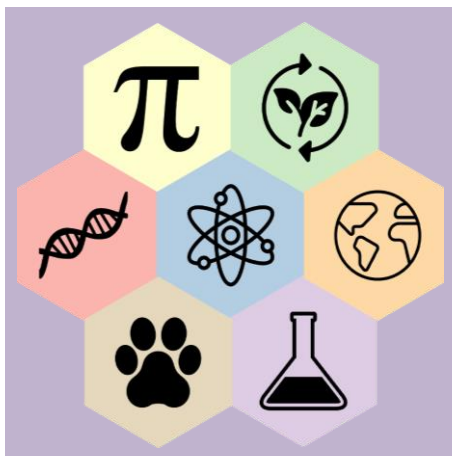


# SCIENCE EARLY CAREER RESEARCH SUMMIT

PLENARY  
& INVITED  
SPEAKERS  
  
ECA ORAL  
& SPEED  
SESSIONS  
  
PRIZES



Tuesday  
4<sup>th</sup> February 2025  
Melbourne Connect

## BOOK OF ABSTRACTS



Brought to you by the Science  
Early Career Academic  
Network (SECAN)

# Faculty of Science Early Career Academic Research Summit 2025 Conference Program



THE UNIVERSITY OF  
MELBOURNE

**08:30 – 09:00** Registration - Shadi Maghool, Vera Korasidis or Rose Macaulay

**09:00 – 09:10** Associate Dean Research – Forum 1

**09:10 – 09:40** Plenary Speaker: Pat Hannah (CSIRO Publishing) – Forum 1

**09:40 – 09:55** Researcher Development Unit Session – Forum 1

**09:55 – 10:10** Library Session – Forum 1

Time	Stream 1A	Stream 2A	Stream 3A
Venue	Forum 1: Rose Macaulay	Forum 2: Sarah McColl-Gausden	Forum 3 : Chris Bradly
<b>10:10</b>	<b>Invited: Ellycia Harrould-Kolieb</b> SAFES	<b>Invited: Mandy Freund</b> SGEAS	<b>Invited: Andrew Urquhart</b> BioSciences
<b>10:30</b>	<b>Ashkan Pakzad</b> Physics	<b>Caitlyn Perry</b> Biosciences	<b>Vera Korasidis</b> SGEAS
<b>10:45</b>	<b>Zahra Islam</b> SAFES	<b>Karen Edwards</b> SAFES	

**11:00 – 11:30** Morning Tea – The Lab and Launch Pad

Time	Stream 1B	Stream 2B	Stream 3B
Venue	Forum 1: Zahra Islam	Forum 2: Bhawana Bhatta Kaudal	Forum 3: Vera Korasidis
<b>11:30</b>	<b>Invited: Wei Huang</b> Maths & Stats	<b>Rebecca Webb</b> VET	<b>Invited: Mel Saligari</b> Teaching
<b>11:50</b>	<b>Veronique Paris</b> Biosciences	<b>Jamie Burton</b> SAFES	<b>Glenda Vasku</b> Chemistry
<b>12:05</b>	<b>Bianca Pickering</b> SAFES	<b>Kristoffer Wild</b> Biosciences	<b>Megan Lucas</b> VET
<b>12:20</b>	<b>Laura Brannelly</b> VET	<b>Toon Goris</b> Physics	<b>Maureen Murphy &amp; Tara Behen</b> SAFES
<b>12:35</b>	<b>Saini Samim*</b> SGEAS	<b>Gerard Tarulli</b> Biosciences	<b>Naveen Vankadari</b> Biosciences
<b>12:45</b>	<b>Manuel Sevenello*</b> Biosciences		

**13:00 – 14:00** Lunch - The Lab and Launch Pad

Time	Stream 1C	Stream 2C	Stream 3C
Venue	Forum 1: Ashkan Pakzad	Forum 2: Marcus Giansiracusa	Forum 3: Shadi Maghool
<b>14:00</b>	<b>Robyn Larsen</b> SAFES	<b>Invited: Martin van Koeverden</b> Chemistry	<b>Invited: Daniel McClosky</b> Physics
<b>14:20</b>	<b>Mary-Louise Wilde</b> Biosciences	<b>Benjamin Wagner</b> SAFES	<b>Charles Frederick Croft</b> Chemistry
<b>14:35</b>	<b>Rui Wang</b> Chemistry	<b>Emily Scicluna</b> Biosciences	<b>Amy Smith</b> SAFES
<b>14:50</b>	<b>Stephen Frankenberg</b> Biosciences	<b>Israporn Sethanant</b> SGEAS	<b>Xinyue Gu</b> Biosciences
<b>15:05</b>	<b>Shikun Ma*</b> Physics	<b>Liyuan (Onery Nexus) Zhu*</b> SAFES	<b>Bridget Walker*</b> Biosciences
<b>15:15</b>		<b>Patricia "Trish" Koh*</b> Biosciences	<b>Ambica Sharma*</b> SGEAS
<b>15:25</b>	<b>Limin Xu*</b> SGEAS	<b>Jingqi Sun*</b> Maths & Stats	<b>Lisa Buche*</b> Biosciences

**15:35 – 16:05** Afternoon Tea - The Lab and Launch Pad

**16:05 – 16:15** TrACEES Instrument Platform – Forum 1

**16:15 – 16:30** Science Media Session – Forum 1

**16:30 – 17:00** Closing address by Prof Moira O'Bryan (Dean – Faculty of Science) and Presentation of Awards – Forum 1

\* indicates speed talk

## Invited Speakers

# **Finding a mechanism of horizontal gene transfer in fungi**

**Andrew Urquhart (Biosciences)**

Horizontal Gene Transfer (HGT), the process by which genes are transferred between organisms without sexual reproduction, challenges the traditional view of genetic inheritance, where genes are passed from parent to offspring. An important property of HGT is that it can move genes between individuals of different species. While HGT is well-documented in bacteria, its role in fungi has long been debated. Recent evidence suggests that HGT does occur in fungi and may play a significant role in shaping key phenotypes, including virulence. Yet we don't know how genes are able to move between different fungal species. Our work has provided an answer to this mystery, which is that giant transposable elements are able to carry genes between different species of fungi. This answer has been elucidated primarily through our discovery of a giant transposable element—named Hephaestus—within the genome of the fungus *Paecilomyces variotii*. Hephaestus carries a number of genes that provide resistance to metal ions, and it is capable of transferring between different species of fungi. This work provides insight into how fungi can rapidly evolve new traits.

# **Governing Acidification in an Ocean of Fragmentation**

**Ellycia Harrould-Kolieb (SAFES)**

Ocean acidification has long been described as existing in the 'twilight zone' of international governance, with no regime explicitly designed to tackle the emergent problem. Moreover, examination of existing activities to address rising ocean acidity finds a fragmented patchwork approach lacking a coherent approach to "minimize and address ocean acidification", as set out in Sustainable Development Goal 14.3. This talk will explore how ocean acidification is currently being addressed and highlight existing gaps that need to be filled in order to create a more cohesive international approach to governing ocean acidification.

# **Imaging neuronal action potentials by defect charge conversion in diamond**

**Daniel McCloskey (Physics)**

Voltage imaging encompasses the range of techniques which can spatially resolve variations in local electric potential. In the field of neuronal electrophysiology, the ability to image electrical dynamics at sub-micron scales may unlock new understanding of mechanisms underlying synaptic signalling and plasticity, neurological disease, and seldom-explored phenomena such as dendritic backpropagation and the compartmentalisation of the intracellular voltage. To date, existing voltage imaging techniques cannot achieve sub-micron resolutions with sufficient signal-to-noise and temporal stability to resolve these dynamics. Recently, we have demonstrated liquid phase optical voltage imaging using charge state switching of the diamond nitrogen-vacancy (NV) centre. Dense ensembles of neutral NV centres formed proximal to a conductive diamond surface provide a means to optically sample local charge accumulation, resulting in label-free, quantitative voltage imaging at the optical diffraction limit. I will present our first results demonstrating single-shot detection of mammalian neuronal action potentials using these diamond voltage imaging microscopes (DVIMs). These results lay the groundwork for studies of mesoscale neuronal network (hundreds to thousands of neurons) dynamics at single-synapse resolution.

