School of BioSciences Report

2015 & 2016

THE UNIVERSITY OF MELBOURNE

School of BioSciences

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We thank and acknowledge Geoff Shaw and all staff and students in the School of BioSciences who contributed photos for this report.

THE UNIVERSITY OF MELBOURNE

SCHOOL OF BIOSCIENCES

OUR VISION

To be one of the leading biological science research, teaching and engagement schools in the world.

OUR MISSION

To contribute to Australia's National research priorities and capacity building by advancing our understanding of biological mechanisms, living organisms and ecosystems for the betterment of society and the environment, and inspiring and training the next generation of world-class bioscientists.

OUR STRATEGIC OBJECTIVES

- Excellent fundamental, applied and cross-disciplinary bioscience research
- Close engagement with governments, industry and the wider community
- A diverse, inclusive and highly motivated professional and academic workforce
- Satisfied and well-prepared graduate and postgraduate students
- Effective and efficient administration

OUR EXPERTISE

Our research and teaching activities are conducted under three broad themes:

- Evolution, Ecology and Environmental Science
- Genetics, Genomics and Development
- Plant Science

REPORT FROM HEADS OF SCHOOL

Raoul Mulder

Mark Burgman

In 2015, the Departments of Botany, Genetics and Zoology – each with venerable traditions of contribution to scholarship, teaching and engagement – merged to form the School of BioSciences, a consolidated entity with the strength, diversity and breadth of expertise needed to tackle the major scientific and societal problems of the 21st century.

We have had the privilege of leading the new school in the first two years of its existence, a period that unsurprisingly, has involved much change, challenge and tumult – but which has also demonstrated, overwhelmingly, great promise.

This report summarises some of the School of BioSciences' achievements during these two years of vibrant activity, and celebrates the remarkable achievements and talents of our staff. Great people lie at the heart of a great school, so it has been particularly rewarding for us during this period to be able to retain outstanding academic staff who are vital to the School's strategic objectives, recognise and promote staff who contribute so importantly to our reputation and standing, and appoint new academic staff who will bridge research areas, initiate new collaborations, and generate fresh intellectual excitement.

Below, we briefly highlight some of the major milestones for the school during this time:

- We developed and implemented new administrative, governance and communication structures vital to the effective functioning of the School, including the appointments of an a largely new cadre of professional staff, consolidation of accounts, new committees, a seminar program, a School website, newsletter and promotional video;
- We undertook wide-ranging reviews of the entire BioSciences teaching curriculum in 2015, and our Master of Biotechnology program in 2016, and worked to translate the recommendations of these reviews into a streamlined and contemporary learning experiences for our students;
- The School's research and teaching capacity was further strengthened with important appointments of academic staff to continuing positions: David Balding, Jane Elith, Fiona Fidler, Gurutzeta Guillera-Arroita, Therésa Jones, Patricia Jusuf, Stephen Leslie, Tom Kompas, Luke Holman, Mike Haydon, Jenny Martin, Ute Roessner and Madeleine van Oppen;
- We established a range of important new initiatives, including an Early Career Mentoring Program (led by Therésa Jones) and the BioSciences Research into Teaching Effectiveness (BRITE) group (led by Jenny Martin);
- The new Centre for Systems Genomics was established, involving cross-faculty collaboration between Science, MDHS and Engineering;
- We developed new infrastructure for research and teaching in BioSciences 1, 2, 4 and old Microbiology (overseen by Paul Beardsley);
- The School continued to enjoy excellent success from a range of research funding schemes, including the Australian Research Council, the National Health and Medical Research Council, and a wide range of other national and international schemes;

At a more personal level, just a few of our colleagues' notable achievements include:

- Well-deserved promotions for Alex Andrianopoulos, Laura Parry, Ute Roessner, Steve Swearer and Brendan Wintle (Professor); Tim Dempster, Jane Elith, Devi Stuart-Fox, Alex Johnson and Mike Innouye (Associate Professor/Principal Research Fellow); Mark Green, Monika Doblin, Paul Umina and Angela van de Wouw (Senior Lecturer/Senior Research Fellow); and Gad Abraham, Heini Kujala, José Lahoz-Monfort, Pascal Bernard and Reid Tingley (Research Fellow);
- Prestigious awards to Jane Elith (Prime Minister's Frank Fenner Prize for Life Scientist of the Year; Academy of Science Frank Fenner Medal for research in biological science); Karen Day (Advance Global Australian Award); Marilyn Renfree (Eureka Prize for postgraduate supervision and mentoring of young scientists; University of Melbourne Award for Outstanding Research Higher Degree Supervision); Dawn Gleeson (Genetics Society of Australasia Education prize); Micheal Kearney (HG Andrewartha Medal from the Royal Society South Australia for outstanding early career

research); Gad Abraham (MDHS Emerging Investigator Award); Therésa Jones and Mark Green (Dean's Award for Excellence in Teaching); Phil Batterham (MJD White Medal for research excellence in Genetics; Dean's Award for Excellence in Engagement); Jenny Martin, Andrew Robinson and Paul Umina (Dean's Award for Excellence in Engagement); Stephen Leslie (Woodward Medal in Science and Technology); Alex Johnson (University of Melbourne Excellence Award for Engagement – Research); and Roger Cousens (University of Melbourne Excellence Award for Internationalisation of Research);

- The election of Ary Hoffmann to the American Academy of Sciences, and Geoff McFadden to the American Academy of Microbiology;
- Recognition of Ary Hoffmann, Jane Elith, Michael Kearney and Staffan Persson as Thompson-Reuters highly-cited researchers;
- The appointment of David Macmillan as BioSciences' first Professor Emeritus;
- ARC Future Fellowships awarded to Fiona Fidler, Staffan Persson and Ben Phillips;
- ARC Discovery Early Career Researcher Awards to Gurutzeta Guillera-Arroita, Heather McFarlane and Reid Tingley.
- McKenzie Fellowships awarded to Nick Golding, Michael Whitehead, Iliana Medina and Jian Yen.

Our professional staff have also been exceptional in their dedication, and deserve enormous credit for rapidly coming to terms with new roles. We thank them for energetically, expertly and cheerfully supporting the School's enterprise in two challenging operational years in its existence.

Our students continue to achieve amazing things in a breathtakingly diverse range of areas, providing a wonderful showcase for the School's emerging talent pool.

We would like to thank all these people, as well as colleagues in the broader university community, for their support and advice during the first two years of the School's existence. The robust success of the School would not have been possible without their prodigious energy, commitment and support.

– Raoul Mulder (Head of School, 2015)

– Mark Burgman (Head of School, 2016)

ARRIVALS AND DEPARTURES

New academics in 2015/2016

David Balding	Professor of Statistical Genetics
Joanne Birch	Herbarium Curator
Fiona Fidler	ARC Future Fellow
Alexandre Fournier-Level	Lecturer in Genetics
Mike Haydon	Lecturer in Genetics
Luke Holman	Senior Lecturer in Genetics
Michael Inouye	NH&MRC Heart Foundation Fellow
Patricia Jusuf	Lecturer in Genetics
Stephen Leslie	Associate Professor of Statistical Genetics
John Morrongiello	Lecturer in Marine Biology
Staffan Persson	Professor of Cell Biology
Lauren Salo	Senior Tutor
Eric Treml	Lecturer in Marine Biology
Madeleine van Oppen	Professor of Marine Biology

Departing academics in 2015/2016

Gillian Brown	Herbarium Curator
Mark Burgman	Adrienne Clarke Chair of Botany
Geoff Shaw	Professor in Reproduction and Development

New professional staff in 2015/2016

Anne Bohte	BioSciences Teaching Manager
Alex Buckle	Occupational Health & Safety Coordinator
Carlos Campanero	Receptionist
Anita George	Academic Support Officer
Anne Moran	Receptionist
Katarina Prince	Manager, Strategy and Operations
Jess Salvador	Receptionist

Departing professional staff in 2015/2016

Asmira Korajkic	Executive Assistant to Head of School
Helen McPartlan	BioSciences and Geography Precinct Manager

RESEARCH CENTRES

The School of BioSciences is a leader or participant in various multi-institute collaborative centres, including the Australian government's Cooperative Research Centres (CRC) program, which encourages collaboration between research institutions and industry, and Australian Research Council (ARC) Centres of Excellence. These are hubs of expertise developed to allow high-quality researchers to collaborate with other universities within Australia and overseas to maintain and develop Australia's international standing in research areas of national priority. The School's six research centres are:

ARC CENTRE OF EXCELLENCE PLANT CELL WALLS

The ARC Centre of Excellence in Plant Cell Walls is a collaboration between the Universities of Adelaide, Melbourne and Queensland in partnership with the South Australian State Government and seven international institutions. Its aim is to advance fundamental scientific understanding of plant cell wall biology to enable sustainable production for: food security, human health and energy.

ARC CENTRE OF EXCELLENCE FOR BIOSECURITY RISK ANALYSIS (CEBRA)

CEBRA is a key initiative in the Australian Government's response to biosecurity risks. With our expansive borders and proximity to Asia, implementing effective biosecurity policies and management tools is essential to protecting the health of the population and our unique ecosystems, as well as the viability of essential sectors of the Australian economy.

PLANT CELL BIOLOGY RESEARCH CENTRE (PCBRC)

Established in 1982, the PCBRC conducts research into many aspects of plant cell biology, abiotic stresses, plant pathogens and evolution. It is a key contributor to a number of important research programs including being a node for the ARC Centre of Excellence in Plant Cell Walls.

ARC CENTRE OF EXCELLENCE FOR ENVIRONMENTAL DECISIONS (CEED)

CEED is an Australian Research Council (ARC) partnership between universities and other research institutions and is the world's leading research centre for solving environmental management problems and for evaluating the outcomes of environmental actions. It tackles the complex problems of environmental management and monitoring in a rapidly changing and uncertain world.

CENTRE FOR AQUATIC POLLUTION IDENTIFICATION AND MANAGEMENT (CAPIM)

CAPIM is a scientific research organisation, established to identify and address the impact of pollution in water environments. Its objective is to improve aquatic ecosystem health by developing innovative approaches to pollution detection for inland waters and estuaries, and working with environmental management practitioners to reduce pollution impacts.

AUSTRALIAN RESEARCH CENTRE FOR URBAN ECOLOGY (ARCUE)

The Australian Research Centre for Urban Ecology (ARCUE) was a division of the Royal Botanic Gardens Victoria that conducted high quality ecological research, education and commercial activities on urban and suburban ecosystems. It contributed to the conservation and management of species and ecosystems of Australian cities and towns, thereby enhancing the quality of life for everyone. ARCUE ceased operations on 31 December 2016.

HIGH PROFILE SEMINAR

The 2016 Miegunyah Lecture

The School of Biosciences was fortunate to host Professor Lee Dugatkin from the Department of Biology, University of Louisville, as the distinguished visiting fellow and speaker for the Miegunyah Lecture in April 2016. Professor Lee addressed an audience of 250 staff, students, and alumni on the evolution of goodness in humans and non-humans, through history, popular culture and cutting-edge research, including his own. The lecture was followed by a warm mixer and reception.

