ALLAN WILSON CENTRE
FOR MOLECULAR ECOLOGY AND EVOLUTION

pheno

October 2012 | ISSUE 6

STEVE JONES: WHAT MAKES YOU WHO YOU ARE?

Well-known geneticist and prize-winning popular science writer Professor Steve Jones will be touring New Zealand in November as a guest of the Allan Wilson Centre for Molecular Ecology and Evolution, with support from the Royal Society of New Zealand. He will be giving a public lecture entitled "Nature, Nurture or Neither?: the more we know about genetics, the more important environment seems to be".

Francis Galton, a cousin of Charles Darwin, popularised the nature-nurture term in his 1874 book, *English Men of Science: Their Nature and Nurture*. He described it as a "convenient jingle of words, for it separates under two distinct heads the innumerable elements of which personality is composed. *Nature* is all that a man brings with himself into the world; *nurture* is every influence from without that affects him after his birth"[1]. Galton was greatly influenced by the work of Charles Darwin, and especially interested in the heritability of traits such as intelligence.

His books provide detailed investigations into the characters and family backgrounds of English scientists and proclaimed geniuses, presenting evidence for a strong inherited component to the intelligence of these men. Later studies of pairs of twins "resulted in proving the vastly preponderating effects of nature over nurture"[2], to Galton at least, and he wrote of his aim to apply this knowledge to improve society. Eugenics, he defined as "the science of improving stock … to give to the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable than they otherwise would have had"[3].

While much of Galton's work acknowledged that nature and nurture as he defined them were interwoven, the conclusions drawn from his studies often set the two in competition

While much of Galton's work acknowledged that nature and nurture as he defined them were interwoven, the conclusions drawn from his studies often set the two in competition, with nature emerging as the clear leader. The rapidly growing eugenic movement of the early twentieth century took this to heart, and biological arguments for inheritance of personal traits were incorporated into social and political agendas throughout the western world.

Professor Steve Jones
Picture courtesy of Michal Maňas

INSIDE THIS ISSUE

Inheritance of Ability

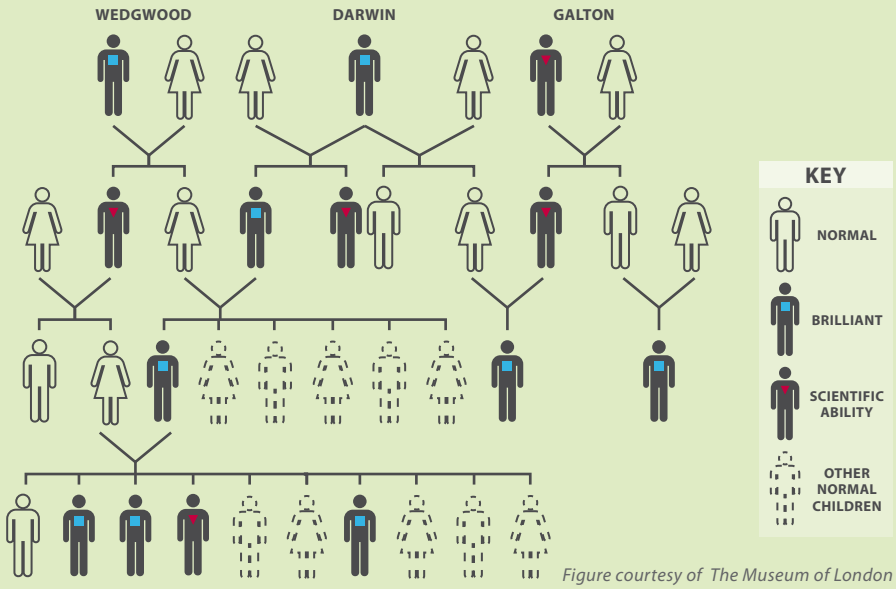


Figure courtesy of The Museum of London

Eugenics in practice ranged from moderate measures – for example the production of posters encouraging people to choose mates wisely - to the extremes of forced sterilisations in the US and several other countries, and the atrocities carried out by the Nazi regime in the 1930s and 1940s. The rhetoric of the eugenic movement with its calls for the elimination, by breeding out, of inborn behavioral traits such as criminality and alcoholism, was out of place in the postwar world, and popular notions of genetic determinism retreated for a couple of decades.

Not all early researchers agreed with Galton regarding "the vastly preponderating effects of nature over nurture." In 1910, Franz Boas published a landmark study entitled "Changes in Bodily Form of Descendants of Immigrants". This study found that measurements taken of American-born children differed from the expected range of inheritance from their European-born immigrant parents, demonstrating that the American environment had a strong influence on growth - an example of nature and nurture factors working in combination.