# **How ENSO can tell you more about Australian rainfall than you think**

**Mandy Freund (SGEAS)**

The basic science of climate change is well understood, yet climate change remains one of the greatest global challenges. Ongoing changes to our climate system are inevitable; the hydrological impacts remain poorly understood and bear large uncertainties and significant risks, particularly in the case of climate extremes. The naturally occurring El Niño Southern Oscillation has impacts around the world, though only happens every 2-7 years meaning only a handful of events have been directly observed. Of particular concern are the future swings of ENSO that are projected to change with further greenhouse warming. The frequency of extreme El Niño events and their counterpart La Niña events are projected to increase with global mean temperatures. At the same time, El Niño events have already undergone changes leading to more El Niño events occurring in the Central Pacific rather than the Eastern Pacific. This is projected to continue under future emission scenarios {Yeh2009}. As ENSO's variability is closely linked to rainfall extremes around the globe, projected changes to natural variability become a substantial source of uncertainty for hydrological projections. The cascading impacts are poorly understood due to their uncertain response to forcing factors and intrinsic event diversity but bear a high risk for major rainfall disruptions in large parts of the world.

# **Metal-Organic Frameworks: Making Hard Sponges with Molecular LEGO**

**Martin P. van Koeverden** (Chemistry)

Electroactive materials i.e. compounds which respond to electrical stimuli, are a hidden workhorse of modern technology. Upon application of an electrical potential, electroactive materials can emit light, store electrical charge or even undergo changes in structure and size, leading to diverse potential application. Dense, non-porous metal-based materials are widely used commercially for these applications, as the material properties can be varied by the identity of the metals. For example, the high-capacity lithium-ion batteries in your phone, depend on the metal-based compound, lithium cobalt oxide, to reversibly store and release electrical energy. However, these existing technologies have notable technical and geopolitical limitations, so that new electroactive materials are required to achieve necessary improvements in device performance and sustainability.

In this presentation, we will explore the synthesis and application of metal-organic frameworks (MOFs) to produce functional and electroactive materials. MOFs are stable, porous materials assembled by connecting metal-based centres together with carbon-based linkers. Through rational selection of the metal centres and linker molecules, predictable porous architectures can be designed and synthesised, akin to molecular LEGO. The porous sponge-like nature of MOFs allows facile movement of various species through the structure, thereby improving their electroactive performance. Additionally, various physical properties, such as light emission or magnetic response, can be engineered into MOFs by selecting metal centres and linkers with appropriate functionality. The tailorable design and porous structure of MOFs contrasts with the dense structure of traditional metal-based materials, which have more limited diversity in composition, structure and properties.

# **An interactive online module to support students undertaking peer review in large cohort undergraduate subjects**

**Mel Saligari (Teaching)**

Authors: Mel Saligari, Jennifer Fox, Hayley Bugeja.

Peer review is the cornerstone of academic work, and it is important that undergraduate students develop their ability to critically evaluate the quality of their own and others' work (Ibarra-Sáiz et al., 2020). Peer review tasks can provide individual feedback but also develop students' self-assessment and academic judgement skills (Topping, 2009). However, undergraduate students often do not trust their peers' ability to judge and provide feedback on their work (Panadero, 2016), which can hinder engagement in peer-review. In this study, we evaluate an intervention to train and prepare students for peer review by using an interactive assessment literacy module, in which students assess authentic assignment samples of varying quality against a rubric and then compare their judgement with expert markers. The assessment literacy module was deployed before students undertook a similar peer review assessment task. Students were surveyed for their perceptions of the module using both Likert-scale and free-text questions. Quantitative descriptive and qualitative content analyses were carried out to identify themes across student responses. Our preliminary findings indicate that students are better prepared to engage in peer-review after completing the module, based on their self-reported perceptions of confidence, academic judgement and understanding of the assessment criteria. This study provides an approach that can reduce barriers to student participation in peer-review in large-cohort subjects, by increasing their confidence in making academic judgements.

## **References:**

- Ibarra-Sáiz, M. S., Rodríguez-Gómez, G. & Boud, D. (2020). Developing student competence through peer assessment: the role of feedback, self-regulation and evaluative judgement. *Higher Education*, 80, 137–156. <https://doi.org/10.1007/s10734-019-00469-2>
- Panadero, E. (2016). Is it safe? Social, interpersonal, and human effects of peer assessment: A review and future directions. In G. T. L. Brown & L. R. Harris (Eds.), *Handbook of Social and Human Conditions in Assessment* (pp. 247-266). Routledge.
- Topping, K. J. (2009). Peer Assessment. *Theory Into Practice*, 48(1), 20–27. <https://doi.org/10.1080/00405840802577569>

# **Balanced Neural Networks Weighting for Causal Effect Analysis**

**Wei Huang** (Maths & Stats)

Understanding cause-and-effect relationships is essential in many fields, including economics, public health, and marketing. Researchers aim to determine how a cause influences an outcome, rather than relying on simple correlations. While randomised controlled trials are the gold standard for establishing causality, they are often impractical or unethical to conduct. As a result, many studies must rely on observational data, where researchers have no control over factors that may introduce bias. To address these biases, many variables must be considered in the analysis, often leading to high-dimensional data challenges. However, existing methods either rely on strict model assumptions or struggle to handle large numbers of variables effectively. In this work, we propose a novel approach based on deep neural networks that can process high-dimensional data while reducing bias, providing a more robust framework for causal inference in complex real-world settings.

## Oral Contributions

# **Investigating the long-term effects of fire regimes on ecosystem resilience**

**Amy Smith (SAFES)**

*Key words: Ecosystem resilience, fire regimes, fire risk*

Wildfire plays an important role in shaping flammable ecosystems around the world, however changes to the fire regime have the potential to threaten ecosystem function and resilience. Climatic changes are predicted to increase the severity and extent of wildfires, increasing the risk to social and ecological values. Globally, fire management generally focuses on the protection of life and property, while maintaining environmental values are often a secondary objective. This means that when trade-offs occur, it is often to the detriment of ecological values. In this project, we used expert elicitation to design a set of fire management regimes with the objective of mitigating the effects of wildfire on ecological values. We used fire simulation modelling and future climate models in five Victorian regions to investigate the effects of these management regimes over 75 years and compared the results. Fire simulation modelling was done in Fire Regime Operations and Simulations Tool (FROST), a fire regime simulator which combines weather, ignition and fuel models with fire behaviour models. Results were analysed in Fire Analysis Module for Ecological values (FAME), to evaluate the impact of the regimes on ecological objectives. The management regimes changed the spatial and temporal distribution of wildfire in the landscape. They also shifted the distribution post-fire age classes and tolerable fire intervals in native vegetation, as well as the abundance of animal species. The results of this research will give Victorian wildfire management agencies improved capability to reduce wildfire risks to ecological values and long-term ecosystem resilience.

# **Towards dose reduction in breast cancer imaging by deep denoising phase contrast X-ray computed tomography**

**Ashkan Pakzad (Physics)**

*Key words: Denoising, Deep learning, Phase contrast X-ray, Breast cancer*

Breast cancer is one of the most prevalent cancers worldwide and X-ray imaging remains the primary modality for breast cancer detection. Conventional X-ray imaging relies on measuring beam attenuation to identify differences in tissue absorption. However, breast cancers can appear similarly to normal tissue in the images. Additionally, images suffer from photon shot noise due to the need to limit ionising doses to patients. In phase contrast X-ray imaging, by using highly coherent X-rays we can also measure differences in tissue refraction to further enhance tissue contrast. This also reduces image noise compared to absorption-based imaging at the same dose, already promising improved image clarity.

We scanned 34 mastectomies using phase contrast X-ray computed tomography with high X-ray doses to train a deep learning model to denoise scans at lower, clinically relevant doses. Lower-dose images were produced by subsampling 28 high-dose scans for training. We evaluated on six test images that were not included in the training set and found that median signal-to-noise ratio was 3.5 times greater after denoising, without any loss in contrast or spatial resolution. These objective measures of image quality correspond to a 12-fold X-ray dose reduction. By combining the phase-contrast X-ray imaging technology with deep denoising we demonstrate an order-of-magnitude dose reduction in mammography. This approach promises advancement in breast cancer imaging, offering a safer modality without sacrifice of image quality.