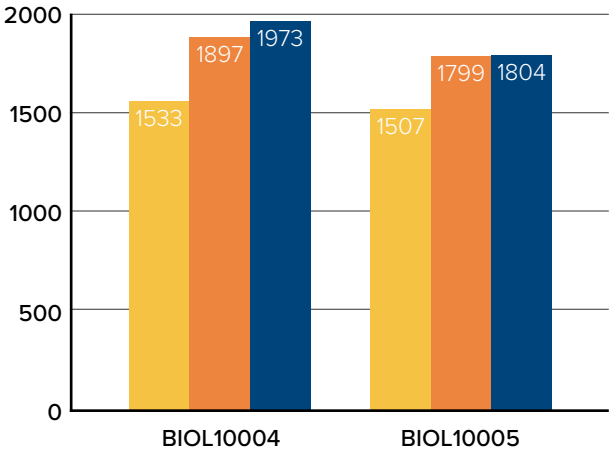
TEACHING HIGHLIGHTS

The formation of the School of BioSciences, from the three existing groups of the Departments of Genetics and Zoology and the School of Botany, provided an excellent opportunity to review the academic programs of the new School. In 2015 an extensive process of curriculum review took place, using an external company to facilitate the process. While a small group of senior academics formed a core working group for the review, the whole School was invited to attend three meetings to develop and review recommendations for the changes. A report was produced in December 2015 with recommendations for change.

In 2014 an interim 'Curriculum Committee' was formed and in 2015 this became the School's Teaching and Learning Committee (chaired by Dawn Gleeson). The committee represents all areas of the academic programs of the School, including undergraduate, postgraduate, the Laboratory Manager, Academic Service Office and the Faculty Manager of Academic Services.

To facilitate the introduction of the recommendations from the curriculum review two working parties were formed, viz a First Year Working Party and a Second and Third Year Working Party. One of the challenges for the First Year Working Party was to develop a program that would be sustainable regardless of student numbers. The graph shows the enrolments in the two core biology subjects of the School for the past three years.

Student enrolments 2014-2016



The first year curriculum changes will be phased over two years. In 2017 the content of the subjects will remain constant and the method of delivery will change. The major changes to delivery include two lectures per week compared to three, the introduction of a one hour Skills Workshop every second week and the use of a SmartBook/eBook and Connect platform linked to the McGraw Hill text Biology: An Australian Focus. In 2018 the content of the course will change to provide a more integrated curriculum.

BRITE

In 2016 the formation of a group called BioSciences Research and Innovation in Teaching Effectiveness (BRITE) was formed (with Dr Jenny Martin as chair). This group provides a forum for sharing ideas and innovations in learning and teaching. Funding was allocated by the Head of the School and has been used to support attendance at appropriate conferences in STEM education. Several members have attended and presented papers, workshops or posters. In 2017 BRITE is hosting a symposium on teaching innovation with Professor John Hattie as the keynote speaker and 12 staff of the School sharing ideas about innovation in their teaching.

TEACHING AWARDS

2015

- Dr Mark Green was awarded the Dean's Award for Excellence in Teaching 2015 (Small Class/ Later Year)

2016

- Dr Therésa Jones was awarded the Dean's Award for Excellence in Teaching 2016 (Small Class/Later Year)
- Assoc Professor Dawn Gleeson was awarded the Genetics Society of Australasia Education prize which recognises an individual who has made an outstanding contribution to genetics education in Australasia.

LEARNING AND TEACHING GRANTS

2015

- Raoul Mulder: Trialling Concept Inventories to assess learning outcomes in large first-year classes; $35,303.00
- Michael Bayly: Online independent learning activities for Biology of Australian Flora and Fauna; $27,814
- Dawn Gleeson, Lyn O'Neill: Undergraduate 'research projects' in First Year Biology; $25,796.00

2016

- Michael Murray: Testing live polling in a large core subject in the second year of the Bachelor of Biomedicine; $6,957

THE UNIVERSITY OF MELBOURNE | SCHOOL OF BIOSCIENCES

RESEARCH IN THE SPOTLIGHT

The University of Melbourne is a pioneering research university, with a community of passionate, world-leading researchers and the largest cohort of research students in Australia. The following stories offer an insight into some of the exciting work being undertaken at the School of BioSciences. All articles first appeared on the University's *Pursuit* website.

For more articles, go to: **pursuit.unimelb.edu.au**

EXPOSING THE CREATURES OF THE DEEP

Brittle star, Ophiothrix spongicola. Picture: Julian Finn

The first map of seafloor diversity has revealed some surprising results.

FOR THE FIRST TIME, A LIGHT HAS BEEN shone on the diversity of creatures that exists in the world's dark, deep seas.

An international team of scientists have created the first map of seafloor diversity across the world's oceans. The map reveals how patterns of biodiversity in deep oceans fundamentally differ from those in shallow waters or on land, and will be critical for conservation efforts.

Focusing on brittle and basket stars (related to starfish), the ground-breaking results, that have taken almost 20 years to compile, have been published in *Nature*.

"The deep seafloor remains the least explored ecosystem on Earth," said lead author Skipton Woolley, from the School of BioSciences, University of Melbourne and Museum Victoria.

This area exists from 2k to as far as 6.5k deep, and covers 70% of the ocean's seafloor.

"We have an innate understanding of the important regions of biodiversity on land, but are much less aware of what is going in the deep-sea," says Mr Woolley.

"It is immense, remote and expensive to survey – so gaining accurate knowledge about the variety of life in the deep sea is difficult."

Over the past two decades, the team has visited museums around the world and combined their collection databases with information from scientific literature to create one 'mega database', which charts where marine invertebrate species have been found.

There are over 2000 species of brittle and basket stars, and they are found in all oceans, from coastal areas, to polar regions.

"We lack information about where seafloor animals are distributed and why some areas support more species than others," said co-author Dr Tim O'Hara, Senior Curator of Marine Invertebrates at Museum Victoria, and an Honorary Research Fellow in the School of BioSciences, University of Melbourne.

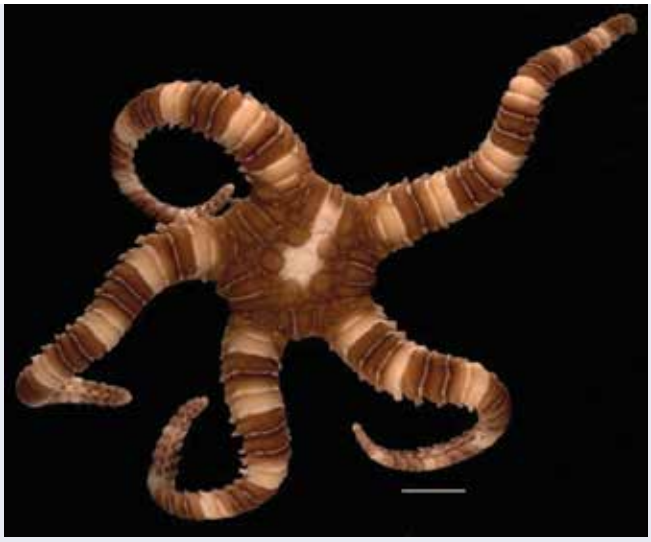
"This is a problem for deep-sea conservation. It is very difficult to protect deep-sea animals and sustainably manage human activities such as deep-sea fishing and mining if we don't know where animals live."

New technology is making activities such as deep-sea mining for minerals including gold and cobalt increasingly viable.

Using sophisticated computer software, the team of researchers from Australia, Canada and the United Kingdom analysed the global distribution of thousands of species of brittle and basket stars to predict and measure patterns of where species occur across the seafloor. They were then able to use this data to compare biodiversity patterns across three different ocean depths: the continental shelf (20-200m), upper continental slope (200-2,000m) and deep-sea (2,000-6,500m).

The ARC Centre of Excellence for Environmental Decisions (CEED) and BioSciences researchers Associate Professor Brendan Wintle, Dr Gurutzeta Guillera-Arroita,

Tim O'Hara with Deep Ocean Biodiversity Map and Brittle Star specimens. Picture: Rod Start

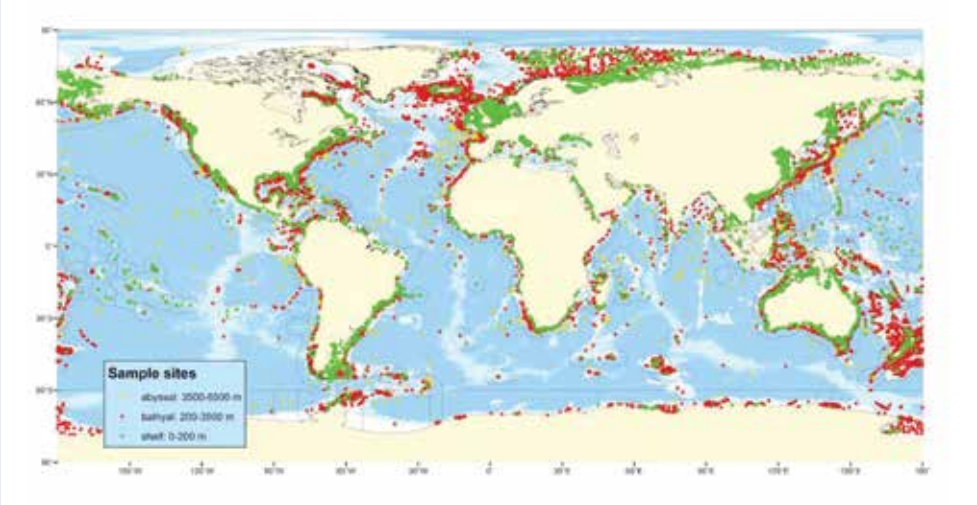


Brittle star, Sigsbeia oloughlini. Picture: Caroline Harding

and Dr José Lahoz-Monfort have particular expertise in the statistical methods used in the study.

"Our major finding is that patterns of biodiversity in the deep-sea differ from those on land or shallow water," says Mr Woolley, who is currently completing his PhD with CEED.

"The number of species peaks in tropical regions on land and in the sea down to 2000 metres. There are more species per square kilometre near the equator than there are in polar regions. In the deep-sea however, the number of species peaks at temperate latitudes, (between 30 and 50 degrees south and north).



Distribution of all survey sites that collected biodiversity data. Picture: Dr Tim O'Hara, Museum Victoria

> "IT IS VERY DIFFICULT TO PROTECT DEEP-SEA ANIMALS AND SUSTAINABLY MANAGE HUMAN ACTIVITIES … IF WE DON'T KNOW WHERE ANIMALS LIVE."

"Deep waters off southern Australia, New Zealand and the North Atlantic are diversity hotspots. This surprising difference in diversity patterns can be explained by the amount of energy available to support life.

"Ecosystems on land and in shallow water receive energy from the sun - this energy is highest in tropical areas, which therefore support a higher number of species," said Mr Woolley.

"In the deep sea however, very little light or heat from the sun penetrates. Energy comes instead from microscopic animals and plants (plankton) that grow in the warm surface waters and ultimately sink to the seafloor to be consumed by hungry creatures living in the dark. There are more plankton in the southern and northern oceans than near the equator."

The team hopes that as data from around the world is collected, global maps of seafloor diversity will continue to become more detailed, increasing our knowledge about the distribution of marine biodiversity. Such maps are crucial for managing the conservation and sustainable use of the deep oceans.

The United Nations is currently negotiating a new international agreement for the management of the high seas through the UN Convention on the Law of the Sea. This research will help inform this process by identifying marine biodiversity in areas beyond national jurisdiction.

OBESITY LINK TO PACKAGING CHEMICAL

Rakesh Rayapaati/Flickr

By Alana Schetzer, University of Melbourne

TODAY, YOU MIGHT BUY A TAKEAWAY coffee on the way to work, eat a home-made salad for lunch with a tin of tuna and pocket the receipt after your weekly supermarket shop on the way home.

But inside that cup, tin and receipt is Bisphenol A (BPA), a common chemical in plastic food and drink containers, and used as a barrier between food and aluminium in a variety of tinned food and soft drink cans.

Studies show traces of BPA can be found in more than 95 per cent of the human population. There has long been debate about the safety of BPA, because its chemical structure is similar to the human sex hormone oestrogen with which it can interfere. BPA exposure has been linked to obesity, behavioural problems, asthma and even cancer, but most public health agencies worldwide consider it to be completely safe.