In the 1970s the nature-nurture debate arose again. The "sociobiology" theory advanced by Edward O. Wilson proposed that social behaviour in humans and other animals is subject to evolution, and heritable. At this time nature-derived arguments of human behaviour were still out of favour, and Wilson's theory was controversial: his book *On Human Nature* won the Pulitzer Prize for Non-fiction in 1979, but met with much criticism from leading biologists of the day.

Attempts to separate out the relative contributions of genes and environment to personal and social traits continue to the present day, for example in twin research programmes. Galton had been quick to identify twins as an excellent research system for studying nature and nurture, and modern twin study techniques involve large samples of both identical and fraternal twin pairs. They contrast findings from the identical twins who share all their genes, to those of fraternal twins who share about half of their genes with each other, as both types of twins share environments and experiences.

At the molecular level, advances in techniques and technologies for DNA analysis now mean that you can mail-order a copy of your own personal genome, for the bargain price of US$4998 (www.knome.com). By contrast, the international Human Genome Project (HGP) begun in 1990 took thirteen years to complete and about $30 billion US dollars of funding. A key finding of the HGP was that only ~1.5% of the three billion nucleotides made up the ~23 000 protein-coding genes. Vast stretches of DNA had no known function.

A second huge multinational research project, called the Encyclopedia of DNA Elements or ENCODE, launched in 2003, announced a summary of its findings in September this year. Researchers have been able to link more than 80% of the human genome sequence to a specific biological function. More then 4 million regulatory regions where proteins interact with DNA have been mapped, piling up the evidence, accumulating for some time, for highly complex gene-environment interactions. In light of this emerging picture of our genetic material, it doesn't make much sense to consider genetic and environment factors as competing alternatives in the style of Galton's original formulation of nature and nurture.

1 F. Galton 'English Men of Science: Their Nature and Nurture' Macmillan, London 1874:12
2 F. Galton 'Inquiries into Human Faculty' Dent and Co., London 1907:217
3 F. Galton 'Inquiries into Human Faculty' Dent and Co., London 1907:17

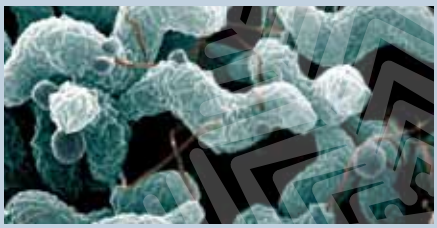
Public Talks by Professor Steve Jones

Seats may be reserved, and tickets purchased (for Auckland and Wellington), at *www.royalsociety.org.nz/events*

- **Nelson:** Monday 5th November, Nelson School of Music, 6pm
- **Palmerston North:** Tuesday 6th November, Central Library, 4 the Square, 6pm
- **Dunedin:** Wednesday 7th November, St David's Lecture Theatre, University of Otago, 7pm
- **Christchurch:** Friday 9th November, CLT1/2/3, University of Canterbury, 7pm
- **Wellington:** Saturday 10th November, Embassy Theatre, Courtenay Place, 6pm, $15/$10 Royal Society members and students (with ID)
- **Auckland:** Monday 12th November, Auckland Museum Events Centre, 6pm, $15/$10 Royal Society and Auckland Museum Institute members, and students (with ID)

TIME OUT TO STUDY "REAL WORLD" SCIENTIFIC QUESTIONS

Matt Balm is taking time out this year from teaching at St Peter's College in Palmerston North to experience science in action as a member of the mEpiLab (Molecular Epidemiology and Public Health Laboratory) at the Hopkirk Research Institute at Massey University. In late 2011, Matt approached Professor Nigel French, a Principal Investigator in the Allan Wilson Centre, and together they developed a project idea for an Endeavour Teacher Fellowship, which supports his leave from school for the second half of 2012.



Campylobacter, Picture courtesy of De Wood; digital colour by Chris Pooley

Matt has jumped right into an analysis of *Campylobacter* bacteria present in pukeko and weka. Different types, known as strains, of these bacteria live in the intestines of animals, and there is some evidence that the New Zealand water rails (pukekos, takahēs and wekas) may harbour two new strains not found elsewhere. One strain is a variant of *C. jejuni*, which is the species responsible for most reports of human campylobacteriosis in New Zealand. The other is a new species of *Campylobacter* that is the closest relative yet identified of *C. jejuni* and *C. coli*; the two species responsible for most human infections worldwide. What is particularly interesting is that the differences in their genetic make-up may be due to evolution within their host bird species. Matt's project involves collecting faecal and gut samples from the birds and using micro and molecular biological techniques back in the lab to identify the strains of *Campylobacter* present.

The first part of Matt's project began in July, with a five-day sampling trip to the remote Manaroa Valley in the centre of the Marlborough Sounds. Intensive lab work has followed, including culturing of the samples to grow colonies of the bacteria present, using media enriched for *Campylobacter*. Matt now has 136 DNA isolate samples to type, using a combination of methods including gel electrophoresis and multilocus sequence typing.