# **Quantifying differences between mature and epicormic Eucalyptus leaf chemistry – drivers of landscape nutritional quality for folivores**

**Benjamin Wagner (SAFES)**

*Key words: fire, eucalyptus, chemistry, wildlife*

Folivores depend on high-quality foraging habitat with preferred tree species that express high nitrogen levels and low leaf toxins within their leaves. The 2019/20 Black Summer megafires burned forests at high severities, leaving only small, unburnt patches of unchanged foraging habitat across southeastern Australia. This caused major losses of mature leaves and led to the release of large volumes of epicormic foliage, potentially altering the foraging landscape for folivores drastically. Surviving arboreal fauna had to rely on this epicormic regrowth for their diet over extended periods.

It remains unclear whether regenerating forests will continue to provide high-quality forage in the months and years following high severity fires. Thus, it is crucial to study how leaf chemistry changes in response to megafires and how these changes scale across the landscape. Our study aimed to quantify these chemical changes to understand post-fire habitat suitability and potential for recolonisation by folivorous fauna. We sampled leaves from temperate mixed-species eucalypt forests in eastern Victoria before and after the fires to investigate chemical differences between mature and epicormic foliage. We sought to determine if post-fire landscapes can offer quality foraging for folivores and whether certain eucalypt tree species mixtures exhibit more significant changes in foraging quality than others, to understand landscape-scale impacts.

Changes in species- or subgenus-specific foliage chemistry may lead to short-term or long-lasting effects on the nutritional quality of forage for folivores, which has important implications for their population recovery and habitat suitability after large-scale fires.

# **Relative influences of climate, fire and tree death on future carbon stocks in Australian temperate forests**

**Bianca Pickering (SAFES)**

*Key words: climate change, carbon stocks, fire-tolerant forests*

Climate change presents multiple challenges to the stability of forest carbon stocks in fire-prone landscapes, including uncertainties arising from complex interactions among climate, fire regimes and vegetation dynamics. This research examines the relative influences of climate, fire and tree mortality on future carbon-stock trajectories in a landscape dominated by fire-tolerant eucalypt forests to improve understanding of the potential magnitude and source of forest carbon change in temperate Australia. We apply a unique spatially explicit modelling framework that couples a stochastic fire regime simulation tool (FROST) with a vegetation dynamics model (LANDIS-II) to test the relative influence of three mechanisms on forest carbon at landscape scales: heat and dryness, more frequent severe fire, elevated post-fire tree mortality. Simulations involved 16 modelled scenarios (4 climate projections x 2 wildfire levels x 2 tree fire tolerances) across a 600,000-ha landscape for a period of 78 years (2020 to 2098). Predicted outcomes for above-ground carbon stocks across the scenarios ranged from mean increases of 16% to substantive decreases of 50% by 2098, with the greatest threat posed by the combined effects of heat and dryness through intensified fire regimes (more frequent, more intense fires) and reduced forest productivity. Commitments to reducing greenhouse gas emissions, and management actions that reduce the extent and frequency of wildfire will improve the outlook for forest carbon stocks and ensure the continued capacity of fire-tolerant forests to act as carbon sinks.

# **Testing climate adaptation predictions (before it's too late)**

**Caitlyn Perry** (Biosciences)

*Key words: Climate change, evolution, modelling*

A species' prospects for survival in a rapidly changing environment depend on the level of relevant genetic variation contained across its populations. Decreasing costs of whole-genome sequencing and increasing threats from climate change have combined to drive a surge of interest in directly measuring within-species genetic variation and calculating its association with environmental factors. Such associations have the potential to inform predictions about survival under climate change scenarios, helping determine where limited conservation resources can most effectively be used. However, these analyses can be confounded by factors such as variable overall relatedness between populations and other geographically variable selective pressures (e.g. toxin exposure). There is as yet no consensus on the best statistical methods to correct for such factors.

Using several *Drosophila* species sampled from along the Australian east coast, I have calculated associations between genetic variants and temperature and precipitation measures using several widespread methods. In parallel, my collaborators have studied laboratory-based adaptation of flies from the same populations to altered climates. Through whole-genome sequencing of flies preserved at various stages of the experimental evolution process, it is possible to identify variants which have changed in frequency, and thus are likely to have played a role in adaptation. These results will provide an empirical test of gene-environmental association methods, which up to this point have been validated (if at all) largely by simulations.

# **Processing Rare Earth Elements using Polymer Inclusion Membranes**

**Charles Frederick Croft (Chemistry)**

*Key words: Sustainability, Separation Science, Green Chemistry*

Australia is predicted to play an increasing role in mining and processing of rare earth elements (REEs), which are vital to modern technologies such as electric vehicles (EVs), computer hard drives, fibre optics, and renewable energy generation. However, industrial production of REEs, namely their processing, is highly chemically complex and requires intensive application of acids and organic solvents. This leads to pollution of the environment, and production of greenhouse and toxic gases.

Polymer inclusion membranes (PIMs) are a novel separation material which have recently seen increased application to REE extraction and processing. These materials are fabricated using a base polymer, such as Poly(vinylidene fluoride-co-hexafluoropropylene), to encapsulate extractant reagents embedded within the polymer matrix, producing homogenous and mechanically durable materials.

PIMs have demonstrated sustainable extraction of valuable metals, such as REEs, through their reusability, low energy input, and decreased chemical requirements for mineral processing. Hence, REE processing using PIMs could help in reducing pollution generation and energy consumption in industrial REE processing. Future research will involve investigating scalability of fabrication and application of PIMs to industrial large scale REE processing.

# **How genetically different are fat-tailed dunnart populations north and south of the Murray River?**

**Emily Scicluna** (Biosciences)

*Key words: genetics, conservation, divergence*

The development of technologies such as Single-Nucleotide-Polymorphism-Arrays (SNP-Arrays) and high-throughput sequencing comes at a time of unprecedented biodiversity loss. This is particularly evident in Australia, which is experiencing the highest rate of mammal extinctions in the world. One of the many mammals under threat, is the fat-tailed dunnart (*Sminthopsis crassicaudata*), the last small, carnivorous marsupial of the basalt grasslands of Victoria. It has recently been listed as Threatened in the state and despite numbers declining at an alarming rate, its genetic diversity has previously been unknown. We aimed to quantify the genetic diversity within populations, the extent of gene flow between populations, and the potential for conservation measures to improve both. Additionally, this project aimed to confirm if the Murray River is acting as a physical barrier to movement, leading to subspeciation. To do so, we resequenced whole genomes of wild and captive individuals to high coverage (>20x) and developed a SNP-Array. This represents a cost-effective tool for researchers and conservation managers to measure genetic diversity and estimate relationships between wild individuals, accurately and cost-effectively. A SNP-Array can also be used on tissue samples and non-invasively collected scat and hair samples, a feature that is particularly useful when targeting small, elusive, and nocturnal species. The research will result in a better understanding of population dynamics in the fat-tailed dunnart with the goal of affecting on-the-ground conservation practices such as strategic translocations to aid gene flow and rehabilitation of captive individuals to increase genetic diversity.

# **Harnessing germline stem cells as tools for marsupial conservation**

**Gerard Tarulli (Biosciences)**

*Key words: Stem Cells; Conservation; De-extinction*

Marsupial conservation is limited by the absence of genetic engineering technologies. This study developed methods to culture and genetically modify marsupial spermatogonial stem cells (SSCs) and generate induced pluripotent stem cells (iPSCs) for differentiation into germ lineages. These tools are necessary to achieve in-vitro gametogenesis as an avenue to generate genetically modified marsupials.

Using fat-tailed dunnarts, a close relative of several endangered/extinct Australian marsupials, iPSCs were generated and assessed for hallmarks of pluripotency, germ layer gene expression, and ability to form embryoid bodies and differentiate into primordial germ cell-like cells (PGCLCs). Second, dunnart testis tissue digestion and culture protocols were developed, to enable maintenance, growth and genetic modification of SSCs in vitro.

Dunnart iPSCs expressed core pluripotency genes, genes associated with germ lineages and differentiation in embryoid body assays. Exposure of dunnart iPSCs to PGCLC differentiation conditions induced expression of PRDM1, PRDM14, and ITGA6 that are hallmarks of PGCLC differentiation in mice/humans. Culture of primary dunnart testis digests identified optimal culture conditions for survival and expansion of germ cells. These cells were maintained in culture for >14 weeks, survived multiple passages and were genetically modified.

This study demonstrates survival, expansion, and genetic modification of marsupial SSCs in vitro; a world first. Together with successful generation of dunnart iPSCs and their germline differentiation, this study provides the critical foundations necessary to generate genetically modified marsupials using germline stem cells.