Now, University of Melbourne researchers have identified a possible mechanism for the link between BPA and obesity, casting fresh doubt on its safety.

The research, published in the *Nature* journal *Scientific Reports*, suggests that even short-term exposure of embryos to environmental levels of BPA in the first days of pregnancy, significantly reduces the number of embryos that develop and, notably, alters their metabolism.

In the ground-breaking study using cattle embryos, the researchers showed BPA exposure led to a substantial rise in the embryo's consumption of glucose, its main nutrient, highlighting a potential mechanism to explain the link between BPA and obesity.

"As a population, we're getting more and more obese and not all of it is because of diet and lack of exercise," says Dr Mark Green, from the School of BioSciences, who headed the study. "There are likely to be other factors, and this research suggests this could include exposure to endocrine disruptors such as BPA."

VOLUNTARY PHASE-OUT

Food Standards Australia New Zealand (FSANZ) states there are no health concerns with current levels of BPA in food and drink packaging. But worldwide, including in the European Union, Canada and several US states, BPA use is being phased out in some products.

In Australia, FSANZ introduced a voluntary phase-out of the use of BPA in plastic baby bottles in 2010. In most cases, the health agencies state that the phase-out is because of consumer demand rather than specific evidence of harm.

Dr Green and his fellow researchers – Dr Alexandra Harvey and MSc student Bom-le Choi – exposed 4,215 cattle embryos to the chemical for four days at concentrations that have been found in humans.

The embryos were then studied until day seven of development.

Some 47 per cent of the embryos in the control group made it to the correct developmental stage by day seven, compared to 40 per cent that were exposed to BPA.

But it wasn't just an issue of whether either group of embryos developed or not. Dr Green says embryo quality was also examined, and the BPA group did "far worse".

BPA is a human-made chemical that is found in many everyday items, such as takeaway coffee cups, food tins, soft drink cans, drink bottles and till receipts. Picture: StockSnap

Many manufacturers now produce BPA-free drink bottles due to consumer demand. Picture: Wikimedia

"On top of the development difference, of the BPA exposed embryos that did develop, there was a 10 per cent decrease in good quality embryos compared to the control embryos,'' Dr Green says. "So by combining the reduction in successfully developing embryos with the drop in good quality embryos, the effect is more like a 17 per cent difference between the groups in terms of good quality embryos that had developed on time."

The most notable finding of the study however was that the BPA-exposed embryos that did continue to develop had an altered metabolism. Over the last 20 years, an increasing body of research has shown changes in the early embryo can affect a person's health in later in life.

SHORT-TERM EXPOSURE

Dr Green says the research suggests even short-term exposure to environmental levels of BPA can potentially have a long-term effect on people.

"There have been a number of epidemiological studies that have identified an association between BPA and obesity in humans, but the mechanism and the timing of when during development and how this occurs was unclear," he says.

"Now we can see that exposure to BPA levels found in the human population can increase glucose consumption in the embryo. This might well result in obesity in later life."

Dr Green stresses that establishing the link between BPA and obesity needs further examination, but this study will likely encourage greater research in this area.

The idea is that BPA, by mimicking oestrogen, could change how people metabolise food, leading to weight gain.

Dr Green says because BPA is found in so many items – almost all people in developed countries have measurable levels of the chemical in their systems – even if they use a BPA-free drinking bottle.

Adverse health impacts of BPA were first raised in the early 1990s. To date, BPA – one of the highest quantity human-made chemicals in the world – is also one of the most studied endocrine disruptors in the world.

Dr Green hopes further BPA research will specifically focus around the critical time of conception and early embryo development.

"Future studies could extend the amount of time the cattle embryos are exposed to BPA and then we could transfer those embryos into surrogates to see what happens to the offspring, in terms of their development and metabolism," he says.

ALMOST ALL PEOPLE IN DEVELOPED COUNTRIES HAVE MEASURABLE LEVELS OF THE CHEMICAL IN THEIR SYSTEMS – EVEN IF THEY USE A BPA-FREE DRINKING BOTTLE.

"The findings of this research may seem alarming but it's important to remember that this study was done in vitro. Whereas in the body, BPA is ingested with food and drinks that may bind it, also the body has the ability to block, breakdown and excrete BPA relatively quickly that means its potential effects are likely reduced."

In the meantime, there have been efforts to reduce people's exposure to BPA. The consumer-led push to get manufacturers to go BPA-free forced them to embrace of alternatives such as Bisphenol S and Bisphenol F – both chemicals that studies show impact human hormones in a similar way.

So what can people do to reduce their exposure to BPA and other similar chemicals?

"In the world we live in, there's no way of avoiding exposure to endocrine disruptors like BPA," says Dr Green. "But if you want to minimise exposure to endocrine disruptors, you can definitely do many simple things such as wash your fruit and veg, don't heat food in plastic containers, don't drink hot liquids out of plastic containers, and drink water from glass or metal bottles; don't use squeeze bottles."

ERADICATING WEEDS ONE WOOF AT A TIME

Detector dogs must navigate complex habitats and changing weather. Picture: Cindy Hauser.

Is our best defence against pests and diseases to smell them out?

By Dr Cindy Hauser, School of BioSciences, Faculty of Science, University of Melbourne

YOU'RE PROBABLY USED TO SEEING SNIFFER (or detector) dogs in airports or music festivals, where they're trained to sniff out illegal products such as drugs and foods.

Well, it turns out that their super sense of smell can also help protect Australia's agricultural industries and natural environment.

And the dogs are willing to do it for the simple reward of playing with a tennis ball.

Around the country dogs are being trained to sniff out threatened species such as koalas and quolls, and to identify threats such as the vine disease phylloxera and noxious hawkweeds.

But how good are they?

Whether a dog's job is to detect drugs, droppings or plants, the first phase of training exercises is very similar. However, detecting that same trained scent in the wild can be much more variable and challenging. A large crop field or national park could be filled with all sorts of other distracting and tantalising odours. Changing winds can whip the scent around on a whim. Thick vegetation is hard work to scamper through and may even trap scents in away from the open air. It's no wonder that a well-trained detector dog might occasionally miss its target.

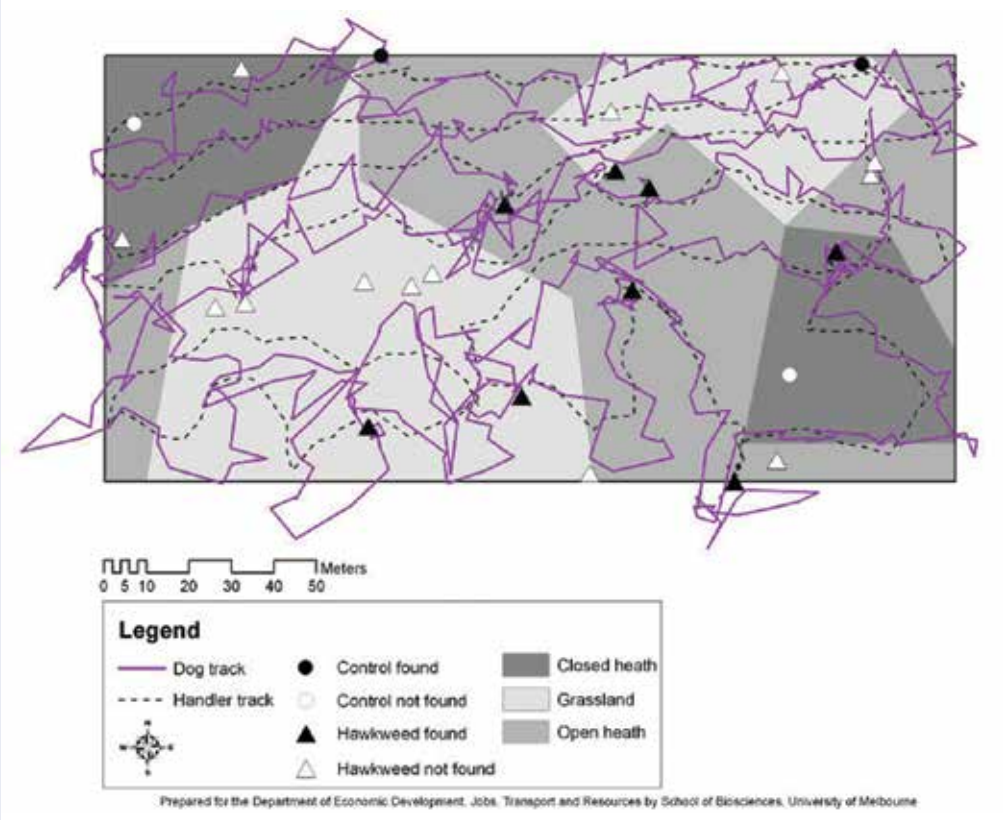
My research identifies what we can detect and what we miss when we go out into the field with observational tools - human eyes, DNA testing of water samples, motion-triggered cameras, or, in this case, a dog's nose. I share my mathematical detection models with government agencies to help them avoid missing what matters most – like hawkweed.

Native to Eastern Europe, several species of hawkweeds have entered the Alpine National Park as escapees from garden plantings in Falls Creek, and possibly also hitchhiking on ski machinery or on the boots or tents of hikers.

If hawkweeds are allowed to spread uncontrolled they have the potential to affect over $1 billion of Australia's agricultural value, as well as crowding out our native flora in the National Park.

But the good news is that the Victorian and NSW governments, with the help of a dedicated group of volunteers, have managed to prevent hawkweed from spreading. With a little more effort they may be able to completely eradicate these weeds.

Missy the weed-detection dog. Picture: Cindy Hauser.



One trial in our January 2015 study, in which Missy (solid purple line) and her handler (dashed black line) search for hawkweeds through a mosaic of three vegetation types (grey background shading). Missy signalled on eight of the 21 hidden Hawkweeds, and two of the four non-hawkweed 'controls' or decoys. Only a full statistical analysis can reveal whether she signals on hawkweeds more reliably than on decoys. Picture: Cindy Hauser.

You might say we have a sniff of success.

My research tests how good detector dogs are at sniffing out hawkweeds under a variety of conditions.

IF HAWKWEEDS ARE ALLOWED TO SPREAD UNCONTROLLED THEY HAVE THE POTENTIAL TO AFFECT OVER $1 BILLION OF AUSTRALIA'S AGRICULTURAL VALUE, AS WELL AS CROWDING OUT OUR NATIVE FLORA IN THE NATIONAL PARK.

During initial trials in the Alpine National Park, my team laid out a series of hawkweed hide-and-seek games to measure what hawkweed-hunting dogs like Missy (pictured) can do. A GPS strapped to her harness keeps track of her search path, and we time how long it takes her to find each plant. Later on, a map of the full course shows us which hawkweeds she missed.

We can then use statistical analysis to pick out common patterns. We can see whether particular plant types, terrain or weather conditions are particularly difficult for Missy to work through.

I recently won a 2016 Science and Innovation Award for Young People in Agriculture, Fisheries and Forestry, sponsored by CSIRO Health and Biosecurity. It will allow me to continue this research with two more dogs, whose training has benefitted from what was learned during the initial trials with Missy. I will compare their efforts to what we already know human searchers can achieve.

Volunteer teams have spent more than a decade searching for hawkweeds in the Alpine National Park and we know they have a sharp eye for the plants' distinctive orange and yellow flowers. But in the many months that hawkweeds don't flower, a dog's nose probably knows more.

My research enables us to bring out the best in Missy and other detector dogs.

It will help trainers and land managers to create the best conditions for dogs to sniff out their targets, ensuring they're alert and healthy, and giving them the extra time they need to do the toughest jobs thoroughly.

