modularity) and significant changes in community composition and relative abundances, however mostly related to changes in plant community structure. Furthermore, we found that DNA metabarcoding methods provide few advantages over traditional methods such as detailed semi-quantification of native bee diets and some insights about bee mobility and pollen flow across the landscape. Overall we found evidence that suggests that climate change is altering Australian alpine plant-bee pollinator network structure, but no clear evidence about changes in alpine native bee diversity.

Francisco Encinas-Viso is a research scientist with the Australian National Herbarium and Centre of Australian National Biodiversity Research at CSIRO. His main research areas are: eco-evolutionary modeling, pollination ecology, conservation genetics, spatial ecology and theoretical ecology. Francisco is very involved in the development of software tools for conservation ecology and biodiversity research.

Amphylaeus morosus by James Dorey (See pages 73, 75 and 77)

2|4|1 What is an effective pollination service? Why a better understanding of bee behaviour is critical for crop production

Helen Wallace

Environmental Futures Research Institute, Griffith University, Nathan, QLD 4111

There is growing recognition of the need for bees in general and native bees in particular to provide pollination services for crops. However, pollination services are often assumed to have been provided simply if bees are present on flowers. Crop breeding systems are complex and this can have major implications for pollination. Many tree crops show some degree of self-incompatibly, meaning that cross pollen is needed to produce fruit set. Self-pollen is any pollen of the same genoptype. Horticultural crops often consist of large plantings of clonal cultivars, and so pollen from the same cultivar is self-pollen, even if it is from a different tree or orchard. This means that bees depositing self-pollen on the stigma are ineffective pollinators. Furthermore, the genotype of the pollen can affect fruit characteristics such as size, seediness, and shelf life and so the type of pollen that bees carry is an important consideration even in self-compatible crops. Some crops have male and female phases and others have separate male and female flowers. Effective pollination is not likely to occur if bees are attracted to only male or only female flowers. Recent research in macadamia orchards has shown that 80 -100 % of the nuts at harvest have resulted from a cross pollination event. Cross pollen had to be transported at least 8–100 m by bees. In some cases, pollen was transported more than 1.2 km. Hand pollination of whole trees increased nut yields by around 1 tonne per ha, indicating that current pollination services provided by bees were suboptimal. We need to better understand bee behaviour, including what flowers they are attracted to, what genotype of pollen they carry, and how far they move in crops, to ensure effective pollination services.

Helen Wallace is Professor of Agricultural Ecology and Group coordinator, Food Futures, Environmental Futures Research institute at Griffith University. Helen's research is focused on the science of plant reproduction and entomology. She has been a bee and pollination researcher for 30 years. Her interests include both theoretical and applied aspects of bee biology, ecology, forestry, horticulture and conservation. Her research projects include topics in landscape ecology, pollination, bee ecology, fruit production, seed dispersal, agroforestry and natural products from plants and bees. She leads large teams of researchers in projects on sustainable food production in Australia and Pacific Island countries.

2|4|2 Floral visitation rates of stingless bees in avocado orchards across transitional floral phases

Cannizzaro, C.[1], Wilson, R.S.[1], Elliot, B[1] & H.M. Wallace[2]

[1]GeneCology Research Centre, University of the Sunshine Coast, Sippy Downs Drive, Sippy Downs, QLD 4556 & [2] Environmental Futures Research Institute, Griffith University, Nathan, QLD 4111.

Avocados are an important food crop in Australia and in recent times, both consumption and production has increased creating a demand that must be met by Australian growers. The production of high yielding avocado crops is limited by pollination efficiency that is mostly serviced by European honey bees (*Apis mellifera*). As avocado production expands, alternative and complimentary pollination services will need to be considered in order to diversify the dependence of crop success. In this study we explore the foraging behaviour of native stingless bees (*Tetragonula carbonaria*) in avocado orchards to assess their suitability as potential, complimentary pollinators alongside honey bees and syrphid flies. To achieve this, we examined floral visitation rates of stingless bees, honey bees and syrphid flies by performing 5-minute, timed observations of replicated 1 cubic metre quadrats in tree canopies at three floral phase transitions: 1) female, 2) female and male and 3) male. We repeated the experiment over two replicate years in Hass cultivar orchards and one year in Shepard cultivar orchards to account for variation in floral phase transitions. Floral visitation rates per cubic meter of canopy was compared between floral phases, which showed that honey bees had the highest abundance of floral visitation in all floral phases, in both cultivars, followed by syrphid flies then stingless bees. All insect pollinators showed increased visitation rates when flowers were in male phase, when pollen was abundant, and decreased in female phase, when nectar was abundant in both cultivars. Results from this study show stingless bees forage on avocado flowers and are a viable option as potential supplementary pollinators in avocado orchards, though further research using comparable stocking rates of stingless bees to honey bees is needed to understand the full capacity of stingless bees as pollinators of avocado.

Chris Cannizzaro's interests are in the ecology and biology of bees. He is currently studying honey bee floral diets exploring how botanical sources of pollen and nectar relate to the nutritional quality of bee bread and honey. He is also investigating how foraging behaviour of bees contributes to cross pollen movement in avocado orchards. Chris Works with subsistence farmers in the highlands of Papua New Guinea and farmers of SE QLD, Australia to try and understand the nutritional landscape of bees.

2|4|3 Australian stingless bees as crop pollinators for strawberries in protected cropping environments

Nzie, O.P., M. A. Hall, J. M. Cook, R. N. Spooner-Hart & M. Riegler

Hawkesbury Institute for the Environment, Western Sydney University, Hawkesbury campus, Richmond, NSW 2753.

Strawberries are one of many important fruit crops grown commercially in Australia. They are highly dependent on pollination services to increase yield and develop well-formed high-quality fruits. Strawberries are increasingly grown in protected environments, such as glasshouses. In order to meet their pollination needs, we must use managed pollinators in these systems. We are testing the pollination efficacy and efficiency provided by managed hives of two Australian stingless bee species (*Tetragonula carbonaria* and *T. hockingsi*) in glasshouse strawberry production. We applied a number of pollination treatments: controlled number of bee visits (1, 2, 5, 10, 15); hand pollination with the same strawberry variety; hand cross pollination with a different variety; open pollination; and bagged flowers without bee visit. We also recorded bee behaviour on the flower, time spent foraging on the flower, whether foraging was primarily for collection of nectar, pollen or both and if the bees had pollen on them prior to visiting the flower. We harvested fruits at standardised maturity and measured several parameters to determine fruit quality: weight, size, shape, deformity, the ratio of fruit total soluble solids (sugars) and fruit titratable acids, and the number of fertilized achenes. Preliminary results suggest that stingless bee visitation increases strawberry yield and produces high quality fruits. While increased number of bee visits led to more well-shaped fruits, this appears to be correlated with bee behaviour and the duration of time spent on flowers. We show that stingless bees are effective pollinators of strawberry in protected cropping environments and could aid commercial growers to increase yield and marketability of fruits.

Onyeka Peter Nzie is a PhD candidate at the Hawkesbury Institute for the Environment at Western Sydney University. He holds a First Class Honours degree in Animal and Environmental Biology.

His MPhil research investigated the diversity of pollinators and their most foraged flowering plant(s) in both natural and agricultural systems in Ghana, West Africa. His current research at Western Sydney University is focused on accessing the efficacy of native stingless bees in pollinating crops in glasshouse environment as well as the effects of the glasshouse conditions on bee health.

2|4|4 Small hive beetle infestation and Cucurbit pollination in Australian stingless bees

Scott Nacko, Mark Hall, Robert Spooner-Hart, James Cook, Markus Riegler

Hawkesbury Institute for the Environment, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia.

Managed stingless bee hives represent a growing industry in Australia, heightening the importance of factors which affect hive health and pollination services. We present findings from the first study to examine Australian stingless bee pollination of cucumbers under protected and field setting. We also present the first detailed study of a small hive beetle infestation in a living hive of the Australian stingless bee *Tetragonula carbonaria*. Nine hives were deployed for use in dwarf cucumber field crop pollination. Stingless bees were not observed visiting crop flowers, and few visits were observed on non-crop resources. After two months on site it was evident that two of nine hives had become weakened, with fewer foragers present and reduced hive weight. Following a sustained heat wave, one hive was removed early from site to recover. After all hives had been returned, one was found to be infested with small hive beetle and was unlikely to recover. All small hive beetle stages except eggs were discovered inside the hive. Extreme daily maximum temperatures coupled with low humidity appear to weaken stingless bee colonies, elevating the need for careful hive placement in open agricultural settings. A follow-up glasshouse experiment examining dwarf cucumber pollination by *T. carbonaria* and *T. hockingsi* revealed bees would visit the crop more readily when given no other alternative food source, and fruit weights did not differ between species.