# **Imaging Mass Spectrometry Approaches: Unraveling Disease Pathways Through Spatial Lipidomics and Metabolomics**

**Glenda Vasku (Chemistry)**

*Key words: lipidomics, mass spectrometry, retina, host-pathogen, infectious diseases*

Lipid dysregulation plays a crucial role in various pathological conditions, ranging from neurodegenerative disorders to infectious diseases. Using spatial lipidomics and mass spectrometry-based approaches, we first investigated lipid alterations in human retinal diseases, with a focus on age-related macular degeneration (AMD). By integrating high-resolution imaging mass spectrometry (IMS) with untargeted lipidomics, we mapped the spatial distribution of lipid species in healthy and diseased human retinal tissues. Our analysis revealed distinct phospholipid and cholesteryl ester (CE) distributions, particularly CE 22:6 and CE 22:5, suggesting a compromised CE transport mechanism within the retina. This work resulted in the development of a comprehensive lipid database, enhancing biomarker discovery and providing new insights into lipid metabolism in retinal degeneration.

Building on this expertise, we now apply spatial lipidomic approaches to study host-pathogen interactions in *Mycobacterium tuberculosis* (Mtb)-infected human macrophages. By comparing lipid remodeling patterns across different Mtb strains, we aim to identify strain-specific metabolic adaptations, lipid signatures linked to pathogenicity and immune evasion, and host lipid alterations that contribute to bacterial survival. This research establishes a novel framework for mass spectrometry-based lipidomics, extending its applications beyond degenerative diseases to infectious disease pathogenesis, with potential implications for biomarker discovery and therapeutic development.

# **The InSAR Lookbook: A Visual Guide to Understanding Earthquake Radar Images**

**Israporn Sethanant (SGEAS)**

*Key words: earthquake hazards, remote-sensing, radar images*

Earthquakes are among the world's most disastrous natural hazards. Understanding the fault locations and their geometries is crucial for improving seismic hazard models that govern building codes and earthquake preparedness. Recent advances in radar satellite technology, particularly Interferometric Synthetic Aperture Radar (InSAR), have allowed scientists to image earthquake-induced ground deformation and interpret source faults, even when buried underground. These images, called interferograms, are widely disseminated across scientific communities but often not well understood. In this research, we apply the InSAR technique to generate synthetic interferograms, producing a visual 'lookbook'—an atlas of static InSAR images designed to help both specialists and the public quickly identify earthquake source mechanisms. We explain how InSAR patterns are shaped by both horizontal and vertical ground movements, as well as by the satellite viewing geometries. The lookbook includes forward model interferograms for a range of faulting styles: strike-slip, reverse, normal, low-angle thrust, low-angle normal, and oblique-slip faults. This highlights the most common InSAR patterns and demonstrates how strike-slip, dip-slip, and oblique-slip earthquakes produce distinct patterns, primarily controlled by the orientation of the fault. We offer guidelines for utilizing the lookbook to visually assess earthquake mechanisms and to pick the causative fault plane from two possible ones. By comparing synthetic interferograms and real-world earthquakes, we showcase the broad applicability of the lookbook, even in complex cases involving multiple fault segments. Lastly, understanding the displacement patterns in the lookbook offers valuable insights for forecasting surface deformation and its relationship to strong ground shaking in future events.

# **Tackling shrub encroachment with mechanical mastication: ecological response in a heathy woodland**

**Jamie Burton (SAFES)**

*Key words: mulching, shrub encroachment, floristic diversity*

Woody shrub encroachment, where ecosystems become heavily dominated by one or two shrub species, is a growing threat to native ecosystems. Woody shrub encroachment can disrupt natural ecosystem processes and alter vegetation community structure and composition. Mastication is increasingly being used to manage shrub-encroachment in south-eastern Australia, however little is known about its ecological impacts. Therefore, in this study, we sought to examine the short-term ecological impacts of mastication on the understorey plant community in a eucalypt woodland. The study took place in far south-west Victoria, in an area of eucalypt woodland dominated by coast wattle (*Acacia longifolia* var. *sophorae*). We compared the effects of two mastication treatments and a control on the structure and composition of understorey vegetation using a randomized complete block experimental design. Each block ( $n = 4$ ) contained all three treatments and understorey vegetation was surveyed pre-treatment, 1-month post-treatment and 12-months post-treatment. Species richness and diversity declined immediately following mastication, then increased to above pre-treatment levels by 12-months post-mastication, driven mainly by increases in native forb and graminoid species. We found the response of the understorey plant community was influenced by the depth of the masticated litter bed, mastication coverage, as well as the infestation density and cover of coast wattle measured pre-treatment. Our study provides the first insight into the impacts of mastication on understorey vegetation in south-eastern Australia and can be used to develop guidelines for mastication to promote floristic diversity.

# **Young people's motivation to study agriculture at university**

**Karen Edwards (SAFES)**

*Key words: agriculture careers, self determination theory, motivation, agriculture education*

This presentation explores the motivations that mobilise young people to engage with university agriculture education. Subsequently it determines if the motivations come from an internal or external source and therefore explores the basis of the motivation to engage in agriculture university education. A qualitative study was conducted with sample of nineteen current agriculture university students via face to face, semi structured interviews. A thematic analysis was undertaken, and the themes were applied to the Self Determination Theory framework. Participants motivations could be categorised into both intrinsic motivation and the four types of extrinsic motivations, with a prevalence of identified and introjected regulation. The results of this study can provide a nuanced understanding of the decision making processes of a cohort of young people who have recently made a commitment to studying agriculture at university. The benefit of this information is that the knowledge gained assists in understanding the complex nature of human motivation and behaviour. It helps explain why students have selected a university agriculture course and what are some of the influences on these choices. The paper builds on previous studies by using Self Determination Theory as a framework for understanding the motivational processes within agriculture education.

# **Climate change and the cost-of-living squeeze in desert lizards**

**Kristoffer Wild** (Biosciences)

*Key words: Ectotherm, Metabolism, modelling*

Climate warming can induce a ‘cost-of-living squeeze’ in ectotherms by increasing energetic expenditures while reducing foraging gains. We used biophysical models (validated by 2,685 field observations) to test this hypothesis for ten ecologically diverse lizards in African and Australian deserts. Historical warming (1950-2020) has been more intense in Africa than in Australia, translating to an energetic ‘squeeze’ for African diurnal species. While no net impact was seen on Australian diurnal species, warming generated an energetic ‘relief’ (by increasing foraging time) for nocturnal species. Future warming impacts will be more severe in Africa than in Australia, requiring increased rates of food intake (+10% per hour active for diurnal species). The effects of climate warming on desert lizard energy budgets will thus be species-specific but potentially predictable.

**Devastating disease can cause increased breeding effort and success that improves population resilience**  
**Devastating disease can cause increased breeding effort and success that improves population resilience**  
**Laura Brannelly (VET)**

*Key words: wildlife disease, conservation, amphibian, reproduction*

Novel and invasive diseases are a key threat to wildlife. The disease chytridiomycosis has had devastating global impacts, but after severe declines some amphibian species can persist and even rebound. Understanding how these species survive is critical to discovering management techniques for supporting declining species. Here we explored the impacts of disease on reproduction in frogs, investigating its effect on breeding effort and success. We found that male frogs are increasing various facets of their breeding efforts resulting in increased offspring. Infected male frogs 1) increased vocal sac coloration, 2) increased sperm quality, and 3) father more egg masses than uninfected males. Management efforts should target the natural mechanisms (e.g., breeding) that species use to overcome key threats because they are more likely to succeed.