Matt Balm

Matt has developed a website (https://sites.google.com/a/stpeterspn.school.nz/mr-balm-s-teacher-fellowship/) describing the work he's undertaking for his Fellowship. A link from there will take you to his blog, giving a running commentary of his experiences. A couple of months into the project, Matt says he's having a great time. He really appreciates the hands-on approach to understanding the nature of science in particular, as he applies techniques he teaches in the classroom to explore "real world" scientific questions.

POISONOUS SEA SLUGS UNDER INVESTIGATION

Yeserin Yildirim began her PhD project in April 2011, arriving at the Rainey Lab at Massey University's Albany campus from Turkey, where she had completed BSc and MSc degrees in molecular biology and genetics. Yeserin is studying the genetic diversity and population structure of *Pleurobranchaea maculata*, the grey side-gilled sea slug, a project well suited to her interests in ecology and evolution.

Several dogs were poisoned on beaches near Auckland in mid 2009, and tests showed the poison to be tetrododoxin (TTX), a powerful neurotoxin which is found in the infamous tropical puffer fish. The sea slugs present in the area were examined, and found to contain high concentrations of the toxin. It is not yet known if the slugs produce the TTX themselves, or if it is accumulated through their diet or as a byproduct of a symbiotic bacteria. The concentration of TTX also differs between samples from different regions of New Zealand, and can vary with the seasons.

Yeserin's project is a collaborative effort, with input from AWC investigators, scientists from the Cawthron Institute in Nelson and the Auckland Regional Council. Through building up a clearer picture of the relationships within and between populations of *P. maculata* throughout New Zealand, Yeserin plans to unravel the relationships between TTX toxicity and the genetic structure of the slugs. She hopes that this study will help to identify the origin of the toxin in sea slugs, and to evaluate the risk of toxic *P. maculata* populations spreading to other regions of New Zealand.

A sea slug
Picture courtesy of Richard Taylor

MEPILAB – THE DISEASE CONTROL AGENCY

The Molecular Epidemiology and Public Health Laboratory (mEpiLab) is led by Professor Nigel French, a Principal Investigator in the Allan Wilson Centre and Director of Massey University's Infectious Disease Research Centre. The mEpiLab is located within the Hopkirk Research Institute on the Turitea campus at Palmerston North.

Opened in 2007, the Hopkirk Institute is a collaborative venture between Massey and AgResearch, providing state-of-the-art scientific facilities for research focusing on the control of parasitic and infectious diseases in animals and food poisoning pathogens affecting New Zealanders. Research by the mEpiLab has resulted in a significant reduction in the rates of foodborne diseases in New Zealand. Team members combine skills and expertise in the fields of epidemiology, microbiology, molecular biology, bioinformatics, mathematical modeling, veterinary science and public health to improve the understanding and control of agents of infectious disease, including *Campylobacter, Salmonella, E. coli, Leptospira, Cryptosporidium* and *Giardia.*

Testing the waters

Ben Phiri

The number of cases of waterborne gastroenteritis (caused by *Cryptosporidium*, *Giardia* and *Campylobacter* pathogens) in New Zealand is a cause for concern, almost doubling in the past twenty years from 18,000 in 1989 to 34,000 in 2008. As part of his PhD work, Bernard (Ben) Phiri has been traveling to fifteen DOC campgrounds on the East Coast, the Coromandel, Wellington, and in the Marlborough-Nelson region of the South Island, looking for evidence of organisms in the local water and in faecal samples from animals that may harbour the pathogens.

Originally from Zambia, Ben completed his MSc degree at Massey University in Palmerston North in 2008 with Allan Wilson Centre Investigator Professor Nigel French as his supervisor. He returned to New Zealand in January 2011 with his family to begin his PhD project as a member of the mEpiLab. Ben is using a number of approaches to examine the samples for organisms. *Campylobacter* bacteria will be cultured in the lab before being assigned to species type using molecular methods while the protozoan parasites *Cryptosporidium* and *Giardia* will be identified microscopically. Two-litre samples of water will be used in metagenomic analyses, where all of the DNA present in the sample is sequenced and analysed to determine the species present.

As well as the campground study, Ben is analysing laboratory data for twenty water source sites throughout New Zealand. The water sources are sampled four times a year and the untreated water is tested for the presence of bacteria (*Campylobacter* and *E. coli*), and protozoa (*Cryptosporidium* and *Giardia*). Land use factors, such as farming, in the areas surrounding the water sources will be analysed in order to identify risk factors for increased concentrations of pathogens in water. Ben is also interested in seeing whether the flow rate of water affects water quality. He has assembled a set of river flow data from NIWA and reported cases of enteric disease over a ten-year period, and will use this to examine the relationship between flow rates and reported infections.