Scott Nacko was born in Duncannon, Pennsylvania in the USA. He completed a Bachelors of Science in entomology with a minor in wildlife conservation at the University of Delaware in 2014, then went on to complete a Masters of Science in entomology at Louisiana State University in 2016. His masters thesis was focused on social evolution in paper wasps, and he is currently studying genetics and pollination efficacy in Australian stingless bees. He has a keen interest in all social insects.

2|4|5 Does the timing of stingless bee *(Tetragonula carbonaria)* hive deployment relative to crop flowering impact foragers crop fidelity and resource use in macadamia orchards?

Allison, C.E., J.C. Makinson, R. Spooner-Hart & J.M. Cook

Hawkesbury Institute for the Environment, Western Sydney University, Hawkesbury Campus, Science Rd, Richmond NSW 2753

In European honeybees (*Apis mellifera*) there is a large body of research investigating the best time to deploy migratory bee hives in mass flowering crops. Studies have consistently found that placing hives in the crop when flowering has already begun produces the best results in terms of crop yield and ensuring bees forage more consistently, and in higher numbers, on the target crop. Stingless bee (*Tetragonula carbonaria*) foraging behaviour is comparable to that of honeybees in that they are generalists, display floral constancy, and rapidly recruit nest mates to resources. Yet, despite their increasing popularity as an alternative pollinator in crops such as macadamia on the east coast of Australia, to date there has been little comparable research in terms of how to best deploy stingless bees in target crops. Stingless bees are often hired out only for the period of crop flowering, or alternatively, bees are placed in crops all year round and managed from a static location. In this study we test how the timing of hive deployment impacted foragers' fidelity to the macadamia crop and how they used resources throughout the flowering period. Here we report initial results, based on pollen entering the hive, that suggest stingless bees follow a similar trend to that of honeybees, with permanently placed hives taking longer to begin foraging on macadamia compared to hives placed in during early flower and then main flower. Pollen entering these later deployed hives was initially dominated by macadamia pollen, with pollen diversity gradually increasing over time. Our results indicate that stingless bees will prioritise the mass flowering macadamia crop when initially deployed but reduce their crop fidelity over time as colonies have more time to explore their surroundings.

Claire Allison is a PhD student at the Hawkesbury Institute for the Environment at Western Sydney University, where she is researching the potential stingless bees hold as managed pollinators in macadamia and avocado. After keeping honeybees for several years and working with bumblebees and other wild pollinators throughout her undergraduate and master's degrees in the UK, Claire moved to Australia to work with stingless bees and expand her knowledge of hymenopteran pollinators in agricultural ecosystems.

2|4|6 Buzz pollination in the Australian bee fauna

Smith, T. J.[1,2] and Saunders, M. E.[3]

[1] School of Biological Sciences, University of Queensland, St Lucia, QLD. [2] Bee Aware Brisbane, Brisbane, QLD. [3]School of Environmental and Rural Sciences, University of New England, Armidale, NSW.

Identifying native bees that have the ability to buzz pollinate is an important first step towards the commercialisation and widespread use of an environmentally-safe pollinator for Australian glasshouse crops such as tomato, capsicum and eggplant. There is great interest from the glasshouse industry in importing and managing exotic bumble bee species in Australia as a low-cost buzz pollination solution. Yet the importation of exotic bumble bees to mainland Australia comes with great risk to native organisms and ecosystems, and as such, must be avoided. Identifying native buzz pollinating bees that can be mass reared and used on a commercial scale will benefit crop growers and Australia's biodiversity. Buzz pollination is not ubiquitous among bees. Importantly the bee species that are used as widespread managed pollinators of crops in Australia, exotic *Apis mellifera* (European honey bee) and the native stingless bee species *Tetragonula carbonaria*, are not able to buzz pollinate. Despite only one species being used as a widespread managed pollinator, Australia has over 1650 native bee species, some of which may offer potential as managed pollinators. Here we compile a list of bee species present in Australia that have the ability to buzz pollinate flowers, using two methods: a literature search for previous records of buzz pollinating bees, and through our own incidental observations in the field between 2016 and 2019. From this we identify species from 19 Australian bee genera that have the ability to buzz pollinate, including three genera not previously reported in the literature. We discuss the life histories and potential for management for some of these genera and advocate the urgent need for further investigation and innovation with the aim of management and commercialisation of a native Australian buzz pollinating bee.

Tobias Smith

Read Biography in presentation # 1-3-6.

2|4|7 Stingless bees and other native pollinators on mango crops in the Northern Territory

Gaurav Singh, Robert Spooner-Hart, James Cook and James C Makinson
Hawkesbury Institute for the Environment, Western Sydney University.

The Northern Territory (NT) produces more than 40,000 tonnes of mangoes a year, with approximately 6350 hectares dedicated to mango production. Much like in the rest of the Australia, many NT mango farmers rely solely on feral European honeybees (*Apis mellifera*) and wild pollinators for crop pollination services. With the threat of the honeybee mite *Varroa destructor*'s arrival to Australia, as well as land use intensification, the need for a more robust and diverse managed pollination industry is increasingly being felt. Eusocial bee species such as stingless bees present a potentially viable alternative and/or addition to managed *A. mellifera* pollination services. We visited mango farms in the Northern Territory to determine whether unmanaged native pollinators such as the local stingless bees species, *Tetragonula mellipes*, were present in the orchards. We monitored the spatial distribution of native pollinators in 8 farms in the Darwin and Katherine regions. We found that *T. mellipes* was the predominant floral visitor across all farms surveyed. Foragers were present up to 400m into the mango orchards, but activity levels declined precipitously with increasing distance from the crop edges. In the Darwin region hoverflies were the next most abundant pollinator species, but were entirely absent in the Katherine orchards. Our results provide the first insight into the potential of *T. mellipes* as a managed pollinator in NT mango plantations.

James Makinson is a behavioural ecologist based at Hawkesbury Institute of the Environment, Western Sydney University. He is a postdoctoral research fellow in stingless bee biology and pollination services, and is tasked with coordinating lab projects studying stingless bees on tropical crops such as mango, macadamia, lychee and avocado. James is interested in the foraging ecology and communication behaviour of social Hymenoptera such as stingless bees, honeybees and bumblebees.

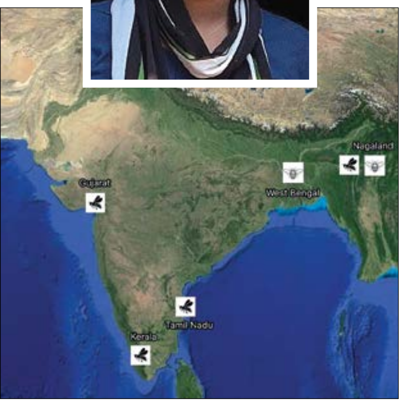
2|5|1 Indian Beekeeping Practices: Photo-documentation

Sunayana Sajith (1), Aila Mushtaq Khan (2), Neil Perry (2), Dilupa Jeewanie Nakandala (2), James M. Cook (1),

1 Hawkesbury Institute for the Environment, Western Sydney University, Richmond 2753, NSW. 2 School of Business, Western Sydney University, Parramatta, NSW

Bees are a highly valued resource across the world. They have been developed for harvesting honey, wax and to use as pollinators. Depending on where in the world you are, the main reasons for rearing bees changes. To understand India's priorities for beekeeping, I travelled across five Indian states, which are widely spread out on the map and cover a wide range of agro-climates, to document beekeeping and the indigenous practices. The species preferred for beekeeping were *Apis mellifera*, *Apis cerana* and *Tetragonula irridipenis* in order of preference. Nagaland, a north-eastern state bordering Myanmar, has been keeping bees for sustainable development. They have been assisted by the Nagaland Honey and Beekeeping Mission (NBHM) who conduct knowledge dissemination workshops to assist with beekeeping and honey extraction techniques. Beekeeping contributes to their economic needs and pollination services as their agricultural practices are tending towards organic. Nagaland also boasts three of the eight stingless bee species identified in India, namely *Tetragonula irridipenis, Tetragonula laviceps* and *Lophotrigona canifrons*. Meanwhile, on the south-west coast, state Kerala State has some innovative stingless beekeepers experimenting with hive design and colony capture methods. They have also developed commercial practices by setting up a production line to build hives along with selling bee products such as honey and balms made from bee wax.