# **Developing gene drives to directly target malaria parasites.**

**Mary-Louise Wilde (Biosciences)**

*Key words: Biotechnology, Gene drives, Malaria*

Gene drives are self-propagating genetic elements that skew inheritance to favour their transmission to progeny, spreading through a population at super-mendelian rates. Gene drives can rapidly change the genetic landscape of a natural population of eukaryotic organisms within a few generations, even if the inherited trait reduces fitness and drives a population to extinction. A major focus of gene drive technology is the eradication of vector-borne diseases, such as malaria, through elimination of malaria-infected mosquitoes. However, the potential environmental and global health risks posed by this solution are significant. We developed an alternate strategy: directly targeting the gene drive to the parasite itself. We developed a sex-biasing gene drive in the mouse malaria parasite, *Plasmodium berghei* targeting a gene which is essential for male gamete development (*md4*). Parasites harboring the drive produce only female gametes and cannot self-fertilize. When outcrossed with a male-only *P. berghei* line, all progeny contained the gene drive inserted in the *md4* locus. Resulting sporozoites successfully infected naïve mice and transmitted to mosquitoes, but no oocysts were produced confirming complete loss of *md4* in progeny and inability to complete the sexual cycle. Having shown a highly efficient sex-biasing gene drive in *P. berghei*, we are currently developing sex-neutral fluorescence-based gene drives to quantify drive efficiency, incorporating multiplexed gRNAs to target multiple genes with a single drive, and recapitulating our gene drives in the human malaria parasite, *P. falciparum*.

# **Planning a resilient food system for Victoria**

## **Maureen Murphy (SAFES)**

*Key words: Food system resilience, Food policy and governance , Food security*

Climate shocks and environmental stresses are disrupting global food systems, contributing to rising food prices and food insecurity. The COVID-19 pandemic and geopolitical conflicts have exacerbated existing food system vulnerabilities, with the greatest impacts on those who are already food insecure. Our study aimed to provide evidence for policymakers about how to take action to build the resilience, health, sustainability and equity of Victoria's food system. We interviewed 26 participants from government, industry and civil society groups between September 2023 and February 2024 to understand the needs of stakeholders for guidance and tools to support food resilience planning. We drew on food resilience frameworks to analyse data. We identified key policy portfolios that influence resilience, and opportunities and barriers to taking action to strengthen food system resilience. 'Making the case' for food resilience planning, building capacity in a food systems approach to food resilience planning, and measuring and monitoring food system resilience emerged as key themes. Our study points to the need for 'whole-of-government' approaches to policy and governance for food resilience planning, and highlights examples of best practice in food resilience planning internationally and in Australia. This research laid the foundations for a collaborative process to co-develop a 'how-to guide' in food resilience planning with stakeholders to build resilience and address food insecurity in Victoria.

# **Hot solutions for cold problems: reducing thermal stress during winter for free-range pigs**

**Megan Lucas (VET)**

*Key words: Animal Welfare, Pig Welfare, Thermal Stress*

Pigs in outdoor free-range production systems have opportunities to engage in experiences that can enhance their welfare but are also challenged with stressors like coping with harsh climatic conditions. Cold weather is a particular challenge for neonatal piglets that have a limited capacity to thermoregulate and increased risk of dying in winter. This research examined if adding door coverings to free-range huts in winter can increase the temperature of pigs' shelters and translate to improved thermal comfort and survival for piglets. A randomised complete block design was used to assign 200 litters to huts with or without rubber door flaps over the hut entryway. Hut microclimate, piglet thermoregulatory behaviours, and piglet survival were examined. Door flaps were effective at increasing temperature, with the daily minimum temperature in huts with door flaps estimated to be 2.4°C (SE = 0.164) warmer than huts without ( $p < 0.0001$ ). Door flaps had no negative effects on other aspects of the hut microclimate, including humidity, ammonia, or bedding moisture ( $p > 0.05$ ). Piglets in door flap huts were less likely to shiver (OR = 0.77; 95% CI = 0.39-1.50;  $p = 0.0002$ ). Door flaps reduced the hazard of piglets dying until 12 days of age by a factor of 0.68 (95% CI = 0.50-0.91;  $p = 0.010$ ). These findings show that simple modifications to existing free-range housing systems can improve thermal comfort and piglet survival in winter. The results have significant implications for animal welfare and productivity, and the sustainability of Australian pig production systems.

# **Genetics of human TMPRSS2 regulate COVID-19 infection**

**Naveen Vankadari (Biosciences)**

*Key words: viral infection, COVID19, human Genetics*

The SARS-CoV-2 is responsible for the COVID-19 pandemic, causing severe acute respiratory distress syndrome (ARDS) that has resulted in over 4.7 million deaths worldwide. Understanding the unique cell entry mechanism of SARS-CoV-2 via processing its spike-glycoprotein has vast implications in the development of potential therapeutics. The spike glycoprotein of SARS-CoV-2 binds to the host receptor ACE2 and is activated by the host serine protease Furin and TMPRSS2 via proteolytic activation for subsequent entrance. Here, we present how TMPRSS2 recognizes and activates the SARS-CoV-2 spike using structural, molecular, clinical, and computational studies. Second, we discovered TMPRSS2 cleavage sites in the S2 domain of the SARS-CoV-2 spike and demonstrated the structure as a complex including the catalytic triad of enzyme processing. We next performed whole-exome sequencing for healthy and COVID-19 patients (n523) and identified a key mutation rs12329760 (V160M) in the TMPRSS2 gene that results in a decreased infection rate in clinically diagnosed COVID19 patients and provides the possible reason behind the differential infection rate among the individuals. We also structurally demonstrate how mutations in the host genome reduce infection. We also present potential drugs to block TMPRSS2 and a cohort of studies showing that Chemostat and Nafamostat are associated with faster lesion absorption in the lungs of infected patients. These findings contribute to our understanding of the mechanism of TMPRSS2 processing causing increased virulence, as well as insight into the highest quality intervention options and widen the knowledge of host factors in viral infection.

# **Designing private residential gardens that are climate resilient and thermally safe**

**Paul Cheung (SAFES)**

*Key words: Private residential gardens, climate resilience, thermal safety*

Private residential gardens are important for people who live in independent houses because they provide a convenient place for them to engage in physical and social activities. The use of artificial surfaces such as artificial turf has increased in private gardens, which may cause excessive heat stress and skin burns. This study aimed to i) identify the design factors that influence human heat stress in private gardens, and ii) measure the risk of human skin burns for different surfaces in private gardens based on their surface temperatures. We recruited nine private homeowners in Melbourne, Australia, to participate in this study. The meteorological conditions of their back and front gardens were measured continuously in 2024's summer. The results showed that the daytime (08:00–16:59) mean air temperature of the back gardens were 0.8 °C lower for every 100 m<sup>2</sup> increase in area. The back gardens of East-West facing houses were 1.2 °C lower than North-South facing houses. The back gardens with irrigated vegetation were 0.6 °C lower than those without. The daytime mean air temperatures of front gardens were not significantly associated with the orientation of the house, presence of irrigated vegetation, and sky view factor. On a warm day (maximum air temperature > 33°C), the surface temperatures of artificial turf (53.5 °C), mulch (49.5 °C), and timber (48.5 °C) exceeded the skin burn threshold of 48.0 °C, set by the International Organisation for Standardisation. The surface temperature of irrigated turf (41.5 °C) did not exceed the threshold.

# **In vitro cell infection models to understand frog fungal disease**

**Rebecca Webb (VET)**

*Key words: chytrid cell model*

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, causes chytridiomycosis, a disease responsible for the decline or extinction of hundreds of amphibian species. Understanding the strengths and weaknesses of this fungal pathogen can inform mitigation measures. Here we develop stable genetic modification methods to customise a cell-line based in vitro chytrid infection model, and use fluorescent protein expression to allow real-time observation and quantification of chytrid growth in a host-like environment. We explore whether methods such as microscopy, flow cytometry and immune gene expression can be used to quantify fungal virulence and disease. As a case study, we examine the importance of host and fungal produced glutathione, and how this influences chytridiomycosis using the techniques we have developed.

# **Insufficient sleep during mid-pregnancy and its association with hyperglycaemic risk**

**Robyn Larsen (SAFES)**

*Key words: Sleep in pregnancy and glycaemic risk*

**BACKGROUND:** Insufficient sleep and poor-quality sleep are associated with poor glycaemic control in the general population. However, this association has not been well characterised in pregnant women, mainly due to challenges with self-reported measures of sleep. Therefore, we investigated whether objectively measured sleep duration and quality were associated with post-challenge glucose levels among pregnant women during mid-gestation.

**METHODS:** In a cross-sectional study conducted at the Mercy Hospital for women, 100 pregnant women at 24-28 weeks gestation were conveniently sampled and recruited. Participants were required to monitor their sleep via both an Actigraph GTX3+ sleep monitor and a diary for a 7-day period in a 4-week period prior to their pregnancy 75g oral glucose tolerance test. Hourly glucose concentrations were used to calculate incremental area-under-the-curve for glucose. Linear regression analyses were used to examine the association of sleep quality (sleep efficiency score) and sleep duration with glucose outcomes after adjustment for potential confounders (age, BMI and ethnicity).