TRAPPING MALARIA IN A GENE NET

A mosquito net. Picture: Andrea Kirkby/Flickr

The ability of this disease to mutate to nullify drugs is actually its downfall, delivering a new weapon for stopping the spread of resistance.

By Andrew Trounson

MALARIA PARASITES ARE TOO CLEVER FOR their own good – fatally.

In what may be a game-changer in the battle against malaria's ability to dodge new drugs by building resistance, scientists have discovered how to turn the parasite's own mutations against it, making it impossible for the mutated parasite to survive in mosquitoes.

It is a giant step towards controlling malaria because the parasites, clever as they are, won't be able to spread their adapted resistance from person to person.

The discovery, published in US journal Science, also means an existing anti-malaria drug, atovaquone, previously thought too prone to resistance is in fact safe to be used on a mass scale.

Malaria remains one of the world's biggest health challenges killing up to 635,000 people every year, most of them young children in Africa.

An international team led by scientists from the University of Melbourne has used basic biology and genetic analysis to discover that when the malaria parasite mutates to resist atovaquone, the mutation makes it impossible for the parasite to subsequently survive when it gets inside a mosquito.

As a result the parasite dies before it can reach the mosquito's salivary glands and be passed back into another human where it would spread its drug resistance.

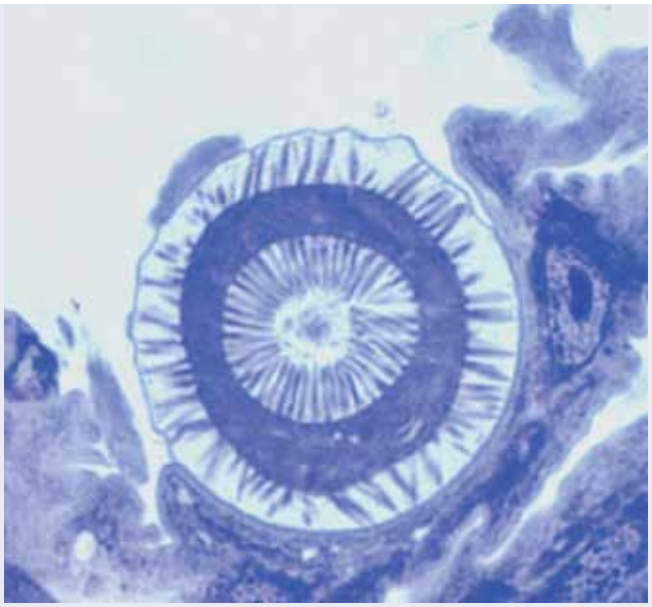
"Genetically it is a very neat little trap," says Professor Geoff McFadden, at the University of Melbourne's School of Biosciences, who jointly led the research with colleagues Dr Dean Goodman and Dr Josephine Siregar, from Indonesia's Eijkman Institute.

"The parasite's resistance strategy is also its Achilles' heel. The mutation is a quick and easy fix for the parasites to get around the drug, but they are digging a hole they can't get out of."

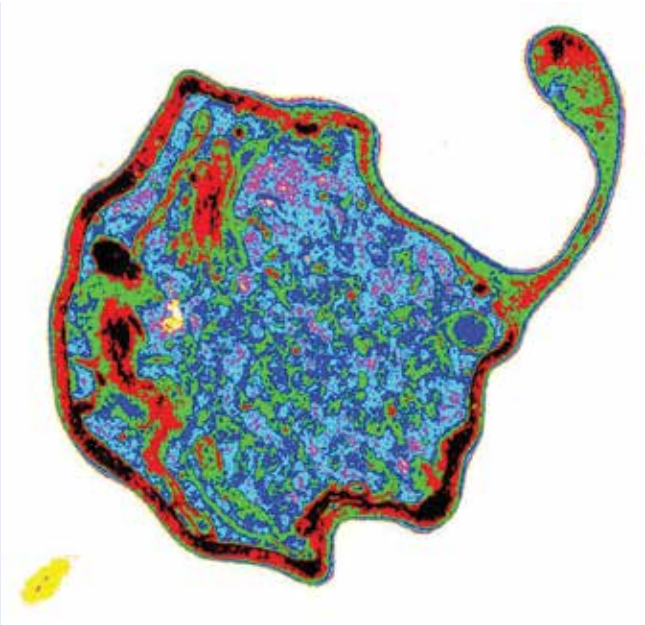
Anti-malarial drug developers should now be able to incorporate the same genetic "trap" in new drugs to prevent resistance spreading. Atovaquone came off patent in 2013.

"This will address the drug resistance problem because it gives us a new strategy to manage it,'' Professor McFadden says.

The use of atovaquone as an anti-malarial drug has always been handicapped by the ability of malaria parasites to develop resistance. In 2000, pharmaceutical company Glaxo Smith Kline brought out a patented version of the drug that was safe for key risk groups such as young children and pregnant women and marketed it as Malarone.



A malaria parasite growing in a mosquito. This healthy parasite is vulnerable to drugs, displaying many infectious spikes. Drug-resistant parasites fail to produce spikes and cannot infect new hosts. Picture: Professor Geoff McFadden.



A malaria parasite in human blood. A genetic trap has been discovered to prevent drug-resistant parasites like this from spreading to new patients. Picture: Professor Geoff McFadden.

GENETIC MUTATION

Professor McFadden says that because of the high risk of resistance spreading, Malarone was specifically targeted at the travellers' market rather than for mass administration in areas of Africa and Asia where malaria is endemic. It was consequently priced at about 10 times the cost of other anti-malarial drugs. But until now no one had thought to examine whether the atovaquone-resistant parasites could even survive in the mosquitoes that spread malaria. It turned out they couldn't.

ANTI-MALARIAL DRUG DEVELOPERS SHOULD NOW BE ABLE TO INCORPORATE THE SAME GENETIC "TRAP" IN NEW DRUGS TO PREVENT RESISTANCE SPREADING.

"It is bizarre that no one had looked before now, but it was simply assumed that the resistance could be spread just like other drug resistance," Professor McFadden says.

The origin of the discovery was a conference in Jakarta in 2013 when scientists, including Professor McFadden, and colleagues from Australia, Indonesia, Japan and the US compared notes on their work on malarial resistance. They realised the genetic mutation in response to atovaquone should make it difficult for malaria to survive in mosquitoes. Tests by Dr Goodman, Dr Siregar and Vanessa Mollard, using a rodent strain of the malaria parasite in Professor McFadden's lab, confirmed it couldn't survive once inside the insect.

The results were then replicated when a human strain of the drug resistant parasite was fed to mosquitoes in the US lab. "It was the Eureka moment," Professor McFadden says.

The human body is a very accommodating environment for parasites, but the mosquito is a much harsher one. The problem for the drug-resistant malaria parasite is that in the human body the parasite can readily cope with the biological cost of living with atovaquone – its respiration becomes less efficient – but it becomes a fatal defect inside the mosquito.

"In humans the parasite is living in an incredibly rich environment with plentiful amounts of glucose and protein and a regulated environment with a steady temperature. It is like a land of milk and honey. But when it moves into the insect where temperatures drop and resources are scarce, it has to work a lot harder," Professor McFadden says.

The task now is to conduct field trials in Africa where blood from people suffering from the drug-resistant malaria parasite will be tested in mosquitoes to confirm that the resistance can't be passed on. If that proves successful, then new generic versions of atovaquone could be used on a mass scale to effectively treat and prevent malaria.

Artemisinin is currently the best available anti-malarial drug compound for mass administration, but resistance has developed in Cambodia and Thailand and is spreading. Professor McFadden said atovaquone drugs could be used to manage outbreaks of resistance to artemisinin.

"This isn't going to eradicate malaria, but it will help to control it," he says. "To get rid of malaria we need not only good drugs but also a vaccine, which so far is proving difficult to develop, and mosquito controls. There isn't just one solution."

The discovery included work by researchers from Indonesia's Eijkman Institute and Hasanuddin University, Japan's Jichi University, Nagasaki University and Tokyo University, and in John Hopkins University in the US.

HOW SUNFLOWERS TRACK THE SUN

Pexels

Once a mythological story of unrequited love was used as an explanation. Now we know there is an internal clock driving its daily movement.

By Gillian Aeria

Plants tell time. Not the way we do – for example, it's 3.40pm, time to pick up the kids. But like animals, plants can sense that winter is coming and it's time to drop leaves.

A sunflower anticipates daybreak, much like a rooster does before starting to crow. At sunrise, sunflowers face east to greet the first rays and continue to move with the sun until it sets in the west. Overnight, the sunflower head swings back around so it faces east at dawn.

Dr Mike Haydon, a University of Melbourne plant scientist, says sunflowers only move until the flower bud opens. At that point they stop their daily dance and permanently face east. "This is where the controversy arises,'' says Dr Haydon, from the School of BioSciences. "People say 'my sunflowers don't track the sun'. Well if they're open sunflowers, then they don't do that because that's when they've stopped."

Before scientists studied a plant's internal clock, the Greek myth of Clytie and Helios was used to explain their movements.

Clytie was a water nymph who fell madly in love with Helios, the sun god. But Helios had eyes for another woman and ignored Clytie. Full of unrequited love, Clytie would watch Helios race his chariot across the sky.

She didn't eat or drink and after nine days of watching him cross the sky, she became rooted to the ground and transformed into a sunflower.

Since *helio* refers to the sun and *tropism* refers to movement, *heliotropism* describes the movement that plants like sunflowers make in relation to the sun. "There is certainly a clock driven component, an internal or circadian rhythm to this,'' says Dr Haydon.

Experiments have shown that if sunflowers in a field are turned 180 degrees, they continue to move during the day, but now in a west-to-east direction, opposite to the sun. After several days, the sunflower corrects itself to move east-to-west again. During this time, the sunflower retunes its internal clock, using one of the most powerful entrainment cues – sunlight.

TICK, TOCK, THE INTERNAL CLOCK

"The external cues remind the plant what time of day it is. It slightly readjusts itself so that its internal clock is matched to the environment," says Dr Haydon. This is essential when dawn changes by three minutes or more everyday depending on your latitude.

"This experiment shows very clearly that there's an internal clock that is driving this plant behavior."

Clytie, waiting and watching for Helios. Painting by Frederic Leighton (1830-1896), Leighton House Museum.

On parade. A field of sunflowers. Picture: Pixabay

But the big question is whether sunflowers actually *track* the sun or would they do it anyway because of its internal clock that is triggered by sunlight. “The missing experiment that would answer this is the one that moves sunflowers growing in the sunshine into a dark room for a day or so,’’ he says.

At its core an internal clock is made up of a set of genes that regulate each other’s expression. Each gene is expressed at a different time of the day to generate rhythms in the plant’s internal cycle. This internal rhythm controls a wide range of processes in the plant including metabolism, movement and growth.

So heliotropism is regulated by an internal rhythm of gene expression. But the actual mechanics of the movement remains “very much a black box … but we suspect that the mature leaves have something to do with it since the rhythmic movement stops when mature leaves are cut off,’’ says Dr Haydon.

He also suggests two possible mechanisms seen in other plants to explain this.

The first theory involves cell elongation, which is how most stems grow. If cell growth on the east and west sides are cyclical and matches the sun’s movement, sunflower stems would appear to ‘follow’ the sun.

WATER MOVEMENT

The other is that of water movement within the plant, known as turgor pressure. Water can be distributed differently within the stem and these differences in water pressure cause it to curve. This distribution of water pressures can be synchronised so that it would cause sunflowers to curve and mimic the sun’s movements.

“The support for this is that the water status of the soil can impact on whether sunflowers move or not. If it’s dry they don’t do it. If the soil is waterlogged, they don’t do it either, so it suggests water balance is important,” says Dr Haydon.

As it stands, sunflowers *do* follow the sun but only until they bloom. Dr Haydon says it’s not fully understood why the moving stops after blooming, but there are two hypotheses.