Along with beekeeping practices, agricultural methods and landscape conditions were studied to explore the potential of bee pollination services. I would like to showcase this diversity of beekeeping across the five states – Kerala, Tamil Nadu, Gujarat, West Bengal and Nagaland through a photo-essay highlighting the indigenous practices of each state and their dependence of beekeeping as a livelihood.



Sunayana Sajith is a PhD student at WSU studying the uptake of alternate managed pollinators in India and Australia. She is looking to interact with beekeepers and growers to understand any barriers to use of beekeeping and managed pollination. She is keen on documenting the growth of the Australian stingless bee industry through an online survey (https://www.surveymonkey.com/r/ZLX6DXL). Sunayana's background is in studying food security and nutrition in semi-arid regions to identify strategies to cope with climate change in Tamil Nadu, India.

2|5|2 The selection of potential native stingless bees for beekeeping in Bintialo Village, South Sumatra, Indonesia

Priawandiputra, W. (1), M. G. Azizi (1), D. Buchori (2) (3),

(1) Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University (Bogor Agricultural University), Indonesia; (2) Department of Plant Protection, Faculty of Agriculture, IPB University; (3) Zoological Society of London (ZSL) Indonesia, Bogor, West Java, Indonesia

Kemitraan Pengelolaan Sembilang Dangku (KELOLA SENDANG) project which is implemented by Zoological Society of London (ZSL) Indonesia with consortium partners propose to achieve "Inclusive economic growth and community prosperity, biodiversity conservation, forest protection and restoration, and the ending of deforestation, peatland drainage and wildfires that reduces land-based Greenhouse Gas emissions". Partnerships with local community in Lubuk Bintialo Village (adjacent to Meranti protected forest) to solve landscape management issues, such as deforestation is one of important project activities. Community development through stingless beekeeping is one alternative economic source developed by KELOLA SENDANG together with Meranti Wana Makmur Gapoktan. The selection of potential local stingless bee species that can be maintained is necessary. However, species of stingless bees in Lubuk Bintialo are still unknown. The aim of the research is to identify native species of stingless bee colonies surrounding Lubuk Bintialo village and Meranti protected forest. The stingless bees were manually sampled from wood log and trees. Overall, twenty three colonies were collected from Lubuk Bintialo. Six, sixteen and one colonies were collected from wood log, trees, and house, respectively. Based on morphological, we assumed that species were belonged to *Geniotrigona thoracica, Heterotrigona itama, Lophotrigona canifrons, Lepidotrigona terminata, Tetrigona apicalis, Tetragonula fucobalteata, Tetragonula laeviceps* and two unidentified species. *G. thoracica, H. itama, L. terminata, T. apicalis* will be potential to maintain for beekeeping in Lubuk Bintialo due to high honey production. The colonies should be moved with sustainable way by using additional hive in front of their nest holes.

Windra Priawandiputra is lecturer staff at Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University. His previous research during doctoral study in Kanazawa University, Japan was about linkages of flowering plants and bees at habitats of satoyama (traditional landscape in Japan) in Kanazawa, Japan. Recently, he and his students work on biology, biosystematics and ecology of native stingless bees in Belitung, South Sumatra and Moluccas, Indonesia. Furthermore, he would like to broaden his research on other native bees in Indonesia.

2|5|3 Papua New Guinea 'Switpela Bi Hani' community program

Middleton, M.

Beezotted, Mooloolah Valley, Queensland; PNG Biomass, Markham Valley, Lae, Papua New Guinea.

'Switpela Bi Hani' native bee community program in the Markham Valley in Morobe Province in Papua New Guinea (PNG) introduces rural communities to meliponiculture. It is one of several community development programs of the PNG Biomass Project in the Markham Valley, about 150km north-west of Lae. PNG Biomass is a renewable energy project, owned by Oil Search Limited, working through an inclusive economic growth model to power PNG and empower communities. Native bees were first used by the renewable energy project in their seed orchards in 2016. After interest shown by local communities in native bees and beekeeping, the Switpela Bi Hani program was established using Matthew's expertise and experience. As a community development program the objective of Switpela Bi Hani is to protect local biodiversity and create a locally operated and sustainable business for communities of the Markham Valley. In this presentation Matthew will share the thrill of bee exploration in this rural region in PNG. You will gain an understanding of the challenges and rewards of delivering effective native bee cultivation and pollination awareness workshops to remote villages speaking only Tok Pisin. Topics covered include:

- trials to ascertain the most appropriate hive type that is practical, affordable and durable
- providing awareness sessions and training on native beekeeping to local communities
- developing local resources to sustain the program into the future
- bee identification and instigating a code of conduct and ethics for meliponiculture in PNG

Matthew Middleton is a registered nurse midwife, artist, and owner/director of Beezotted. He has been involved with stingless bees since nursing in remote Kimberley communities in the early 80s, and now works with several species of stingless bees in Qld, NSW, WA and PNG. As well as keeping numerous box hives, he and his daughter Jacinta carve log hives to create functional art sculptures. Matthew also facilitates bee workshops and performances for children and community groups, accompanied by didgeridoo playing, story time and the famous pollination dance. Since 2018 Matthew has provided technical expertise to the PNG Biomass Switpela Bi Hani community program in the Markham Valley.

2|5|4 Stingless beekeeping in the wet tropics of Far North Queensland

Neil Fraser

Mourilyan, Far North Queensland

I've been keeping honeybees for three years and they always succumb to foulbrood but native bees don't and I've built hundreds of mini OATHs with wasted industrial resources and am currently budding them with mostly *Tetragonula clypearis*/*T. sapiens* and 50 *T. hockingsi* with constant upgrades in eduction techniques around far north Queensland Cairns region. I also wish to share my knowledge in protecting hives for tropical weather, finding nests in urban areas, making transfer's into a buried budding concrete block hive for honey production with *T. sapiens*, locating free box construction materials and finally sharing my hope of selling NB honey to Chinese natural healers and selling local species to encourage potential new native beekeeping.

Beekeeping I have viewed as important to agriculture as I been a labourer most of life on the land. Three years ago I started a European bee sideline business to sell honey locally and pollinate Atherton tablelands avocados, but it has failed due to American foulbrood bacterium destroying most of my hives in the wet tropics. 2 years ago I started a new business model with the stingless bee and I'm still impressed by the low input costs and availability of recruitment of stingless bees around Cairns region. I endeavour to impart knowledge of nectar flows and better insect pest control methods of the wet tropics.

2|5|5 Managing stingless bees in the commercial orchard environment

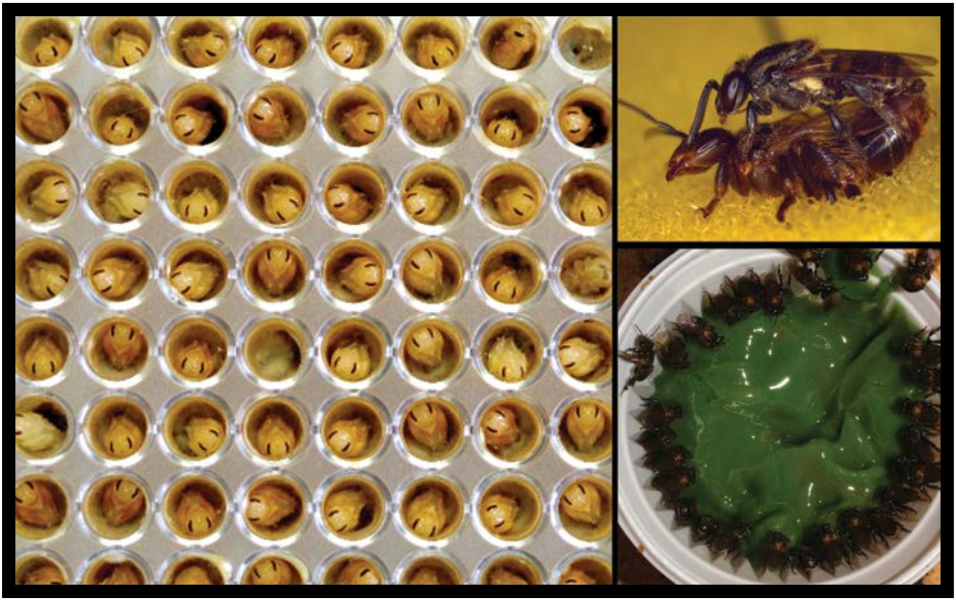
Fuller, C.