**RESULTS:** This study found that 31% of women has insufficient sleep (sleep duration <7 hours) and 54% had poor-fair sleep quality. Both sleep duration and sleep efficiency were associated with disturbances in post-challenge glucose levels. Women with a shorter sleep duration had a higher overall glucose response ( $\beta = -0.60$  [SE=0.24],  $P=0.013$ ), while those with a lower sleep efficiency had a higher 2-hour glucose ( $\beta = -0.074$  [SE=0.024]). These associations persisted after accounting for well-known risk factors for gestational diabetes.

**CONCLUSION:** Insufficient and poor-quality sleep were associated maternal hyperglycaemia during mid-gestation. These findings may have implications for managing glycaemic risk in routine antenatal care.

# **Retention-Time-Independent Fingerprint Approach for Source Identification of Emerging Contaminants**

**Rui Wang** (Chemistry)

*Key words: HRMS, Fingerprints, Source Identification*

High-resolution mass spectrometry (HRMS) fingerprinting is a powerful analytical approach for source identification, but traditional methods depend heavily on retention time (RT) and precursor ion characteristics. This reliance on RT makes these methods sensitive to changes in LC conditions, rendering them unsuitable for cross-laboratory comparisons. To address this limitation, this study introduces a retention time-independent fingerprinting strategy using data-independent acquisition (DIA) mode, which relies on precursor-fragment pairs instead of RT-dependent features. A custom algorithm was developed to extract and compare key data, including  $m/z$ , fragments, and intensities, enabling robust and reproducible analysis. The method was validated using three distinct source samples analyzed by LC-QTOF-MS to construct precursor-fragment fingerprints, which were then applied to five simulated mixed-source samples. Results demonstrated that the precursor-fragment fingerprints accurately identified sources even under altered LC conditions, where traditional RT-based fingerprints failed. Moreover, the intensities of fingerprint compounds strongly correlated between the samples and their sources, further validating the approach. This retention time-independent strategy offers significant potential for source identification and enables reliable fingerprint comparisons across laboratories.

# **Unearthing the secrets of Australia's most enigmatic and cryptic mammal, the marsupial mole**

**Stephen Frankenberg (Biosciences)**

*Key words: marsupial mole; adaptation and convergent evolution; conservation*

The marsupial moles are arguably Australia's most enigmatic marsupials. Almost indistinguishable from placental (eutherian) moles, they provide a striking example of convergent evolution. Exploring the genome of the southern marsupial mole, we provide insights into its unusual biology. We show definitively by retrophylogenomic analysis that marsupial moles are most closely related to bandicoots and bilbies (order Peramelemorphia). We find evidence of a marked decline in marsupial mole effective population size, most likely preceding the arrival of humans in regions near its range, and potentially corresponding to periods of climatic change. Our analysis of loss of eye function—an adaptation to subterranean life—reveals a structured order of loss of gene function associated first with the lens, then cone, and finally rod cells. Last, we identify genetic changes suggestive of adaptation to an oxygen-- poor environment and of its evolution of partially descended testes.

# **Vision restoration using high frequency ultrasound**

**Toon Goris (Physics)**

*Key words: vision restoration, Sonogenetics, Neuromodulation*

Vision loss due to the degeneration of light-sensitive cells in the retina significantly reduces the quality of life for patients with retinal degenerative diseases such as retinitis pigmentosa and diabetic retinopathy. Current research efforts aim to restore vision in these patients using retinal prostheses, which bypass the damaged light-sensitive layer and directly transmit visual information to the intact retinal ganglion cells. Approaches include electrical stimulation of retinal ganglion cells or optical stimulation following genetic modification to render these cells light-sensitive. While these methods show promise, they remain invasive and lack the spatial resolution necessary to restore vision beyond legally blind thresholds.

An alternative approach involves mechanical stimulation of retinal ganglion cells using high-frequency ultrasound waves. Ultrasound can penetrate deep into biological tissue non-invasively while maintaining high spatial precision. However, since retinal ganglion cells are not inherently responsive to mechanical stimuli, they must be genetically modified to express mechanosensitive ion channels.

In this study, we used focused ultrasound waves in an in vitro model to assess their effects on genetically modified mechanosensitive retinal ganglion cells. Our results demonstrated that ultrasound stimulation effectively modulates the frequency and amplitude of cell activity. Additionally, ultrasound stimulation influenced spontaneous activity within the retina, altering the rhythmic patterns typically observed in degenerative retinas.

# **Cool-temperate riparian floras in the Early Cretaceous rift valley of Victoria, Australia**

**Vera Korasidis (SGEAS)**

*Key words: Early Cretaceous, palynology, fluvial*

To better understand the riparian floras associated with Early Cretaceous vertebrate localities in Victoria, Australia, we studied 261 palynological samples from the Otway and Gippsland basins. Podocarpaceae represent the major component of the open canopy forests of the Barremian-Aptian, whereas Araucariaceae are increasingly prolific in the Albian. Ferns including Cyatheaceae represent large components of the understory flora through the Barremian-Aptian, whereas Schizaceae and Gleicheniaceae ferns in addition to angiosperms are more common in the Albian. Notably, all palynofloras recorded imply a high rainfall regime, despite the high paleolatitude, through the Barremian, Aptian and Albian in Victoria. The increasingly warm conditions globally, from the Barremian to Albian, likely drove the prominent floral turnover observed, including numerous extinctions, and the rapid diversification of angiosperms. Increased competition, in particular the inability of lycophytes to outcompete angiosperms in rapidly colonizing newly available braid plain sites after a flooding event, may also have contributed to the decline in lycophyte diversity and abundance. These inferences, also consistent with geochemical and paleobotanical proxies, suggest that cool-temperate climates supported dynamic and forested floodplain environments in the Early Cretaceous rift valley of Victoria.

# **Modern Mosquito Control: A Trial in Melbourne's Inner West to Control the Spread of Buruli Ulcer**

**Veronique Paris (Biosciences)**

*Key words: Mosquito control, Buruli ulcer, Public Health*

Mosquito-borne diseases pose significant public health challenges in Australia, with native species like *Aedes notoscriptus* contributing to the transmission of pathogens such as Ross River virus, Barmah Forest virus, and *Mycobacterium ulcerans*, the causative agent of Buruli ulcer. In response to the rising incidence of Buruli ulcer and its geographic spread into Melbourne's urban areas, there is an urgent need for innovative mosquito control strategies tailored to local environments. This study evaluates the efficacy of the In2Care Mosquito Station, a dual-action mosquito control system, in reducing urban populations of *Ae. notoscriptus* in Melbourne's inner-western suburbs.

In a randomized controlled trial, approximately 600 In2Care stations were deployed across treatment sites, with egg counts monitored weekly for eight weeks in treatment and control sites. Laboratory assays indicated the impact of the system's active ingredients, including *Beauveria bassiana* and pyriproxyfen, on adult mosquito survival. Field monitoring demonstrated significant reductions in *Ae. notoscriptus* egg counts in treatment sites compared to control sites. Laboratory findings confirmed reduced mosquito survival following exposure to the In2Mix. This study underscores the potential of the In2Care system as an effective tool for integrated mosquito management in urban Australian settings, particularly in areas at risk of Buruli ulcer transmission. Coupled with community engagement and public education efforts, the deployment of the In2Care system offers a promising approach to mitigate the public health risks associated with nuisance mosquitoes and vector-borne diseases.

# **Exploring the use of endosymbionts for agricultural pest control**

**Xinyue Gu** (Biosciences)

*Key words:*

Aphids are important pests that cause great losses to crops (more than \$700 million per year in Australia) through feeding damage and virus transmission. One endosymbiont, *Rickettsiella viridis*, has a large fitness cost following transfer from its natural aphid host *Acyrtosiphon pisum* into a novel host aphid *Myzus persicae*. Here, we investigated host impacts after transferring the same *Rickettsiella* strain to an important cereal aphid, the Russian wheat aphid *Diuraphis noxia*. *Rickettsiella* in this host resulted in modest fitness effects, but *Rickettsiella* surprisingly increased aphid virulence to wheat plants and to two non-crop hosts of *D. noxia*, barley grass and brome grass. *Rickettsiella* also reduced the proportion of alates in aphids held in small cages and in larger mesocosms containing multiple wheat plants where short-distance dispersal of aphids was impacted. These results provide compelling evidence that *Rickettsiella* can affect virulence - the first case of an endosymbiont transfer directly influencing aphid virulence to host plants – and highlight the species-specific impacts of endosymbiont transfers on aphids which can involve multiple traits.