“It could simply be mechanical: as the sunflower head grows, it simply becomes too heavy for the stem to move, ‘’ he says. “The other possibility is that it is related to diminishing robustness of the internal clock. There is evidence that circadian rhythms weaken with age, not only in plants but also in animals.”

After it blooms most people recognise the plant as a sunflower. And then it remains steadfast watching the eastern sky, like Clytie waiting for Helios to rise.

EMPTY CALORIES NO MORE

Rice crop. Picture: University of Melbourne

RICE IS THE STAPLE FOOD FOR BILLIONS OF people throughout the developing world. But beyond easing hunger pains and providing carbohydrates for energy, it has little nutritional value.

It means many people who depend on rice as a staple food are effectively being starved of essential micronutrients such as iron, zinc and pro-vitamin A.

Nutritionists call it "hidden hunger".

The World Health Organisation estimates two billion people, or 30 per cent of the world's population, are anaemic, in many cases due to iron deficiency. This condition leaves people weak and lethargic and poses a significant and even fatal health risk to pregnant women and their children. Equal numbers are at risk of zinc deficiency with severe health consequences including stunted growth and impaired immune function.

But researchers are now on the cusp of making a real difference. University of Melbourne plant geneticist Dr Alex Johnson and colleagues have created a genetically modified (GM) rice that produces grain with significantly more iron and zinc through a process called biofortification. And field trials have now shown that the biofortified rice is just as high yielding as conventionally bred rices.

FIELD TRIAL SUCCESS

In results recently published in *Scientific Reports*, an open access journal from prestigious scientific publishers *Nature*, Dr Johnson and colleagues describe how they were able to grow iron and zinc biofortified rice plants in the field.

Rice grains usually contain just 2-5 parts per million (ppm) of iron. The researchers were aiming to increase that to at least 13 ppm to address iron deficiencies in rice-based diets. They managed to get to 15 ppm. Similarly, they had been targeting to increase the amount of zinc from 16 ppm to 28 ppm, but they managed to get to 45 ppm.

"The results shows that this technology actually works in the field, not just in the glasshouse," says Dr Johnson, from the School of BioSciences. "We exceeded our biofortification targets and the rice was just as high yielding as existing rice varieties."

Crucially, the field-testing also showed that while the genetic modification had enabled the biofortified rice to take up more iron and zinc from the soil, it didn't increase the take up of harmful heavy metals such as cadmium.

Finally, nutritional testing of grain produced in the field trials showed that if we were to eat this rice, our bodies would readily absorb the increased quantities of iron and zinc. The scientists were able to determine this by "feeding" the rice to so-called Caco-2 cells, which are a human cell line that can be grown in the lab to resemble cells of the small intestine. The biofortified rice was "fed" to the Caco-2 cells by first artificially "digesting" it using enzymes that mimic our own digestive process.

"There are no deal breakers in these results. We have proven our concept in a major variety of rice, and we are now ready to move this into a developing country," says Dr Johnson.

"Rice is the staple food for billions of people today and that isn't going to change anytime soon, so rice

Fishing among rice fields in Bangladesh. The country could be the first where iron biofortified rice is released. Picture: Michael Foley/Flickr.

Rice biofortification researchers in an Indonesian rice field. From left to right: Conrado Dueñas (International Rice Research Institute), Inez Slamet-Loedin (International Rice Research Institute), Prabhjit Chadha-Mohanty (International Rice Research Institute) and Alex Johnson (University of Melbourne). Picture: University of Melbourne.

biofortification is a tool that we can use to address hidden hunger in a huge number of people.

"Over time that should lead to healthier and more productive populations in the developing world, boosting local economics and eventually supporting more diverse and balanced diets.

"We can and do use vitamin and mineral supplements and food processing to help people suffering from micronutrient deficiencies, but those interventions are recurrent costs and need industrial processing that may not be readily available in developing countries. Biofortification is a sustainable solution because once it's in the seeds you've increased the nutritional quality of the crop itself. The farmer simply needs to plant biofortified seeds."

TARGETING THE RIGHT GENE

Dr Johnson's research has been funded and supported by several partners including the Australian Research Council and the not-for-profit HarvestPlus initiative. HarvestPlus is backed by the Bill and Melinda Gates Foundation and is tackling hidden hunger in developing countries with biofortified crops. Dr Johnson's ambition is that farmers around the world would face no additional cost for adopting the iron and zinc biofortified rice.

Dr Johnson, an American who later also became an Australian, did his PhD at Virginia Tech in the US where he worked to genetically modify potatoes to create resistance to the Colorado Potato Beetle.

At the University of Melbourne he has been working on genetic strategies to boost the iron content of rice since 2009. In 2011, his team identified a specific rice gene that when "switched on" increases the amount of iron taken up from the soil and transported to the grain. Usually this gene is only activated when the rice plant itself is short on iron, but by modifying what drives the gene they were able to keep the gene switched on all the time. "We have basically tricked the plant into thinking it is continuously short of iron."

They also found that it increased the uptake of zinc. "It was a dream result," says Dr Johnson.

His fascination with plants goes back to his childhood when he was enthralled by seeds growing into something that his family could eat. He remembers following his mother around the garden and impatiently digging up her plants to see what they looked like as they were growing. Now as a scientist, he has had to learn the patience of a good gardener.

"Given the huge opportunity we have here to fight human malnutrition, there are times when the project doesn't seem to be going fast enough. But plants can only grow so fast and we need time for replicated field trials in multiple countries. It's important that we fully understand how our biofortified rice grows in as many different environments as possible."

Dr Johnson and his colleagues are now aiming to introduce the iron and zinc biofortified rice into Bangladesh where almost 80 per cent of cultivated land is dedicated to rice, but where more than half of all children and 70% of women are iron deficient. He says iron biofortified rice could have a huge impact in this country.

REAL SOLUTION FOR REAL PROBLEM

Another reason that the team is targeting Bangladesh is that it has already released other GM crops such as an eggplant variety that has allowed farmers to drastically reduce their insecticide use.

GM crops are controversial because of concerns from some, including Greenpeace, that such crops may have unforseen consequences that could eventually harm the environment and pose a health threat. But Dr Johnson says that there is a wealth of information showing that GM crops are safe and notes that over a hundred Nobel Prize winners from a range of mostly science disciplines, recently penned a letter asking Greenpeace to end its opposition to genetically modified organisms.

"Hidden hunger isn't a hypothetical problem, it is a real problem, and biofortification is a real solution. I've not met anyone who is against that."

WAITING FOR THE TIGER MOSQUITO

Aedes albopictus is an active biter during the middle of the day, making it an especial nuisance. Picture: Rick Miller/Flickr.

It may be just a matter of time before the tiger mosquito arrives on mainland Australia bringing tropical diseases south.

By Andrew Trounson, University of Melbourne

A SWARM OF MOSQUITOES IS AN accident waiting to happen. But perhaps the bigger issue facing Australia isn't so much whether the mosquitoes here are swarming, but rather whether a certain "tiger" mosquito lurking just to the north in the Torres Strait ever makes it to the Australian mainland.

A female mosquito lays hundreds of eggs at a time, and within ten days newly minted adults are leaving their stagnant water homes to buzz around our ears and ankles. Victoria is braced for swarms of the things after late winter floods and warming spring temperatures created perfect breeding conditions, prompting public health warnings and forcing councils to start spraying breeding sites.

But as Victorians stalk their bedrooms and hallways armed with insecticide cans, they should count their blessings that for now at least the *Aedes albopictus* mosquito remains in the Torres Strait.

Nicknamed "Tiger" because of the bright white stripe on its back and the white bands on its legs, *albopictus* is a biting mosquito that can carry a variety of tropical diseases. And it doesn't mind a bit of chilly weather. Which means, if it crossed to the mainland it could cover much of the country, making once exotics tropical diseases into more common temperate ones.

"*Albopictus* is one of our main quarantine pests," says Professor Ary Hoffmann of the Bio21 Institute at the University of Melbourne. "Its ability to withstand colder weather has allowed it to invade Europe and North America." And as far as Professor Hoffmann is concerned, despite our quarantine efforts it is likely a matter of when, not if, the Tiger makes it to the mainland. It was first reported in the Torres Strait islands in 2005.

At the moment the rise in mosquito numbers in Victoria has prompted health warnings about comparatively rare mosquito-borne diseases such as the non-fatal Ross River Fever and Barmah Forest viruses, and the potentially fatal Murray Valley Encephalitis. But if *albopictus* arrives here Professor Hoffmann says we will have to add dengue fever, which is currently just limited to northern Queensland, as well as the zika and chikungunya viruses.

Many mosquito breeds tend to be more active at dawn and dusk when the air is more humid and the insects are at less risk of drying out. But Professor Hoffmann says *albopictus* doesn't mind a bit of daylight. It means that *albopictus* is active and biting in the middle of the day. "It is regarded as a massive irritant as well as being a vector for diseases, making it a real nuisance for outdoor activities."

Professor Hoffmann and colleagues have modelled the possible reach of *albopictus* if it does arrive, and they predict it could become widespread as far south as northern Tasmania. "It will go a long way," he says

While their modelling suggests it would be concentrated on the coastal fringes of the continent, its spread so far in North America and elsewhere suggests forms of this mosquito could also travel further inland in Australia.

Dengue fever is spreading rapidly elsewhere around the world as a direct result of *albopictus* migrating into more temperate climes and the ongoing spread of its sister

Shutterstock

species *Aedes aegypti*. Since 1970 the number of countries where dengue is endemic, that is it is present, has risen from just nine to now 100. And there are a rising number of outbreaks.

The World Health Organization says 2015 was a particularly bad year with outbreaks of over 100,000 cases in the Philippines and Malaysia, representing a 60 per cent and 16 per cent increase respectively on the previous year. The number of cases in Brazil trebled to over 1.5 million, and Delhi in India reported its worst outbreak since 2006 with 15,000 cases. In 2014, China's Guangdong province near Hong Kong reported its worst outbreak with 45,000 reported cases and six confirmed deaths.

The proboscis of an Aedes albopictus mosquito feeding on human blood. Picture: James Gathany, Centers for Disease Control and Prevention's Public Health Image Library (PHIL).

WHO now warns that Europe is also at risk of possible outbreaks. Cases of local transmission were reported in France and Croatia in 2010.

The main vector of dengue has been *Aedes aegypti* mosquito, which is limited to tropical climates including northern Australia. But the ability of *albopictus* to withstand cold temperatures means the disease is now spread more widely. It is believed to have travelled into northern climes by breeding in water puddles caught inside imported tyres and bamboo. Its eggs can survive temperatures below freezing.

Dengue fever has similar symptoms to mosquito-borne malaria, but is less fatal. Dengue can cause severe flu-like symptoms, headaches and joint pain, as well as vomiting and rashes. Severe dengue fever, known as dengue haemorrhagic fever, is present in most Asian and Latin American countries, and with proper medical attention fatality rates from severe dengue can be kept below 1 per cent. It is estimated that every year abour 500,000 people are infected with severe dengue fever requiring hospitalisation, of which about 2.5 per cent die. In contrast, in 2015 there were 438,000 deaths from malaria.

BUT THE ABILITY OF *ALBOPICTUS* TO WITHSTAND COLD TEMPERATURES MEANS THE DISEASE IS NOW SPREAD MORE WIDELY. IT IS BELIEVED TO HAVE TRAVELLED INTO NORTHERN CLIMES BY BREEDING IN WATER PUDDLES CAUGHT INSIDE IMPORTED TYRES AND BAMBOO. ITS EGGS CAN SURVIVE TEMPERATURES BELOW FREEZING.