Nutworks Australia / Kin Kin Native Bees

Native stingless bees are increasingly being used for pollination in commercial crops with macadamia being a prime example. Recent research has shown stingless bees are efficient pollinators of macadamia and their promotion has led to strong demand for hives. There are stingless beekeepers offering pollination services, traditionally bringing the hives into the orchards during the pollination period. There are also growers starting to build up their own numbers of stingless bee colonies and keeping the hives 'on farm' permanently. There can be hazards to hives in either scenario. Crops can incur losses if they are attacked by pests during their flowering period. In macadamia there are pests such as Macadamia Flower Caterpillar *Cryptoblabes hemigypsa*, Felted Coccid *Eriococcus ironsidei*, Macadamia lacebug *Ulonemia* sp. and Flower Thrips *Scitothrips* sp. with some capable of inflicting 100% crop loss if not detected and left unchecked. Some pests can be dealt with using beneficial insect releases and others by using 'soft chemicals' such as Methoxyfenozide, but often, to stop crop loss, heavier chemicals with the potential to harm bees are required to be used pre flower or even during open flowering. Acephate, Diazinon, Methidathion and Trichlorfon could all potentially be used around flowering time and often with fungicides such as Carbendazim or Pyraclostrobin. Management techniques such as hive placement, time of spraying and chemical selection assist in minimising the hazards to bees. As more hives are being kept on farm year round, permanent hive stands with multiple hives are being developed. Native bees can be susceptible to extreme heat above 40˚C for a number of days. These stands often need to be in exposed areas within flight range of the target crop so a wide roof offering good sun protection is required. As these stands may be distant from bushland, artificial feeding can be employed. The planting of alternate forage for bees should be investigated to provide a nectar and pollen source for times outside of macadamia flowering.

Chris Fuller gained his interest in Australian native bees while working for over 20 years as an entomology and IPM consultant to the macadamia industry on the Sunshine Coast. He currently works for Nutworks, based in Yandina, pest scouting and running a managed native bee program for their suppliers. Early in his career he started investigating the importance of native bees as macadamia pollinators. This, in conjunction with the decline in feral honeybees, prompted him to start building and propagating hives of native stingless bees and now offers a commercial pollination service to help growers maximise crop yields. Chris's interest now also include the education of macadamia growers in the use of stingless bees and also the safer use of agricultural chemicals when bees are 'on farm'.

A permanent hive stand for stingless bees. Refers to previous page, Chris Fuller



In-vitro queen production

3|1|1 Nesting biology of stingless bees: applications for meliponiculture OR Biology and management of stingless bees

Cristiano Menezes

Brazilian Agricultural Research Corporation (Embrapa Meio Ambiente)

Stingless bees have been studied as alternative pollinators of several crops in tropical and subtropical areas, such as tomato, strawberry, macadamia, coffee and assai berry. Although they are efficient pollinators of around 30 crops, management techniques and multiplication methods still require improvements to attend the demand of growers. In the last decade, we have studied several aspects of basic biology and management of the stingless bee *Scaptotrigona depilis*, which allowed us to start an efficient colony production system in Brazil. A technique to produce large number of in vitro queens has been developed; queen mating has been successfully managed; an artificial diet for replacing nectar and pollen has been achieved; and incubation techniques have been improved to produce colonies under laboratory conditions. Although the production system still requires improvements to increase productivity, it is possible to produce colonies in commercial scale using these techniques. We have also studied the management of this species at strawberry and coffee crops and developed techniques to transport and protect colonies from environment stress. These techniques are now being tested in other crops such as macadamia, lychee and assai. The advances achieved so far allow us to stablish a production system of stingless bee colonies and also an instruction guide to offer colonies for pollination services to growers.

Cristiano Menezes is a biologist (Federal University of Uberlândia – 2006) and entomologist (PhD at University of São Paulo – 2010). His expertise is stingless bees' biology and management. His R&D focus in colony multiplication technologies and use for crop pollination services. He is also involved in public policies for bee conservation and sustainable growth of meliponiculture industry.

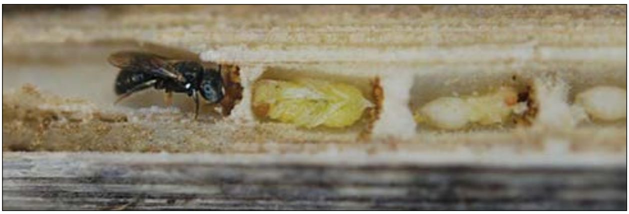
3|1|2 Behavioural genetics and social evolution of the small carpenter bees

Sandra Rehan
Department of Biology, York University, Toronto, Canada

Plenary Addresses

Understanding how eusociality evolves has always been a major and highly challenging goal of evolutionary biology. Genomic tools are now beginning to allow us to directly assess the roles of genes and genetic architecture in social evolution. Here I present data on the genomes and transcriptomes of six bee species to determine the molecular signatures of selection for social complexity. Facultatively social bees exhibit behavioural plasticity in response to changes in ecological conditions and social environment, and thus provide a natural experiment to compare solitary and social behaviours in single species. Such species can therefore provide empirical insights into the evolution of eusociality. The small carpenter bees (genus *Ceratina*) are of special interest because they exhibit rich behavioural plasticity. Species range from solitary to eusocial and benefit from detailed behavioural research and well-established phylogeny. As such, small carpenter bees are poised to further comparative genomic studies which emphasize the necessity of molecular phylogeny for understanding the conserved nature of brain transcriptomics underlying social phenotypes and organizational complexity. Here, I present genomic, ecological, and behavioural data in bees across the social spectrum, highlighting the importance of simple societies and facultatively social taxa to examine the evolution of social traits. I will discuss my ongoing research establishing carpenter bees as an emerging model system for the study of social evolution as well as developing new methods for characterizing plant-pollinator networks and pollen-microbial communities.

Sandra Rehan is an Assistant Professor of Molecular Evolution at York University in Toronto, Canada. Sandra's research focuses on the ecology and social evolution of native bees. She uses a combination of field ecology, behavioural experiments, historical biogeography and comparative genomics to test hypotheses concerning life history evolution in a demographic and phylogenetic framework. Her ongoing research examines the ecological and genetic mechanisms of social complexity in the Australian small carpenter bee. This work is establishing a new model system for the study of social evolution and recent work also includes population genomics and microbial ecology of native bees.



3|2|1 The mating system of *Tetragonula carbonaria* stingless bees

Smith, T. J.[1,2]

[1] School of Biological Sciences, University of Queensland, St Lucia, QLD. [2] Bee Aware Brisbane, Brisbane, QLD.

Mating systems in stingless bees (Meliponini) are poorly understood for the vast majority of the world's estimated 600 species. It is generally assumed that in most species, a virgin queen leaves the nest on a single nuptial flight, mates with a single drone and returns to the nest and uses the stored sperm for the remainder of her life. A number of genetic studies have supported the hypothesis of single mating, through demonstrating shared paternity of workers within colonies for multiple stingless bee species around the world. One mechanism for ensuring only a single drone mates with a queen is through male genitalia detachment during mating, which forms a residual mating plug inside the queen, thereby physically prohibiting other males from mating with her. Despite being thought to be the norm for stingless bees, male genitalia detachment has only been observed in a small number of species from the neotropics. Here I report on detailed observations of matings in four queens of the Australian stingless bee *Tetragonula carbonaria*. In each case male genitalia detachment was observed, and as such, I provide here the first evidence of male genitalia detachment in any Asian-Australian stingless bee lineage. I also provide possible evidence for female mate choice for *Tetragonula carbonaria* queens. I discuss these findings and outline the next steps required in more fully understanding the mating system of *Tetragonula carbonaria*.

Tobias Smith

Read Biography in presentation # 1-3-6.

Comparison of a virgin vs reproductive queen of *Tetragonula carbonaria*

Comparison of a worker with a male *Tetragonula carbonaria*

3|2|2 Sperm with wings: long-distance male dispersal in *Tetragonula carbonaria*

Garcia Bulle Bueno, F. (1), B. Garcia Bulle Bueno (2), Heard T. (1), T. Latty (1), B. Oldroyd (1) & R. Gloag (1)

1 Behaviour and Genetics of Social Insects Laboratory, School of Life and Environmental Sciences A12, University of Sydney, Sydney NSW 2006, Australia., 2 Institute of Data Systems and Society of the MIT., 3 Insect Behaviour and Ecology Laboratory, School of Life and Environmental Sciences A12, University of Sydney, Sydney NSW 2006, Australia.