# **Native polymer degradation capacity of microorganisms in agricultural soils**

**Zahra Islam (SAFES)**

*Key words: biodegradation; soil microbiology; agriculture*

With a growing global population increasing demand for food production, fertilisers are of paramount importance in the agricultural industry. New fertiliser coating candidates may reduce environmental harm but it is critical that they are evaluated for their native biodegradation potential within agricultural soils and their effects on microbial communities. Four of the seven compounds tested, poly(1,4-butylene adipate) (PBA), polyethylene adipate (PEA), polycaprolactone (PCL) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), showed degradation by indigenous soil microorganisms with headspace CO<sub>2</sub> concentrations increasing between 14 to 98% compared to the soil only control. Surprisingly, two previously characterised biodegradable polymers, polyethylene succinate (PES) and poly(1,4-butylene succinate) (PBS), showed minimal biodegradation in our study. Polymer degradation was confirmed visually using scanning electron microscopy and occurred in conjunction with shifts in the bacterial and fungal community composition of the soils. Soils with PBA, PEA, PCL and PHBV were enriched with polymer degrading microorganisms, such as *Streptomyces* spp., *Bacillus* spp., *Exophiala* spp. and *Talaromyces* spp. Altogether, we demonstrated how different populations of microorganisms were affected by the presence of polymer candidates and highlighted their biodegradation potential in soil at ambient temperature. This approach enables us to identify and select promising polymer candidates suitable for use in new fertiliser coatings, contributing to the development of environmentally sustainable agricultural practices and the future of eco-friendly controlled release fertilisers.

# Speed Talks

# **Structure of Neotectonic Faulting and Earthquake Magnitude Potential of the Northeastern Eyre Peninsula**

**Ambica Sharma (SGEAS)**

*Key words: Earthquakes, Neotectonics, Intraplate faults*

The Eyre Peninsula region of South Australia hosts critical infrastructure and significant mineral and energy resources, including hydrogen and helium exploration, necessitating robust seismic hazard assessments to ensure the safety and resilience of communities and industries. We integrated high-resolution data from drone imagery, lidar, and satellite radar to generate high-resolution digital elevation models (DEMs). These DEMs were then used to precisely locate and map fault traces, identifying subtle geomorphic features such as fault scarps, and lineaments that were previously unrecognized.

Furthermore, we analysed the spatial relationships between these faults and the surrounding geological features, including pre-existing rock units, regional tectonic trends, and geomorphic indicators of past ground deformation. By incorporating an assessment of uncertainties associated with key fault source parameters, including length, dip, rupture area, slip rate, and recurrence intervals, we aimed to improve the robustness and reliability of our earthquake magnitudes.

Our findings demonstrate a strong correlation between the orientation of the faults and the underlying geological structure, highlighting the significant influence of pre-existing weaknesses within the Earth's crust on fault development and activity. This research provides crucial data for the development of a 3D fault model of the Eyre Peninsula, a critical step towards refining seismic hazard assessments and informing robust mitigation strategies, such as building codes, land-use planning, and emergency response protocols, for the region.

# **The Last of Us: How do we combat infectious fungi in real life?**

**Bridget Walker** (Biosciences)

*Key words: Fungi, Infection, Genetics*

The post-apocalyptic television series 'The Last of Us' has recently put fungi in the spotlight, generating curiosity and fear about what fungi are potentially capable of. While the show and the threat of a fungal-zombie apocalypse is fictional, the risk that fungi pose to human health is very real. Invasive fungal infections claim the lives of ~2.5 million people annually, and the World Health Organisation has recently called for a global effort to prioritise research into these infections.

The reason fungi seem able to grow anywhere and everywhere, including within the human body, is that they are master scavengers and can metabolise a very broad range of compounds to acquire the elements needed to survive. In fact, they are able to sense and 'reprogram' their metabolic pathways according to what is available, helping them to grow and reproduce in even the harshest of environments. This frightening adaptive ability is especially critical for disease-causing fungi to survive within nutrient-restricted host environments but the molecular mechanisms underlying this process are largely unknown.

Disrupting fungal metabolism could be a viable strategy for treating life-threatening fungal infections, but first we need to know more about how it operates on a genetic level. Using modern molecular biology techniques, I have been characterising the functions of specific genes involved in regulating metabolism in a pathogenic fungus that infects humans. I have found that disrupting some of these genes significantly impacts the fungus' ability to use certain nutrients and survive in different environments, suggesting that we are well on our way to understanding (and fighting) these super-scavengers.

**Structural and functional characterization of COG0523  
GTPases as putative Zn<sup>(2+)</sup>- binding  
metallochaperones  
Gayatri Nishikant Dharmadhikari (Chemistry)**

*Key words: Bacterial metal homeostasis*

Multidrug resistance in pathogenic bacteria like *Klebsiella pneumoniae* and *Escherichia coli* has caused an alarming increase in deaths from 2017 to the present. This is a rising cause of concern in healthcare systems. So, the World Health Organization (WHO) has placed such bacteria on the high-priority list. These bacteria require metal cofactors to cause virulence; zinc is an essential cofactor in *E. coli* and *K. pneumoniae*; it carries out various enzymatic reactions, cell growth, and development. As a trace element, zinc is required in minor quantities, beyond which it acts as a toxin and inhibits elementary processes in the bacteria. Hence, bacteria need to maintain zinc homeostasis for ideal functioning. Usually, in bacteria, this is done with a diverse set of proteins, including proteins known as metallochaperones, these deliver metal ions to the target proteins. GTPases are a family of hydrolase enzymes; they hydrolyse the nucleotide Guanosine Triphosphate (GTP) to Guanosine Diphosphate (GDP) and inorganic phosphate. This project will be focusing on the COG0523 subfamily of GTPases. This project aims to synthesize and crystallize *E. coli* GTPase: YeiR and *K. pneumoniae* GTPase: KpGTPase from the COG0523 subfamily to study their structure configurational changes upon metal binding. We will also examine the effect of metal binding on the catalytic activity of these enzymes by comparing their reaction rates before and after metal binding. The main goal is to find the exact metal binding site on GTPases so we can control and manipulate the binding to inhibit virulence.

# Representation theory of inhomogeneous Gaussian unitaries

Jingqi Sun (Maths & Stats)

*Key words: Gaussian unitaries, representation theory, CV quantum computing*

Gaussian unitaries are generated by exponentials of Hamiltonians quadratic in creation and annihilation operators. Such Hamiltonians form a representation of the symplectic and special orthogonal Lie algebras for bosons and fermions, respectively. However, the generated Gaussian unitaries form a representation of the double covers of the respective Lie groups. [arXiv:2409.11628:article] explicitly constructed a parametrization of these double covers, namely the metaplectic group for bosons and the spin group for fermions. This parametrization allows us to relate the double cover sign ambiguity to the expectation values of Gaussian unitaries with respect to Gaussian states.

I will present an extension of this parametrization to the case of inhomogeneous Gaussian unitaries, which includes the group of displacement operators. For bosonic systems, the resulting group is a semi-direct product of the metaplectic group with the Heisenberg group. As part of this construction, we utilize the Baker-Campbell-Hausdorff formula to split the exponential of a linear-quadratic Hamiltonian into a product of a Gaussian unitary and a displacement. A similar construction also applies to fermions, where we parametrize the Pin group and even include its disconnected component to describe the full Spin group. If time permits, I will discuss potential applications in the context of phase estimation and continuous-variable quantum computing.

# **A machine learning modelling approach to automated 3D geological mapping and modelling**

**Limin Xu (SGEAS)**

*Key words: Earth Science, Machine Learning, Surface Mapping and Modelling*

Scientists are turning to artificial intelligence techniques, specifically machine learning (ML), to better understand Earth's geology. This project explored how ML could help automate the task of creating geological maps and modeling the structure of Earth's crust at different scales - from entire regions down to specific mineral deposits.