"Dengue isn't as deadly as malaria, but while the incidence of malaria is going down the incidence of dengue fever is going up, and the resulting economic impact can be massive because dengue can still really knock people around."

"We hope *albopictus* won't hit the mainland but I think it is inevitable that it will at some stage, it is just a matter of time. And when it does you will certainly notice it."

The odd temporary swarm of mosquitoes may be the least of our problems.

HELPING CORALS SURVIVE A RAPIDLY CHANGING WORLD

Brain coral, Trachyphyllia geoffroyi (Public Domain)

Professor Madeleine van Oppen wants to manipulate the complex relationship between corals and microbes to accelerate coral evolution

WE LIVE IN A MICROBIAL WORLD, EVEN US humans. We have more microbial cells in and on our bodies than we have human cells, and even a large part of our DNA is derived from microbes – viruses and bacteria and so on. And that is true for all organisms. We now realise how important microbes are for our health and functioning.

I was trained as a marine ecologist and during one of my master's research projects I got exposed to genetics. It was around the time that PCR (Polymerase Chain Reaction) methods were developed, which really was a huge advance in genetics because we could quickly pull out parts of the genome and sequence them. This technological development allowed a range of interesting ecological questions to be addressed. Then I did a PhD, using genetic tools to study the evolutionary history and population genetics of cold-water seaweeds. In 1997 I came to Australia to work on corals.

Corals have quite complex microbial relationships, or symbioses, because in addition to bacteria, they also live with single-celled plants, or algae. That plant lives inside the coral's cells, and it uses the sun to make sugars. It leaks a lot of those sugars to the coral tissues and the coral relies on those sugars for nutrition.

If the coral loses the symbiotic algae it will eventually die because it starves. During climate change driven extreme warm weather events – and also a range of other environmental disturbances – the symbiosis between the algae and the coral breaks down, so the coral basically loses those symbionts and it dies.

Corals have many mechanisms by which they can potentially adapt or acclimatise- they are very plastic organisms. The problem with climate change is the rate of change, so there's concern that corals may not be able to respond quickly enough and we have already seen loss of coral across the world.

We have just started a project where we are attempting to accelerate the rate of evolution in corals by manipulating them and trying to accelerate naturally occurring evolutionary processes in the hope that we can create some varieties that are more resilient to predicted future environmental conditions.

We call it 'Assisted Evolution of Coral'. We will trial a range of different approaches. One is selective breeding of the coral animal itself. We are also trying to evolve the algal symbionts in the laboratory and make them more heat and acidification resistant and then put them back into the coral animal and examine whether that creates a more resilient organism. We are examining whether non-genetic factors – epigenetics – play an important role in acclimation of corals across generations. For example, if we pre-condition an adult coral to warmer conditions, will its offspring be more tolerant to warmer water?

And finally, can we actually change the composition of the microbial symbionts of corals, and may that be a way by which we can enhance their resilience?

In the next five years we will figure out which of these approaches will work for coral – and hopefully some of them will – and then the aim is to move into a second phase where we can hopefully implement some of these approaches in coral reefs, pending regulatory approvals.

– As told to Dr Daryl Holland

STUDENT ACHIEVEMENTS

2015

Dhika Amanda, supervisors Kim Johnson, Tony Bacic & Monika Doblin, University of Melbourne Botany Foundation Travel Award and the School of BioSciences Travel Grant. Funds used to attend the 26th International Conference on Arabidopsis Research (ICAR), held in Paris, France, 5 to 9 July.

Danielle Christesen, supervisor Phil Batterham, Dame Margaret Blackwood Soroptimist Scholarship.

Joanna Durrant, supervisors Therésa Jones, Mark Green, 1) The Robert Johanson & Anne Swann Fund towards her PhD studies concerning the Australian environment; 2) An ANZ Trustees Foundation – Holsworth Wildlife Research Endowment towards her PhD research project.

Yin Ying Ho, supervisors Monika Doblin & Tony Bacic, Norma Hilda Schuster (nee Swift) scholarships for research which is significantly aligned to the field of biochemistry.

Maria Jelinic, supervisors Laura Parry, Mary Wlodek from the School of Biomedical Sciences and Marianne Tare from the Physiology Department at Monash University, 1) 10th World Congress for Microcirculation Travel Reimbursement Award; 2) 7th International Conference on Relaxin and Related Peptides Travel Award.

Rebecca Jordan, supervisors Ary Hoffmann, Suzanne Prober and Shannon Dillon (CSIRO), Australian Flora Foundation Prize for best student presentation "on the biology or cultivation of an Australian plant" at the Ecological Society of Australia Conference in Adelaide, 29 Nov to 3 Dec 2015.

Edgar Liu, supervisors Kim Johnson & Tony Bacic, 1) John S. Turner Postgraduate Scholarship, by the University of Melbourne Botany Foundation; 2) University of Melbourne Botany Foundation Travel Award and the School of BioSciences Travel Grant. Funds used to attend the 26th International Conference on Arabidopsis Research (ICAR), held in Paris, France, 5 to 9 July.

Liz Milla, supervisor Therésa Jones, best student talk at the Society of Australian Systematic Biologists (Dec 2015).

Estibaliz Palma, supervisors Jane Catford, Peter Vesk, 1) The David Ashton Travel Award; 2) Australian Wildlife Society University Research Grant; 3) Botany Foundation Travel Scholarship; 4) student lodging subsidy for the Ecology and Management of Alien Plant Invasions conference; 5) Student Travel Grant to attend the Ecological Society of Australia Annual Conference; 6) Postgraduate student top-up scholarship.

Caitlyn Perry, supervisor Charles Robin, 1) Alfred Nicholas Fellowship for 2015; member of the Australian team competing in the Linnaean Games, a student entomological trivia contest associated with the Entomological Society of America conference.

Michaela Plein, supervisors Peter Vesk, Michael Bode, Melinda Moir and Mick McCarthy, travel grant from the Australian Biological Resources Study.

Himali Ratnayake, supervisors Michael Kearney, Justin Welbergen, Christopher Turbill and Rodney van der Ree. 'Best Speed Talk' at the Australian and New Zealand Society for Comparative Physiology and Biochemistry (ANZSCPB) conference 2015, Fowlers Gap, N.S.W.

Michael Sievers, supervisors Kirsten Parris, Rob Hale, Steve Swearer, 2015 Nature Conservancy Applied Conservation Award through the ESA.

Brooke Sullivan, supervisor Michael Keough, Ernest Hodgkins Estuary Research Award from AMSA, the Margaret Catto Award from Biosciences, and a travel grant from ABRS. Finalist for the Victorian Marine Science Consortium research award from the Victorian Coastal Council.

Howard Tang, supervisor Michael Inouye, NHMRC Scholarship for his PhD studies in BioSciences.

Asher Trama, supervisor Michael Keough, Muriel Ramm Science bursary for 2015.

Hung Thi Hong Vu, supervisors Vincent Pettigrove, Michael Keough and Sara Long, 1) Holsworth Wildlife Research Endowment, Research Grant, 2015-2016; 2) The University of Melbourne, Faculty of Science Travelling Scholarship, 2015; 3) The University of Melbourne, Drummond Travel Award, 2015; 4) SETAC Australasia Student Travel Award, 2015; 5) SETAC North America Student Travel Award, 2015.

Camille While, supervisors Tim Dempster (Uni Melb), Peter Nichols (CSIRO), Jeff Ross (IMAS), Giovanni Turchini (Deakin), Symon Dworjanyn (SCU) & Raymond Bannister (IMR), FRDC prize at the AMSA conference.

2016

Bryant Gagliardi, supervisor Ary Hoffmann, Science Abroad Travelling Scholarship (SATS) & Holsworth Wildlife Research Endowment.

Katherine Giljohann, supervisors Mick McCarthy, Tracey Regan [DELWP - Arthur Rylah Institute for Environmental Research] and Luke Kelly, Ecological Society of Australia 2016 Conference - Student Award for best spoken presentation on restoration or management.

Rebecca Hull, supervisor Michael Keough, 1) Australian Institute of Nuclear Science and Engineering Post-Graduate Research Award (AINSE PGRA 2015-2016, Collaborators: Dr Tom Cresswell and others); 2) Georgian Sweet Research Scholarship in Zoology (2015-2016); 3) Ecological Society of Australia Student Research Award (2016); 4) Young Scientist Research Prize, The Royal Society of Victoria (2016) - Biological Sciences (non-human) Finalist and awarded Runner-Up.

James Maino, supervisor Michael Kearney, Chancellor's prize for excellence in a PhD thesis in 2016.

Caitlin Jade Selleck, supervisor Jason Goodger, Botany Foundation's David H. Ashton travel award.

Oliver R.B. Thomas, supervisor Steve Swearer, John and Allan Gilmour Award (Faculty of Science), Holsworth Wildlife Research Endowment, ASBIC8 Student Travel Award.

GRADUATIONS

PhD - Science, 2015 Completions

Name	Titile
Canessa, Stefano	Decision analysis for threatened species management across the captive-wild spectrum
Carnell, Paul	Resilience of kelp dominated reefs of south-eastern Australia
Coleman, Rhys	Conservation of the dwarf galaxias, Galaxiella pusilla (Mack 1936) (Teleostei: Galaxiidae), a threatened freshwater fish from south-eastern Australia
Colombo, Valentina	Optimising new approaches in aquatic ecotoxicology
Haines, Margaret	Evolutionary ecology of Australian alpine lizards (genus Pseudemoia)
Hetz, Jennifer	Nutritional control of growth, development and growth axis maturation in a marsupial (Macropus eugenii)
Hodgkin, Lisa	Leadership behaviour in larval aggregations of the social sawfly Perga affinis
Maino, James	The importance of body size: scaling of physiological traits in insects
McBride, Marissa	Expert knowledge for conservation: tools for enhancing the quality of expert judgment
Schmidt, Joshua	The genetics of DDT resistance in Drosophila melanogaster: novel insights into an old debate
Shears, Melanie	Exploring how fatty acids synthesized by malaria parasites are incorporated into lipids:characterization of the Plasmodium apicoplast glycerol-3-phosphate acyltransferase
Smith, Ian	The potential of shelterbelts to enhance the abundance of natural enemies of agricultural pest arthropods
Somers, Jason	Using insecticides to probe nicotinic acetylcholine receptors in Drosophila melanogaster
Straka, Tanja	The shared habitat: understanding and linking the needs of insectivorous bats and people at urban wetlands
Warren-Myers, Fletcher	Enriched stable isotope mass marking techniques for aquaculture and fisheries

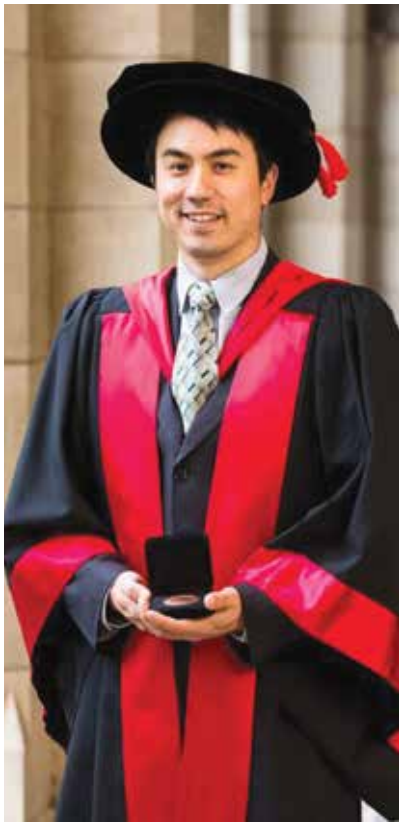
Master of Philosophy - Science, 2015 Completions

Smith, Kathleen Rose	Thermal advantages of colour change in bearded dragon lizards, Pogona vitticeps

PhD - Science, 2016 Completions

Name	Title
Amanda, Dhika	The roles of DEFECTIVE KERNEL1 (DEK1) in control of mechano-sensitive growth in Arabidopsis thaliana
Baker, Christopher	Optimal resource allocation for invasive species management
Balasubramaniam, Shandiya	Evolution and ecology of major histocompatibility complex (MHC) genes in south-eastern Australian passerines
Barrett, Rosemary	Phylogeny and phylogeography of Zieria (Rutaceae)
Binder, Natalie	Male obesity negatively affects fecundity; reducing seminal plasma quality, embryo physiology and pregnancy health
Bird, Tomas Joda	Novel methods to account for individual heterogeneity in capture-recapture studies

INSECT STUDY WINS CHANCELLOR'S PRIZE FOR EXCELLENCE IN A PHD THESIS



Our PhD student, James Maino (right), supervised by Associate Professor Michael Kearney, has won the Chancellor's Prize for excellence in a PhD thesis passed in 2015. This is the first time a Botany, Zoology or Genetics (BioSciences at the present time) student has won this award.