In stingless bees, males are expelled from the colony once they reach sexual maturity. From that moment on their goal is to search for a virgin queen with which to mate. When males detect a colony containing a queen reading for mating, they will congregate in swarms outside the colony waiting for the receptive queen to appear. The lives of stingless bee males between leaving their natal nest and joining a mating swarm remain largely unknown. We aimed to figure out how far males of *Tetragonula carbonaria* travel during their search for queens. We manipulated colonies into rearing virgin queens, deposited the colonies across a maximum distance of 48 km and then analysed the genotypes of the males that formed mating aggregations outside these colonies. We found that males can readily disperse up to 16 km from their natal nests, which they probably do over a period of many days. Most males, however, were likely travelling smaller distances, with average distances estimated at around 3.4 km from their natal nests. Natural selection presumably strongly favours dispersal by males, as it ensures that they evade the deleterious effects of inbreeding, even in fragmented landscapes. We propose that the genetic diversity of males from mating aggregations can serve as a tool for estimating the population health and colony densities of stingless bees, which are important pollinators of crops and native vegetation across the tropics.

Francisco Garcia Bulle Bueno is a current PhD student at the University of Sydney. My object of study is the Australian stingless bee *Tetragonula carbonaria*, commonly known as sugar bag bee and my research focuses on the fascinating yet mysterious life of the stingless bee males and queens. I am especially interested in their behaviour and ecology. My undergraduate education is from the National Autonomous University of Mexico where I conducted a research project on Stimulation of Colony Initiation and Colony Development in the Mexican Bumblebee Species *Bombus ephippiatus*.

3|2|3 Spatial Ecology and Queen Turnover Rates in a wild population of the Stingless Bees *Tetragonula carbonaria* and *T. hockingsi*

Keir, M. (1), Gloag, R. (2), Hauxwell, C. (1)

(1) Queensland University of Technology, George St, Brisbane, QLD 4000;
(2) University of Sydney, Camperdown, NSW 2006.

Pollinators play a vital role in Australia's environment, via the pollination of native plants, and economy, via the pollination of crops. The current threats of climate change, habitat loss, and honeybee decline on these pollination services make it imperative that we improve our understanding of the ecology, genetics and behaviour of wild native pollinating insects. We investigated the population dynamics of two Australian stingless bee species – *Tetragonula carbonaria* and *Tetragonula hockingsi* – in 25ha of South East Queensland open eucalypt forest. These species are today widely-propagated in hives and are increasingly used as managed pollinators in some tropical and subtropical Australian crops. Many of their behaviours under natural contexts, however, remain poorly known, including their enigmatic tendency to usurp con-generic colonies. Over a three-year period, we collected data on changes in population size, spatial distribution, queen turnover rates, and colony relatedness of 60 *Tetragonula* colonies. Queen turnover rates were determined by comparing the genotypes of workers collected at 12-month intervals and then inferring changes in the parental genotypes. Our results shed new light on several key aspects pf the population dynamics of Southern Queensland *Tetragonula*, including interactions between these congeneric species.

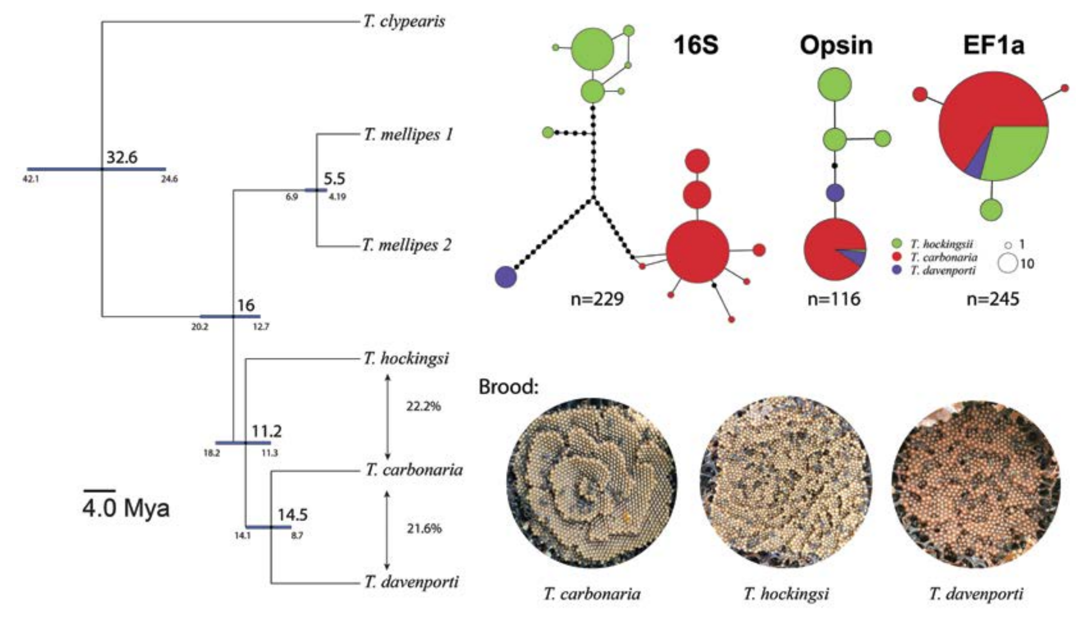
Matt Keir, having been interested in nature and science from a young age, studied environmental science and ecology at QUT, and is two years through his PhD investigating the chemical, behavioural, and spatial dynamics at play in the warfare exhibited by Australia's stingless 'sugarbag" bees. While on a hiatus from his PhD, Matt is working as a research technician for Plant and Food Research, assessing the level of honeybee dependence for numerous crops around Australia.

3|2|4 Is there hybridisation between *Tetragonula carbonaria, T. hockingsii* and *T. davenporti?*

Hereward, J., Smith, T, Brookes, D. & Walter, G.
School of Biological Sciences, The University of Queensland, St Lucia, Brisbane, 4072

These three stingless bee species live close to each other in South East Queensland, take over each other's hives and can even live as mixed-species colonies following a hive take over. Mating is associated with fighting, and mixed-species drone congregations can be found. Previous studies have suggested that hybridisation occurs between these species, but these studies suffered several technical issues and the frequency of hybridisation remains unknown. If hybridisation does occur, how do the species remain distinct? We revisited this issue using new DNA sequencing technology and compared the newer methods with older ones. We find no evidence of hybridisation using these newer techniques and find continued support for *T. davenporti* being a distinct species.

James Hereward is a research fellow in the School of Biological Sciences at the University of Queensland in Brisbane. He is interested in using genetics and genomics to better understand ecology and evolution, and insect-plant interactions in particular. James runs a bioinformatics discussion group, and is interested in taking new genomics approaches developed in humans and applying them to plants and insects.



3|2|5 How to find food fast: olfactory eavesdropping by Australian stingless bees

Ros Gloag, Jordan P. Smith, Matt Ludowici, Ruby Stephens, Tim A. Heard & Madeleine Beekman.

School of Life and Environmental Sciences, The University of Sydney.

Foraging social bees deposit odours at food sites, either intentionally (pheromones) or unintentionally (chemical "footprints"), that remain there after the bee itself has left. These odours may be used by nestmates to locate a profitable patch of flowers, but can also be exploited by other species for the same purpose. They can therefore have a significant role in how two species interact, even if those species are rarely seen to make contact directly. Here we show that three species of Australian social stingless bee (*Tetragonula carbonaria*, *Tetragonula clypearis* and *Austroplebeia australis*) not only detect the odours left behind by conspecifics, but also those of the honey bee *Apis mellifera* (Apini). Using choice trials, we find that foragers of *Tetragonula carbonaria*, *Tetragonula clypearis* and *Austroplebeia australis* were more attracted to feeders recently used by, and thus carrying the odours of, their own species (both nestmates and non-nestmates) or honey bees, than to clean unused feeders. One explanation for this result is that Australia's stingless bees can learn to associate honey bee odours with food. Indeed, in the lab we show that *T. carbonaria* can learn to associate a common honey bee pheromone with food as efficiently as they can learn the odours of flowers. Further investigation of the recruitment behavior of Australian stingless will shed light not only their foraging ecology, but also their interactions with honey bees.

Ros Gloag is a lecturer in evolutionary biology at the School of Life and Environmental Sciences, the University of Sydney. She researches the behaviour and genetics of bees in Australia, including invasive bees and native stingless bees.

3|2|6 How will climate change affect stingless bee population dynamics and crop pollination potential?

Hall, M.A. (1), J. Connell (2), T. Smith (3) T. Heard (4), J. Makinson (1), R. Spooner-Hart (1) & J. Cook (1).