The research focused on Victoria's Bendigo Zone, a gold-rich area in southeastern Australia. This region has a complex geological history, shaped by intense pressures that squeezed and folded ancient seafloor sediments, later punctuated by granite formations and volcanic activity. By feeding different types of data into ML algorithms - including aerial surveys that measure magnetic and gravitational fields, along with information from drilled rock samples - we developed tools to automatically identify important geological features. These include fault lines (breaks in rock layers), the thickness of surface materials covering bedrock, and different types of rocks ranging from sedimentary deposits to volcanic flows.

Our analysis suggested that processing raw geological survey data before using it in ML models significantly improved their performance. We also successfully tested the approach by predicting gold concentrations in the northern Bendigo region based on existing geological survey data.

While the study faced some technical challenges, particularly in handling spatially related data and evaluating how well the models truly performed, it demonstrates that ML can be a valuable tool for automating geological interpretation across different scales and features.

# **The importance of facilitation for species persistence**

**Lisa Buche** (Biosciences)

*Key words: Species interactions, Plant ecology, Biodiversity*

How do species persist in nature? Understanding this is critical to conserve biodiversity, yet we poorly understand processes that determine species persistence. Current theoretical frameworks focus on how competition between species decreases population growth which skewed our predictions of species persistence toward extinction. However, empirical studies have shown facilitative interactions, which may moderate or negate competitive effects, to be ubiquitous in natural systems.

Thanks to a new theoretical framework considering species interactions along a continuum from competitive to facilitative interactions, I showed the prevalence of facilitative interactions in natural annual plant communities. These facilitative interactions help species offset competition and persist in the environment. Indeed, facilitating interactions increases the prediction of species coexistence and internally-driven dynamics often observed in nature. Additionally, I identified what general characteristics (i.e., traits), such as longer stems or thicker leaves, are correlated with facilitative interactions. Plants with more conservative root traits (e.g., smaller root depth and higher root mass density) have a higher probability of receiving facilitative interactions. Additionally, in all communities studied, species with more different trait values have a higher chance of being involved in facilitative interactions. A high difference in trait values allows species to be complementary and reduce their competition for similar resources. These findings enhance our understanding of which species can be involved in facilitative interactions and highlight their importance for conservation strategies. The inclusion of facilitative interactions in the study of species persistence can help us improve our understanding and prediction of local biodiversity.

# Isolation and Characterization of Natural Products in Native Australian Plants

Liyuan (Onery Nexus) Zhu (SAFES)

*Key words: Natural Product Chemistry*

Herbs and medicinal plants have been an important source of bioactive natural products for centuries. Many natural products present in the herbs have been found to be promising drug leads in modern pharmaceutical research. Therefore, phytochemical investigation of herbs and medicinal plants is necessary to discover new drugs from nature.

Acacia mangium, belonging to Fabaceae family, is native to Australia, Indonesia, and Papua New Guinea. Preliminary screening of the plant previously showed the presence of terpenoids, saponins, flavonoids, and alkaloids, but these natural products have not yet been isolated and characterized. The aim of this project is to isolate and characterize natural products from the leaves and green pods of A. mangium to generate a phytochemical profile.

Eight known lupane-type triterpenoids, betulin (49), (E)-betulin-3 $\beta$ -coumarate (51), (Z)-betulin-3 $\beta$ -coumarate (50), lupeol (45), (E)-lupeol-3 $\beta$ -ferulate (46), (E)-lupeol-3 $\beta$ -coumarate(48), (Z)-lupeol-3 $\beta$ -coumarate (47), and lupen-3-one (44), were isolated from the leaves of A. mangium. Their chemical structures were successfully characterized by 1D and 2D NMR techniques as well as LC-MS, GC-MS and HRMS. Most compounds have been reported to exhibit distinct biological and therapeutic properties and thus are promising leads to explain the bioactivity of the plant.

# **Exploring the mating system of a native daisy in a fragmented landscape**

**Manuel Sevenello** (Biosciences)

*Key words: Plant ecology, pollination dynamics, habitat fragmentation*

Following habitat fragmentation, plant populations that once extended continuously across landscapes are split and isolated into multiple subpopulations that experience reduced gene flow and distinctive patch conditions. Plant mating responses to fragmentation are linked to the biotic and abiotic conditions of the new habitat remnant, such as plant community, pollination diversity, patch size, and land-use practices. Over time, these isolated populations evolve local adaptation to their new environmental conditions, developing unique reproductive polymorphism in relation to the degree of pollen limitation experienced in each patch. The self-fertilization rate is expected to increase in smaller and more isolated patches due to reproductive assurance. In this study, we investigate how local environmental physical and biotic conditions influence pollinator communities, pollination dynamics, floral morphology, and plant mating patterns in twelve populations of *Waitzia acuminata* within an agricultural mosaic. We sampled the pollinator community and conducted pollination experiments in various vegetation remnants of the highly fragmented York Gum-Jam woodlands in southwest Western Australia. Preliminary results show that all sites experience a similar degree of pollen limitation, and it is not influenced by patch size, or pollinator abundance. However, pollen limitation is stronger in remnants with lower conspecific abundance. Flower size is negatively influenced by pollinator abundance, but not conspecific abundance. Flower size does not influence pollen limitation or selfing rate. Plant selfing rate and pollen limitation are positively correlated, suggesting that the reproductive constraints imposed by pollen limitation are driving ongoing selection for self-fertilization in this species.

# **Fish in warm water: growth of brown trout across thermal and hydrological gradients in Australia**

**Patricia "Trish" Koh (Biosciences)**

*Key words: fish, environment, climate change, ecology*

Freshwater fish are particularly vulnerable to the impacts of human-induced climate change due to the dendritic and fragmented nature of their environment. In Australia, weather conditions are projected to become more extreme and unpredictable with declining rainfall and warming temperatures altering the hydrological and thermal regimes of many south-eastern waterways. We examined how variable environmental conditions have affected the growth of brown trout, *Salmo trutta*, a non-native coldwater fish species of high environmental, economic and social importance in south-eastern Australia. Otoliths, the ear bones of fish, can be used to describe both the age and the growth of an individual fish over their lifetime. We used otoliths to model the growth dynamics of brown trout with temperature and river flow as key variables. We found that annual trout growth displayed distinct spatial and temporal variation which could be attributed to a mix of short- and longer-term hydrological and climatic variables within its range. In particular, trout grew faster when there was a warmer than average summer and across wetter years. However, we detected age-dependent responses with younger fish performing more poorly than older fish. Our findings indicate that the growth of brown trout may increase under certain conditions, but the response may be modulated by the age of the fish.

# **The Chronicles of Ash: From Volcanoes to Human Origins**

**Saini Samim (SGEAS)**

*Key words: Volcanoes, Human origins, Geochemistry*

The Turkana Basin in Kenya is a site of immense paleoanthropological significance due to the discovery of numerous human (hominin) ancestors for e.g., Australopithecus, Homo erectus, Homo sapiens along with artefacts representing their cultural technology. These fossiliferous sequences are interspersed with multiple volcanic ash layers (tuffs) that allows establishing a chronological sequence for these important sedimentary packages. Tuffs contain minerals called feldspars that serve as target crystals for  $^{40}\text{Ar}/^{39}\text{Ar}$  radiometric isotopic dating. However, precise dating of these finds is often challenging due to the overlapping  $^{40}\text{Ar}/^{39}\text{Ar}$  ages of ash layers and the geochemical similarity between eruptions, which complicates the assignment of unique ages to individual eruptions. In addition, large uncertainties in age estimates of bracketing tuffs, prevent us from understanding the possible role of recurrent volcanic activity and their links to paleoenvironmental changes and hominin evolution.

In order to address these limitations, we utilized modern-day mass spectrometers (like ARGUSVI) to obtain single-grain, high resolution,  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronology on feldspar grains to obtain distinguishable eruption ages for multiple ash layers. We also used single-grain LA-ICP-MS trace element geochemistry on individual volcanic glass to provide individual eruptions its own geochemical identification. Together, these datasets resulted in providing unique age and geochemical identification for each individual eruption. These integrated datasets allowed us to: a) identify previously indistinguishable eruptions, b) investigate eruption triggers and volcanic processes leading to eruptions and c) assess the potential influence of periods of heightened volcanic activity on environmental changes during times recording the co-existence of multiple hominin species. Our results highlight the importance of robust ash layer characterization in providing tighter chronological constraints and assessing the potential influence of volcanism and paleoenvironmental variability in a dynamic region.