James completed an honours degree in mathematics but had a passion for biology. So he decided to do his PhD research on theories about metabolism – a very large field with a long history of study and some very big controversies and arguments. He worked in particular on 'Dynamic Energy Budget (DEB) Theory', which was developed by Prof. Bas Kooijman from Vrije University in the Netherlands. In fact he was jointly supervised by Prof. Kooijman and obtained a double degree from both The Univeristy of Melbourne and Vrije University.

In his project he helped apply DEB theory to the holometabolous insects, one of the most specious groups on earth, showing how it can beautifully explain how metabolic rates vary through the life cycle from egg, to larva, pupa and adult.

He also wrote a prize-winning and influential paper about how DEB theory can be reconciled with a popular alternative theory called the 'Metabolic Theory of Ecology'. This paper tactfully pointed out how both theories arrive at the same conclusions, but for very different underling reasons. James is now applying his conceptual and modelling expertise developed during his PhD to understand the population dynamics of pest insects with CESAR Australia.

Conway, Stephanie	Analysis of cell division patterns in the shoot apical meristem of gymnosperms
Dodd, Aaron	Risk-based investment in post-border invasive plant biosecurity programs
Fobert, Emily	Early life-history drivers of connectivity in a temperate marine fish metapopulation
Ghosh Dutta, Amrita	Does expression of pyrophosphatases improve seedling vigour and salinity tolerance in barley?
Giljohann, Katherine	Optimal fire management for biodiversity conservation
Hu, Yang	Numerical and functional consequences of landscape disturbances on reptile communities
Jayawardana, Nadeeka	The role of LEUNIG_HOMOLOG in regulating mucilage release from the Arabidopsis testa
Jeppe, Katherine	Contaminant exposure affects gene expression markers in the cysteine metabolism of Chironomus tepperi
Kesten, Christopher	Good companions: the cellulose synthase complex and the CC proteins
Koh, Poh	Characterisation of the self-incompatibility related F-box proteins of Nicotiana alata
Lee, Yee	Identifying metabolic determinants of embryo viability and normality
Millers, Kimberley	Quantifying search and control performance during marine invasive surveys: a case study from Asterias amurensis
Mok, Lawrence	Characterisation of the host-pathogen interactions between Nelson Bay Orthoreovirus and mammalian cells
Ohadi, Sara	Patterns of genetic and phenotypic variation in invasive Cakile species in Australia
Pharo, Elizabeth	Evolution and regulation of the Early Lactation Protein gene in an Australian marsupial, the tammar wallaby (Macropus eugenii)
Plein, Michaela	Assessing and managing interacting species at risk of coextinction

Selby-Pham, Jamie	A molecular investigation of parameters responsible for increased iron concentrations in biofortified rice
Shelley, James	Evolution and biogeography of Australian tropical freshwater fishes
Slatyer, Rachel	Geographic range and the mountain niche: ecology, adaptation, and environmental change
Southwell, Darren	Optimal management of metapopulations across space and time
Tan, Eunice	The evolution of colour patterns in Chrysomelines
van Asten, Timon	Coping style and group dynamics in a cooperative breeder, the superb fairy-wren (Malurus cyaneus)
Weiss, John	Do locusts seek greener pastures? An evaluation of MODIS vegetation indices to predict presence, abundance and impact of the Australian plague locust in south eastern Australia
West, Matthew	Contrasting population responses of ecologically-similar sympatric species to multiple threatening processes
Wright, Daniel	Prevention and control of key ecto-parasites in mariculture
Wu, Li-Hsin	Parasitism by Trichogramma wasp: potential and reality under climate change scenario, with focus species attacking Asian corn borer
Wu, Xingwen	Characterisation of wall-associated kinases (WAKs) in grasses

Master of Philosophy - Science, 2016 Completions

Farrar, Alison	Social evaluations and ecological outcomes of management actions in urban grassland conservation reserves: A case study of endangered temperate grasslands in South-Eastern Australia
Hicks, John	Management structures of Tiwi indigenous landowners and responses to changing resource values
Johnstone, Michele	Sources of variation for heat resistance in Drosophila hydei: developmental rearing and hardening acclimation, cross generational effects, (sex) and laboratory adaptation
Popa, Kerryn	Phytoextraction of Cadmium by species of the Brassicaceae

HIGH PROFILE SEMINAR

The Inaugural BioSciences Public Seminar

Our first School of Biosciences public seminar entitled 'Where Conservation and Science Collide' was held in December 2015. Professor Peter Kareiva, Director of the Institute of the Envrionment and Sustainability, UCLA, and former Chief Scientist for The Nature Conservancy, gave an impassioned speech about the opportunities for powerful conservation actions across the world. The 300-strong audience of alumni, staff, and students were also treated to three conservation vignettes from BioSciences researchers (Matt Le Feuvre, Heini Kujala and Mick McCarthy) at the cutting edge of their field.

FEATURED PUBLICATIONS

EVOLUTION, ECOLOGY AND ENVIRONMENTAL SCIENCE

Fithian W, **Elith J,** Hastie T & Keith D. 2015. Bias Correction in Species Distribution Models: Pooling Survey and Collection Data for Multiple Species. *Methods in Ecology and Evolution*. 6: 424–438.

Frankham G, **Handasyde KA** & Eldridge MD. 2016. Evolutionary and contemporary responses to habitat fragmentation detected in a mesic zone marsupial, the long-nosed potoroo (*Potorous tridactylus*) in south-eastern Australia. *Journal of Biogeography.* 43: 653-665.

Guillera-Arroita G, Lahoz-Monfort JJ, Elith J, Gordon A, Kujala H, Lentini PE, McCarthy MA, Tingley R & **Wintle BA**. 2015. Is my species distribution model fit for purpose? Matching data and models to applications. *Global Ecology and Biogeography.* 24: 276-292.

Hale R & Swearer SE. 2016. Ecological traps: current evidence and future directions. *Proceedings of the Royal Society B.* 283: 20152647.

Hall ML, Parson T, Riebel K & **Mulder RA**. 2016. Personality, plasticity, and resource defense. *Behavioral Ecology.* 28: 138-144.

Hipsley CA, Rentinck M-N, Rödel M-O & Müller J. 2016. Ontogenetic allometry constrains cranial shape of the head-first burrowing worm lizard *Cynisca leucura* (Squamata: Amphisbaenidae). *Journal of Morphology*. 277(9): 1159-1167.

Hoffmann AA, Ross PA & **Rašić G**. 2015. *Wolbachia* strains for disease control: ecological and evolutionary considerations. *Evolutionary Applications.* 8: 751-768

Jenkins GP, Spooner D, Conron S & **Morrongiello JR.** 2015. Differing importance of salinity stratification and freshwater flow for the recruitment of apex species of estuarine fish. *Marine Ecology Progress Series*. 523: 125-144.

Jones TM, Durrant J, Michaelides EB & **Green MP.** 2015. Melatonin: a possible link between the presence of artificial light at night and reductions in biological fitness. *Philosophical Transactions Royal Society B*. 370. DOI: 10.1098/rstb.2014.0122

Kearney MR & Porter WP. 2016. NicheMapR - an R package for biophysical modelling: the microclimate model. *Ecography*. doi:10.1111/ecog.02360

Kelly E & Phillips BL. 2015. Targeted gene flow for conservation. *Conservation Biology.* 30: 259-267.

Kelly LT, Bennett AF, Clarke MF & **McCarthy MA**. 2015. Optimal fire histories for biodiversity conservation. *Conservation Biology*. 29: 473-481.

Marcelino VR, **Cremen MCM**, **Jackson CJ**, Larkum A & **Verbruggen H**. 2016. Evolutionary dynamics of chloroplast genomes in low light: a case study of the endolithic green alga *Ostreobium quekettii. Genome Biology and Evolution*. 8: 2939-2951

Mesgaran MB, Lewis MA, Ades PK, Donohue K, Ohadi S, Li C & **Cousens RD**. 2016. Hybridization can facilitate species invasions, even without enhancing local adaptation. *Proceedings of the National Academy of Sciences USA*. 113(36): 10210-10214.

Morrongiello JR & Thresher RE. 2015. A statistical framework to explore ontogenetic growth variation among individuals and populations: a marine fish example. *Ecological Monographs*. 85: 93-115.

Parker TH, Forstmeier W, Koricheva J, **Fidler F,** Hadfield JD, Chee YE *et al*. 2016. Transparency in ecology and evolution: real problems, real solutions. *Trends in Ecology & Evolution*. 31: 711-719.

Samsing F, Solstorm D, Oppedal F, Solstorm F & **Dempster T**. 2015**.** Gone with the flow: current velocities mediate parasitic infestation of an aquatic host. *International Journal for Parasitology.* 45(8): 559-565.

Sharp JG, Garnick SW, **Elgar MA** & **Coulson GM**. 2015. Parasite and predator risk assessment during foraging: nuanced use of olfactory cues. *Proceedings Royal Society B*. 282: 20151941.

Smith KR, **Cadena V**, Endler JA, **Kearney MR**, Porter WP & **Stuart-Fox D**. 2016. Color change for thermoregulation versus camouflage in free-ranging lizards. *American Naturalist.* 188(6): 668-678.

Smith MD, Fulton EA & **Day RW**. 2015. An investigation into fisheries interaction effects using Atlantis. *ICES Journal of Marine Science.* 72: 275-283.

Sutherland W J & **Burgman MA**. 2015. Use experts wisely. *Nature*. 526: 317-318.

Treml EA, Fidelman P, Kininmonth S, Ekstrom JA & Bodin Ö. 2015. Analyzing the (mis)fit between the institutional and ecological networks of the Indo-West Pacific. *Global Environmental Change*. 31: 263–271.

Pollock LJ, Bayly MJ & **Vesk PA**. 2015. The roles of ecological and evolutionary processes in plant community assembly: the environment, hybridization, and introgression influence co-occurrence of Eucalyptus. *American Naturalist*, 185: 784-796.

Vu HT, Keough MJ, Long SM & **Pettigrove VJ**. 2015. Effects of the boscalid fungicide Filan® on the marine amphipod *Allorchestes compressa* at environmentally relevant concentrations. *Environmental Toxicology and Chemistry* 35(5): 1130-7.

Wang Q, **Goodger JQD**, **Woodrow IE** & **Elgar MA**. 2016. Location-specific cuticular hydrocarbon signals in a social insect. *Proceedings of the Royal Society B.* 283: 20160310.

FEATURED PUBLICATIONS

Woolley SN, Tittensor DP, Dunstan PK, **Guillera-Arroita G, Lahoz-Monfort JJ, Wintle BA** *et al.* 2016. Deep-sea diversity patterns are shaped by energy availability. *Nature*. 533: 393-396.