(1) Hawkesbury Institute for the Environment, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751; (2) Department of Ecology, Environment and Evolution, La Trobe University, Bundoora, VIC 3086; (3) School of Biological Sciences, The University of Queensland, St Lucia, QLD 4067; (4) Sugarbag bees, West End, Brisbane, QLD 4101

Human-induced climate change will likely affect the distribution of species, by either expanding, contracting or shifting their current range as environmental conditions are altered. A species' ability to adapt to changes and access potentially suitable habitat will be a key factor in their survival and will impact ecosystem function, as species required to support key processes are lost or displaced. Such distributional constraints are likely to impact key ecosystem service providers, such as pollinators. Bees are the most effective pollinators of both native and commercial crop plant species worldwide. Australia is home to 11 eusocial stingless bee species from two genera, *Austroplebeia* and *Tetragonula*, which are distributed across the north and east of Australia and are ideal for use as both wild and managed crop pollinators. Extreme temperatures are known to decrease forager activity, influence brood development, thermoregulation of hives and ultimately lead to parasite invasion and potential colony collapse of many eusocial species. Important commercial crops may then lose valuable pollination service, potentially affecting yield and economic gains. Thus, predicting distributional changes under future climate scenarios will enable better planning and management of both ecological and commercial outcomes for bee species and the plants they pollinate. We collated distribution data from across Australia for all 11 stingless bee species as well as for a number of important commercial crops that are known to be visited by them. We selected four representative concentration pathway (RCP) scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC): 2.6 (least amount of climatic increase), 4.5, 6.0 and 8.5 (most climatic change). We modelled all 11 stingless bee species against these future climate scenarios to test the effects of climate change on their distributional ranges using Maxent algorithm. We present how future distributional shifts disrupt population dynamics and the pollination potential of these species.

Mark Hall is a pollination and community ecologist, interested in all aspects of bee biology and conservation, pollination efficiency, health and behaviour, and how we can best support species into the future. He is currently a postdoctoral research fellow at Western Sydney University studying the health, behaviour and pollination efficiency of stingless bees. This work is supported by Hort Innovation, and will provide vital information on stingless bees as alternative pollinators for many food crops.

3|2|7 Yeasts associated with nests of Australian stingless bees

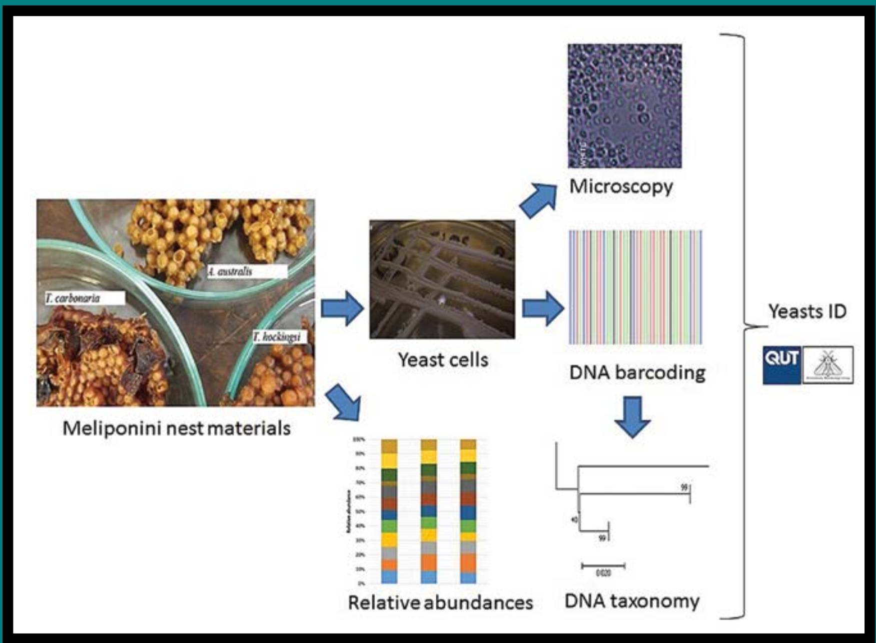
Massaro, C.F. (1), L. Gill (1), B. Tarlinton (1), R. Luttrell (2) & C. Hauxwell (1)

(1) Invertebrate Microbiology Group, Queensland University of Technology, Brisbane Gardens Point, QLD 4001; (2) Highvale, QLD 4520.

Stingless bees (tribe Meliponini) feed on honey and pollen stored in pots made of a mixture of resin and beeswax. These bees rear their young by mass-provisioning: loading the brood cells with a mixture of honey, pollen and protein-rich glandular secretions before egg-laying. Nest materials harbour bacteria, fungi and yeasts, which can contribute to improved nutritional value and preservation. The microbiota associated with nests of Australian Meliponini remains largely unexplored. In our study, we sampled from pot-pollen, honey, brood food and cerumen, from brood cell walls from 9 healthy colonies of *Tetragonula carbonaria*, *T. hockingsi* and *Austroplebeia australis* in 2017 and 2018. All beehives were located at the same site in South East Queensland and bees were assumed to be foraging within the same radius. Fungi and yeasts were isolated using selective high-osmolarity media with antibiotics, then identified by microscopy and Sanger sequencing of ITS/LSU 'barcodes', followed by phylogenetic tree construction with concatenation of amplicon sequences. The relative abundance of bacteria in pot-pollen was estimated from sequence reads generated from 16S 'barcodes' by PCR amplification and Next Generation Sequencing using the MiSeq platform. No yeasts were isolated from any of the brood food samples, but originated from the cerumen, pot pollen and honey. These included *Starmerella meliponinorum, Candida* species and other Ascomycota and Basidiomycota unreported in Australian Meliponini bees. Bacteria (Proteobacteria, Firmicutes) previously identified in bee guts were also detected. Analyses of yeast barcode sequences, volatiles and small metabolites derived from yeasts are ongoing as part of larger research on the relationships between Australian Meliponini bees and their symbionts.

C. Flavia Massaro investigated hive-resins and honey from stingless bees in Queensland for her Honours and PhD studies at the University of the Sunshine Coast. As an Australian Endeavour Fellow, she studied British bumblebee rearing and the effects of pesticides on honeybee larval development at the British Centre of Ecology. Flavia is a member of the Invertebrate Microbiology Group (IMG) at Queensland University of Technology. The IMG group works in collaboration with Queensland farmers and beekeepers to apply solutions to real-life agricultural problems.

How will climate change affect stingless bee population dynamics and crop pollination potential?



Flow chart for studying yeasts associated with nests of stingless bees

3|3|1 Genomic evaluation of native bees as pollen-transport vectors

Simon M. Tierney

Hawkesbury Institute for the Environment, Western Sydney University, Richmond, NSW.

The mutualistic symbioses between Apoidea and angiosperms demarcate the origin of bees from their sphecoid wasp ancestors, and are likely to have facilitated adaptive radiations in both bees (~20,000 species) and flowering plants (~300,000 species) since the Cretaceous period. Foraging behaviour undertaken by bees provide cross-pollination services that have much broader ecological implications which are important for the maintenance of ecosystem function and human food supplies. This study explores how bee-mediated pollen transport occurs across disparate landscapes - an orchard adjacent to World Heritage National Park forest. Two species of bees are directly contrasted: bushland colonies of the endemic stingless bee *Tetragonula carbonaria cf.* managed hives of the European honey bee *Apis mellifera*. Bee specimens were collected from flowers across an orchard matrix (20m x 20m array), in addition to opportunistic collections from the surrounding flowering native vegetation; replicated throughout the crop flowering period. Hybrid-capture genomic methodologies will be employed to identify pollen carried by bees as well as assessing population genetics of the insects. Results will elucidate the presence of each bee species across the matrix as well as indicating the prevalence of pollen derived from crop (apple & persimmon) and non-crop (native and weed) plants carried on the body of the bees.

Simon Tierney is an Evolutionary Ecologist who aims to understand the interplay between organisms, their environment and their genes, with a particular focus on social insect organisation, photic niche shifts and pollination. His PhD investigated allodapine bees that can switch between solitary and social lifestyles (Flinders University), and he then undertook a series of postdocs exploring halictine bees that are similarly social, but unusual in their habit of nocturnal foraging (Smithsonian Tropical Research Institute, Panama). This led to projects exploring the molecular evolution of vision genes in bees, and regressive evolution of eyes in blind beetles (University of Adelaide). He is currently involved in a multi-disciplinary project aimed at understanding and safeguarding the pollination services provided by Australian bees (Hawkesbury Institute for the Environment, Western Sydney University).