Wootton HF & **Keough MJ**. 2016. Disturbance type and intensity combine to affect resilience of an intertidal community. *Marine Ecology Progress Series.* 560: 121-133.

GENETICS, GENOMICS AND DEVELOPMENT

Abraham G, Rohmer A, Tye-Din J & **Inouye M**. 2015. Genomic prediction of celiac disease targeting HLA-positive individuals. *Genome Medicine*. 7: 72.

Anstead CA, Korhonen PK, Young ND, Hall RS, Jex AR, Murali SC, Hughes DST, **Lee SF**, **Perry T**, Stroehlein AJ, Ansell BRE, **Breugelmans B**, **Hofmann A**, Qu J, Dugan S, Lee SL, Chao H, Dinh H, Han Y, Doddapaneni HV, Worley KC, Muzny DM, Ioannidis P, Waterhouse RM, Zdobnov EM, James PJ, Bagnall NH, Kotze AC, Gibbs RA, Richards S, **Batterham P** & Gasser RB. 2015. *Lucilia cuprina* genome unlocks parasitic fly biology to underpin future interventions. *Nature Communications*. 6: 7344.

Battlay P, Schmidt JM, Fournier-Level A & **Robin C.** 2016. Genomic and transcriptomic associations identify a new insecticide resistance phenotype for the selective sweep at the Cyp6g1 locus of *Drosophila melanogaster*. *G3: Genes| Genomes| Genetics*. *6* (8): 2573-2581.

Buerger P, Wood-Charlson EM, Weynberg KD, Willis BL & **van Oppen MJH.** 2016. CRISPR-Cas defense system and potential prophages in Cyanobacteria associated with the Coral Black Band Disease. *Frontiers in Microbiology.* 7: 2077.

Clouston A, Edwards O, & **Umina P**. 2016. An insecticide baseline study of Australian broadacre aphids. *Crop and Pasture Science* 67(2): 236-244.

Choi B-I, **Harvey AJ** & **Green MP**. 2016. Bisphenol A affects early bovine embryo development and metabolism that is negated by an oestrogen receptor inhibitor. *Scientific Reports*. 6: 29318.

Goodman CD, **Siregar JE**, **Mollard V**, Vega-Rodríguez J, Syafruddin D, Matsuoka H, Matsuzaki M, **Toyama T**, **Sturm A**, **Cozijnsen A**, Jacobs-Lorena M, Kita K, Marzuki **S & McFadden GI.** 2016. Parasites resistant to the antimalarial atovaquone fail to transmit by mosquitoes. *Science.* 352 (6283): 349-353.

Hetz JA, **Menzies BR**, **Shaw G**, Stefanidis A, Cowley MA & **Renfree MB**. 2016. Effects of nutritional manipulation on body composition in the developing marsupial, *Macropus eugenii*. *Molecular and Cellular Endocrinology*. 428 C: 148-160.

Jacomb F, Marsh J & **Holman L.** 2016. Sexual selection expedites the evolution of pesticide resistance. *Evolution*. 70: 2746-2751.

Kei JNC, Dudczig S, Currie PD & **Jusuf PR**. 2016. Feedback from each retinal neuron population drives expression of subsequent fate determinant genes without influencing the cell cycle exit timing. *Journal of Comparative Neurology.* 524: 2553-2566.

Leo CH, **Jelinic M**, **Ng HH**, Tare M & **Parry LJ**. 2016. Serelaxin: A novel therapeutic for vascular diseases. *Trends in Pharmacological Sciences*. 36(6): 498-507.

Leslie S, Winney B, Hellenthal G, Davison D, Boumertit A, Day T, Hutnik K, Royrvik EC, Cunliffe B, Wellcome Trust Case Control Consortium 2, International Multiple Sclerosis Genetics Consortium, Lawson DJ, Falush D, Freeman C, Pirinen M, Myers S, Robinson M, Donnelly P & Bodmer W. 2015. The fine-scale genetic structure of the British population. *Nature*. 519(7543): 309-314.

Martin FC, **Ang CS**, **Gardner DK**, **Renfree MB** & **Shaw G**. 2016. Uterine flushing of the tammar wallaby after reactivation from diapause. *Reproduction.* 152(5): 491-505.

Noble LM, Holland LM, McLauchlan AJ & **Andrianopoulos A.** 2016. A plastic vegetative growth threshold governs reproductive capacity in *Aspergillus nidulans*. *Genetics.* 204(3): 1161-1175.

Pert M, Gan M, Saint R & **Murray MJ.** 2015. Netrins and Frazzled/DCC promote the migration and mesenchymal to epithelial transition of Drosophila midgut cells. *Biology Open*. 4(2): 233-243.

Phillips TR, Wright DK, **Gradie PE**, Johnston LA & **Pask AJ**. 2015. A comprehensive atlas of the adult mouse penis. 2015. *Sexual Development*. 9(3): 162-172.

Rask TS, Petersen B, Chen DS, **Day KP** & Pedersen AG. 2016. Using expected sequence features to improve basecalling accuracy of amplicon pyrosequencing data. *BMC Bioinformatics*. 17: 176.

Scutari M, Mackay I & **Balding D.** 2016. Using genetic distance to infer the accuracy of genomic prediction. *PLoS Genetics*. 12(9): e1006288.

Shapouri F, Saeidi S, de longh RU, Casagranda F, Western PS, McLaughlin EA, Sutherland JM, Hime GR & **Familari M**. 2016. Tob1 is expressed in developing and

HIGH PROFILE SEMINAR

The Hermon Slade Celebration

Since 1995, the Hermon Slade and Australia Pacific Science Foundations have generously supported more than 26 research projects at the University of Melbourne. To acknowledge the impact of the HSF and APSF on our research the School of BioSciences organised a public symposium in April 2015 to celebrate the achievements of HSF and APSF awardees. To an audience of more than 200 alumni, staff and students, six talks were presented by awardees. The talks ranged across topics from freshwater biodiversity in the Kimberley, to bird behaviour, climate change, and the responses of plants to salinity. Old friends and new met and talked at the post-talk mixer.

The Hermon Slade Foundation

Australia & Pacific Science Foundation

FEATURED PUBLICATIONS CONTINUED

adult gonads and is associated with the p-body marker, Dcp2. *Cell Tissue Research*. 364(2): 443-451.

Wale PL & **Gardner DK**. 2016. The effects of chemical and physical factors on mammalian embryo culture and their importance for the practice of assisted human reproduction. *Human Reproduction Update*. 22(1): 2-22.

PLANT SCIENCE

Bayly MJ, **Holmes GD**, Forster PI, **Cantrill DJ**, Munzinger J & **Ladiges PY**. 2016. Phylogeny, classification and biogeography of *Halfordia* (Rutaceae) in Australia and New Caledonia. *Plant Systematics and Evolution*. 302(10): 1457–1470.

Bonneau J, Baumann U, **Beasley J**, Li Y & **Johnson AAT**. 2016. Identification and molecular characterization of the nicotianamine synthase gene family in bread wheat. *Plant Biotechnology Journal*. 14(12): 2228-2239.

Endler A, **Kesten C**, **Schneider R**, **Zhang Y**, **Ivakov A**, **Froehlich A**, **Funke N**, & **Persson S**. 2015. A Mechanism for Sustained Cellulose Synthesis during Salt Stress. *Cell***.** 162(6): 1353-1364.

Fournier-Level A, Perry EO, Wang JA, Braun PT, Migneault A, Cooper MD, Metcalf CJE & Schmitt J. 2016. Predicting the evolutionary dynamics of seasonal adaptation to novel climates in *Arabidopsis thaliana*. *Proceedings of the National Academy of Science of the USA*. 113(20): E2812–E2821.

Goodger JQD, **Senaratne SL**, Nicolle D & **Woodrow IE**. 2016. Foliar essential oil glands of *Eucalyptus* Subgenus *Eucalyptus* (Myrtaceae) are a rich source of flavonoids and related non-volatile constituents. *PLOS ONE*. 11(5) e0155568.

Haydon MJ, Román A & Arshad W. 2015. Nutrient homeostasis within the plant circadian network. *Frontiers in Plant Science* 6: 299.

Hill CB, **Cassin A**, Keeble-Gagnère G, **Doblin MS**, **Bacic A** & **Roessner U.** 2016. De novo transcriptome assembly and analysis of differentially expressed genes of two barley genotypes reveal root-zone-specific responses to salt exposure. *Scientific Rep.* 6:31558.

Ianiri G, Averette A, Kingsbury JM, Heitman J, & **Idnurm A**. 2016. Gene function analysis in the ubiquitous human commensal and pathogen Malassezia genus. *mBio*. 7(6): e01853-16.

Lampugnani ER, **Ho YY**, **Moller IE**, **Koh P-L**, **Golz JF**, **Bacic A** & **Newbigin E.** 2016. A glycosyl transferase from *Nicotiana* pollen mediates synthesis of a linear (1,5)-α-L-arabinan when expressed in Arabidopsis. *Plant Physiology*. 170(4): 1962-1974.

Lim B, Smirnoff N, **Cobbett CS** & **Golz JF.** 2016. Ascorbate-deficient *vtc2* mutants in *Arabidopsis* do not exhibit decreased growth. *Frontiers in Plant Science*. 7: 1025.

Rautengarten C, Ebert B, Liu L, Stonebloom S, Smith-Moritz AM, Pauly M, Orellana A, Scheller HV & **Heazlewood JL.** 2016. The Arabidopsis Golgi-localized GDP-L-fucose transporter is required for plant development. *Nature Communications*. 7: 12119.

Wilson SM, Lampugnania ER, Ho Y, Bain M, Van de Meene AML, Bacic A & **Doblin MS**. 2015. Determining the subcellular location of (1,3; 1,4)-β-D-glucan synthesis and assembly. *Plant Cell*. 27(3): 754-771.

FINANCIAL REPORT

	2015	2016
Income	**69,725,570**	**75,991,165**
Operating	44,186,610	48,407,780
Research	25,538,960	27,583,385
Expenses	**70,477,279**	**72,670,293**
Operating	16,891,738	19,373,855
Research	27,668,563	26,592,066
Faculty Levy	5,948,575	5,696,796
University Levies	19,968,403	21,007,576
Surplus	**-751,709**	**3,320,872**
Operating	1,377,894	2,329,553
Research	-2,129,603	991,319

Note: The University's accounting policy for University Levies changed in 2015. From 2015 Faculty and University Levies (i.e. Property Common Services etc.), are charged to the School which is compensated for by an increase in income.

THANK YOU TO DONORS

The School of BioSciences wishes to acknowledge the generosity of past and present donors who have given in support of our work in botany, zoology and genetics resulting in over 35 Trusts recognising excellence in our undergraduate and postgraduate students, staff and research.

The very first gift was for a scholarship supporting students studying botany in 1894 gifted by Reverend David Kay as part of his will. Our most recent bequest was received in 2016 for the classification of plants and animals gifted into both botany and zoology with the latter helping us to create a sub-fund in the newly established Trust for Native Australian Animals and their ecosystems.

The generosity of our current supporters whether alumni or friends of the School continues and is helping us to develop the careers of students and researchers to be the next leaders and change makers in society. Please accept our heartfelt thanks for helping us to make a difference.

To discuss individual opportunities to support students and research in Science, please contact Penny Fairbank, Science Advancement Development Manager: fairbank@unimelb.edu.au or call +61 3 8344 3792.

To find out more about how to support plant sciences go to the Botany Foundation at science.unimelb.edu.au/engage/giving-to-science/botany-foundation.

If you are interested in supporting native Australian animals and their environments go to the Native Australian Animals Trust at biosciences.unimelb.edu.au/engage/native-australian-animals-trust.

THE UNIVERSITY OF MELBOURNE

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