3|3|2 Pollen collection by bees and the need for a molecular approach

Kor-jent van Dijk, Eleanor Dormontt, Katja Hogendoorn, Michelle Waycott & Andy Lowe
The University of Adelaide, Adelaide SA, Australia

While honey bees are mostly flower constant and often collect either pollen or nectar, many native bees do not stick to one pollen source during a foraging trip. Among the latter, broad generalists in particular tend to carry a wide range of pollen. Visitation and observation of pollen collecting behaviour of bees may not reflect the importance of pollen sources, due to differences between plant species in handling time, amounts of pollen present and collection bias, i.e. more species are collected from the shrub and herb layer than from flowering trees. To identify the important pollen sources in the landscape, molecular methods are needed that identify the pollen on bee legs and in larval food supplies. In collaboration with the State Herbarium of South Australian and the University of Adelaide, a novel barcoding approach has been developed using an RNA bait hybrid capture enrichment approach. Traditionally plant phylogenetic research and barcoding has relied primarily on the sequencing of multiple loci, mostly of plastid origin. The discrimination of species has been difficult, and, in many cases, concatenated loci are needed to resolve relationships. There is not a single gene region, similar to the mitochondrial gene cytochrome c oxidase I (CO1) for animals, that can be used as a barcode for plants. As a consequence, genetic resources are haphazard and limited, making the available resources unreliable. With the newly developed Hybrid Capture, which will target 18 Chloroplast loci, CO1 for bees and 30 nuclear loci, 200 insect pollinated plants species will be sequenced and databased as a genomic resource for the pollen identification study. This pilot study forms part of a larger initiative –The Exemplar Project– where tentatively three representatives of each plant genus in South Australia will be sequenced.

Kor-jent van Dijk research associate School of Biological Sciences, University of Adelaide and affiliate researcher State Herbarium of South Australia. Research interests are population genetics of plants in extreme environments, conservation genetics and development of novel tools for plant metabarcoding using high through put sequencing technologies.

3|3|3 Metabarcoding native bee pollen within restored landscapes

Dona Kireta[1], Katja Hogendoorn[2], Kor-jent van Dijk[1], Andrew J. Lowe[1]

1 School of Biological Sciences, The University of Adelaide, Adelaide SA 5005, Australia.
2 School of Agriculture, Food and Wine, The University of Adelaide, Adelaide SA 5005, Australia

Australian native bees provide important ecological functions such as pollination services, in native and agricultural landscapes. Given the likely future decline of wild honey bees due to the varroa mite, there is interest in restoring native bees to bridge the potential pollination gap. International research primarily in the US and Europe suggests that planting habitat for native bees can improve their abundance and species diversity. Australian native bee populations may benefit from revegetation with native perennials, which would enhance floral resource availability. To explore how revegetation, and revegetation quality, helps to restore native bee fauna, bee surveys were done within different types of restored landscapes. Bee abundance and diversity are low in areas with low diversity revegetation (generally fewer than five flowering species, little to no understory) and significantly higher in areas with high diversity revegetation (greater than five species, multiple strata). To demonstrate that this is related to diversity and abundance of floral resources, pollen was collected from the scopa of captured bees, and metabarcoded using hybrid capture libraries. Next Generation sequencing and quantitative metabarcoding will allow reconstruction of pollination networks within the restoration treatments. The outcome can inform restoration strategies for native bees.

Dona Kireta completed her honours degree at the University of Adelaide, where she described the population genetic structure of three Goodenia species across South Australia. She is currently a PhD student in the School of Biological sciences at the University of Adelaide, where she studies revegetation strategies for restoring native bee populations. She is interested in improving restoration outcomes and applying genetic tools to ecological conservation. Her work incorporates novel genomic methods that may help to simplify pollination research.

3|3|4 Reproductive skew in the uniquely social colletid bee *Amphylaeus morosus*

Lucas R. Hearn*[1], Olivia K. Davies[1], Mark I. Stevens[2,3] & Michael P. Schwarz[1]

1 College of Science and Engineering, Flinders University, GPO Box 2100, SA 5001, Adelaide, Australia. 2 School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, Australia. 3 South Australian Museum, GPO Box 234, SA 5001, Adelaide, Australia

To understand the earliest stages of social evolution we need to identify species that are undergoing the initial steps into sociality. *Amphylaeus morosus* is the only known social bee in the hyper-diverse bee family Colletidae, and provides an independent origin of sociality within the Apoidea to investigate the selective factors promoting the transition to social nesting from solitary antecedents. Previous studies have estimated intracolony relatedness for *A. morosus* nestmates as low and have shown minimal direct benefits to group living, suggesting only a minor role for kin selection in the social evolution of *A. morosus*. However, those estimates had low resolution and were unable to ascertain maternity and paternity of brood, so were unable to examine how kin selection may be operating in this novel social species. Using genome-wide SNP genotyping, we infer robust pedigree relationships to identify maternity of brood for nests collected at the end of brood rearing. Our analyses show extremely high reproductive skew within social colonies and, given the low benefits for social nesting, suggest that indirect fitness arguments are not sufficient to explain social nesting in this incipient form of sociality. These initial results raise significant concerns for the utility of kin selection and reproductive skew theories to explain early stages in social evolution, but highlight the opportunities that combine genomic approaches with non-model species.

Lucas Hearn is a PhD student in the College of Science and Engineering at Flinders University. He discovered a passion for insects at a young age, whilst growing up in the Adelaide Hills. Lucas completed his Honours looking at the social nesting behaviour of the Australian native bee, *Amphylaeus morosus* and is now continuing that research with his PhD. His research focuses on the genetic and behavioural dynamics that allow for sociality to be promoted and maintained in this unique bee species.

3|3|5 How to design a study using next-generation sequencing tools

Alexander Mikheyev
Australian National University, Canberra, ACT, Australia

The revolution in next-generation sequencing and bioinformatic data analysis has facilitated in-depth investigations of non-model organisms, particularly insects. Given the wide range of sequencing platforms and downstream bioinformatic pipelines available, identifying which ones to use can be bewildering. How good a genome assembly do you need? What kinds of markers should you use? How many samples should you sequence? What software is available? In this talk, I will briefly review two common use cases of large-scale sequencing data analysis: phylogenomics and analysis of natural selection. I will show how to answer the questions above by focusing on a hypothesis-driven endpoint of the analysis. For example, if the goal is to test a specific phylogenetic hypothesis, large numbers of well-assembled genomes generally don't help, since (a) the amount of shared data decreases with genetic distance between the organisms and (b) larger data sets become computationally intractable. Instead, resources can be optimized by focusing on better taxon sampling and the sequencing of a restricted number of genes. By contrast, identifying targets of natural selection benefits form a high-quality, well-annotated reference genome as well as many samples of the species of interest. However, cost-saving approaches involving either reduced representation or low-coverage sequencing are available. Understanding the pros and cons of existing technologies for a given question can streamline study design and accelerate research.

Alexander Mikheyev's lab uses technological advances, largely in sequencing, to understand how organisms respond to biotic changes in their environments.

To do this he often uses historical or biogeographic collections to study microevolutionary changes, combining field work, laboratory experiments and bioinformatics. He frequently uses social insects, especially honey bees as models, and has a big project looking at coevolution between honey bees and their parasites and diseases. In addition, he has a side gig on the molecular evolution of venoms.

Photo courtesy of OIST Graduate University

3|4|1 Prevalence of a pervasive parasite across the Australian hylaeine bees

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Amphylaeus morosus (Smith) is an Australian native bee within the diverse and cosmopolitan subfamily Hylaeinae (Colletidae). This species has very unusual mitochondrial DNA characteristics, where i). there is almost no mitochondrial DNA variation throughout its large geographical range and ii). it has consistent and conserved mitochondrial heteroplasmy (two mitogenomes per individual). In a species with such an extensive geographical range (southwestern Victoria to southern Queensland), it is strange to exhibit such conserved and invariable mitochondrial DNA. Additionally, *A. morosus* is consistently infected with two strains of the common bacterial parasite *Wolbachia*. This intracellular parasite has recently received attention for its ability to affect the sex-determination of its host, to outcompete host pathogens and its potential as a biocontrol agent. *Wolbachia* is a very common insect parasite, with estimates of up to 70% of all terrestrial insect species infected. We have hypothesised that the unusual conserved mitochondrial heteroplasmy is being enabled by dual *Wolbachia* infection where each *Wolbachia* strain enables the inheritance of each one of the mitogenomes. To explore whether *Wolbachia* and mitochondrial heteroplasmy are consistently associated, approximately 500 specimens (~ 200 species) of hylaeine bees have been screened for *Wolbachia* infection. We present preliminary data of infection prevalence and future directions for determining phylogenetic patterns of deviant mitochondrial DNA and parasite pervasiveness.

Olivia Davies is a PhD candidate at Flinders University, SA and is fascinated by the evolution of insects and other invertebrates. Her research project focuses on the hylaeine bees (or masked bees), a cosmopolitan and diverse group of pollinators which have particularly unusualgenetics, incredible biodiversity and a strange relationship with their parasites.

3|4|2 Exploring the virosphere of stingless bees in Eastern Australia

Roy, B., R. Spooner-Hart, M. Riegler, & J. M. Cook

Hawkesbury Institute for the Environment, Western Sydney University, Richmond, NSW.

The virosphere of honeybees includes a growing list of so-called *honeybee associated viruses*. Meanwhile, some of these viruses have also been detected in other pollinating insects including bumblebees, ants, wasps, and stingless bees. However, the virosphere of stingless bees themselves is relatively uncharted territory, and we don't know if unknown viruses of stingless bees are shared with other pollinating insects, especially honeybees. Exchange of viruses between honeybees and stingless bees in both directions could stem from their use together in commercial pollination services, or co-foraging in the wild. Additionally, exploring the virosphere of honeybees has been suggested as a tool for early detection of crop plant viruses. Stingless bees may also be useful in this context, as they have shorter foraging ranges and so may be more useful for pinpointing diseased plants. The present study therefore aimed to explore the virosphere of stingless bees using RNA sequencing of bees from hives of *Austroplebeia australis* (n=10), *Tetragonula carbonaria* (n=20) and *Tetragonula hockingsi* (n=10), as well as individual honeybees (n=10) from New South Wales and Queensland. Honeybee associated viruses (BQCV, LSV1 and LSV2) were detected in honeybees, but not in the stingless bees. The study did not find any new viruses in stingless bee. Furthermore, the data did reveal in Eastern Australia, plant viruses of horticultural importance. Two of these, *Tomato ringspot virus* in honeybees and *Pelargonium Zonate Spot Virus* in stingless bees, were previously reported only in Western Australia. Additionally, the partial genomes of two novel partite-like viruses were uncovered in the study, one in honeybees and one in *Austroplebeia australis*.

Bronwen Roy is a PhD candidate at Western Sydney University at the Hawkesbury Institute for the Environment, where she is researching the pathogens particularly viruses that our native stingless bees encounter. This includes known honeybee viruses that may be shared across honey and stingless bees, but also involves the wider virosphere of stingless bees. Additionally, the research extends to include the microbiome of stingless bees and its association with bee health.

3|4|3 Susceptibility of Australian native bees to the Varroa-vectored Deformed Wing Virus

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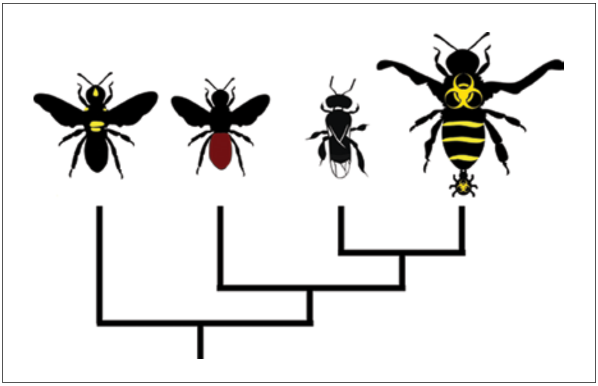
The parasitic mite *Varroa destructor* is a major threat to honeybees (*Apis mellifera*) globally. Although damaging as a hive pest, it is most destructive as vector and incubator of RNA viruses such as Deformed Wing Virus (DWV). Native (non-*Apis*) bees are not susceptible to *Varroa*, but are infected by honeybee-associated viruses, likely through co-foraging. While otherwise prevalent worldwide, both *V. destructor* and DWV are currently absent from Australia. Their expected establishment will rapidly shift the viral landscape, decimating feral honeybee populations in Australia and the free pollination services they provide. How native bees, which are also excellent pollinators, are impacted by DWV is currently unknown. To determine whether Australian species are susceptible to the virus, we exposed live specimens to DWV isolated from *Apis* in Germany. As the virus originated within *Apis* we included species that vary in their relatedness to the genus – *Tetragonula carbonaria* (Apidae: Apinae), *Exoneura robusta* (Apidae: Xylocopinae) and *Amphylaeus morosus* (Colletidae: Hylaeinae). We find variation in virus replication between target species, suggesting taxon-specific management approaches may be appropriate. Our results demonstrate that DWV will likely impact Australian native species and that the arrival of *Varroa* will require intervention beyond *Apis*-related industries.

Scott Groom's research experience has focussed near-exclusively on native bees and their utility for addressing questions across multiple disciplines. During my doctorate at Flinders University I investigated the genetic diversity of bee faunas of Pacific archipelagos and my subsequent postdoctoral fellowship at Kyoto University in Japan saw me exploring gene expression patterns across castes of a socially polymorphic bee. More recently at the University of Adelaide, I have been looking at the contributions native bees make to Australian agriculture and how we might secure these services.



The Annual General Meeting of the Australian Native Bee Association Inc.

A notice of agenda, reports and the financial statement were sent out to financial members early in November. The meeting will vote on these reports, proposed changes to the Rules and positions on the Management Committee.

History. ANBA grew from a need to get some clarification around the honey from stingless bees. At any early meeting in Oct 2018, the need for an association to back any honey proposal became obvious. The scope of the association grew when people realized its potential e.g. to supply insurance and encourage local branches. The scoping group proposed to include all native bees in its scope, (not just stingless bees), to form a national network and encourage local branches, and to include enthusiasts as well as professionals. The ANBA officially formed from the well-established Brisbane Native Beekeepers Club in March 2019. At this meeting a draft constitution was accepted, and an interim management committee was elected. That committee is still in place but is up for re-election at this AGM.

Our Mission Statement. The ANBA promotes the conservation and sustainable use of all Australian native bees. ANBA achieves that by providing resources, disseminating information, supporting members and communicating with stakeholders.

In our first year we have established ourselves and ticked off the tasks of new organisation including:

1. Legal incorporation as a non-profit organisation.
2. Purchase of Public liability insurance which provides national protection.
3. Recruited members, nearly 400 joined between May and Dec 2019.
4. Formed five branches (Brisbane, Rockhampton, Gladstone, Sydney, Mid North Coast NSW).
5. Designed a logo through a fantastic community engagement program.
6. Built a website.
7. Established a monthly newsletter, The Cross-Pollinator.
8. Organised this conference.
9. Put together an awesome honey committee who are making progress on the tricky road to official recognition of a food standard.

Our next year will be one of consolidation and working towards our objectives in particular:

1. Complete the work of the honey subcommittee.
2. Establish an education committee to move ahead with the idea of a formal course in stingless beekeeping.
3. Work towards an animal ethics and conservation subcommittee.
4. Plan the 3rd Australian Bee Conference.

Field Trip

Thursday 5th December 2019

Itinerary and information sheet

Your hosts for the day will be Drs Tim Heard and Mark Hall with Francisco Garcia Bulle Bueno, PhD Student The University Of Sydney.

1245	Meet at the front of St Leos College. Coach transport will depart promptly at 1pm.
1-230	Travel by coach from University of Queensland to 220 Sahara Road, Glasshouse Mountains, 78 km.
230-345	Visit macadamia farm to observe a hive shelter, a structure for communal housing of hives. We will discuss placement and management of hives on farms. We will discuss some trials to learn to better manage hives on farms.
345-415	Travel by coach from 320 Sahara Rd, Glasshouse Mountains to 116 Old Gympie Road, Mooloolah Valley, 25 km.
	Visit lychee farm to observe a hive shelter, a structure for communal housing of hives. Demonstrate hive propagation by splitting.
5-630	Return by coach to University of Queensland.

Notes Depending on weather and coach size, a walk of up to 1 km may be required from the road to and from the farm site.

Limited numbers of people who are unable to manage this walk can be ferried by small vehicle.

Notes

Pharohylaeus lactiferus
Image by James Dorey

Author of
Bees of Australia
A Photographic Exploration

Social media • Twitter hashtag, use #ANBC2019
• https://www.facebook.com/AustralianNativeBeeConference/

www.australiannativebeeconference.com.au