Ben collecting samples at the river to examine for organisms

Understanding an all-too-common New Zealand infection

Anja Friedrich

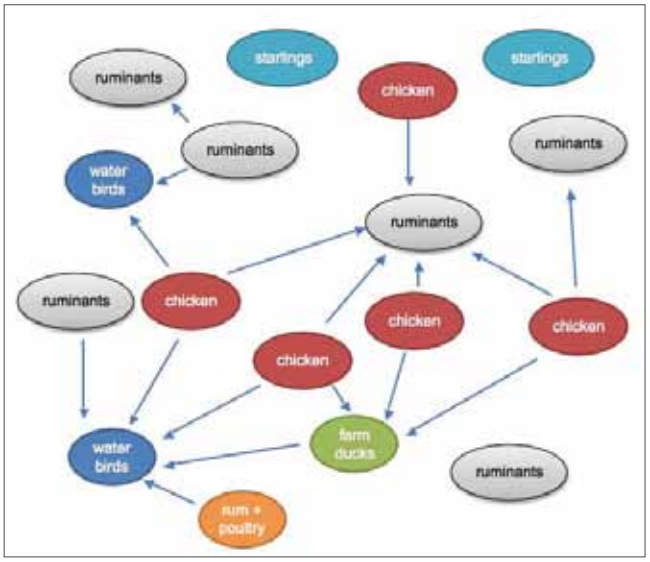
Campylobacter infections of the intestines are among the most common bacterial diseases in humans. The symptoms begin 2-4 days after eating or drinking contaminated food or water, and can include fever, nausea, vomiting and diarrhea lasting for about a week. Not pleasant, but far less common than it used to be thanks to the molecular detective work of AWC Principal Investigator Nigel French.

As part of his team, and the ongoing effort to reduce the rate of infection, Anja Friedrich is examining several aspects of *Campylobacter* species present in New Zealand for her PhD project in the mEpiLab. Anja comes from northeast Germany, and previously studied at the University of Greifswald, specialising in phylogenetics and discrete mathematics.

She began her work in April 2011 and has already analysed multilocus sequence typing data collected from more than 4000 bacterial isolates from different sources, including chicken, ruminants (cattle and sheep), farm duck and starlings. She found that distinct *Campylobacter* lineages, or genotypes, are associated with different host species and that there is evidence for different levels of gene transfer within and between these lineages.

The figure shows a detail of the study, with arrows between the *Campylobacter* clusters derived from water bird, ruminant, farm duck and chicken samples indicating shared genes. The lineages from all of the source animals except starlings have shared genes. The highest level of mixture was found in the wild water birds, with genes detected coming from chicken, farm duck and ruminant lineages. Anja suggests that one reason for this could be that the migration patterns of ducks and geese provide opportunities for the different *Campylobacter* strains to exchange genes.

Another question Anja aims to answer is whether isolates of *Campylobacter* associated with human infections are particularly well-suited to adapting to the human body temperature of 38°C from the 42°C body temperature common to poultry. This study will take advantage of phenotypic microarray technology, which will enable the respiration and growth of several isolates to be monitored at the two different temperatures.



Gene transfer between Camplyobacter strains

The effect of translocation on the health of our birds

Zoe Grange

Zoe Grange is a doctoral candidate in the mEpiLab working in collaboration with DOC and the NZ Wildlife Health Centre. Translocation is the transport of endangered species from one location to another for release into a safer environment and has become an important and common conservation management strategy in New Zealand. Zoe is examining the effects of translocations on the health of endangered birds by examining pathogens present in the animals and their environments.

Zoe began her work in August 2011, and has been kept busy collecting and analysing samples from the rare flightless takahē (*Porphyrio hochstetteri*). A small population of takahē was rediscovered in 1948 in Fiordland, fifty years after they were presumed to be extinct due to predation and habitat destruction. Over the following years, small groups of the birds were moved to predator-free, offshore islands and mainland sanctuaries. The population has fluctuated over the years, and is now estimated at 227 adult birds - 84 of which have been sampled by Zoe on trips to the remote offshore island sanctuaries and breeding centre near Te Anau.

As well as using takahē as a model for the effects of translocation, Zoe has been visiting Maud Island in the Marlborough Sounds every three months to collect samples from passerines and is about to embark on a subproject working with Little Blue Penguins. Zoe says she has been particularly enjoying the fieldwork component of her project, as sampling trips take her to remote parts of the country others rarely get a chance to visit.

A Takahē
Picture courtesy of Thomas Burns

WALKING THE TALK: THE TRANSIT OF VENUS HERALDS A NEW VISION FOR TOLAGA BAY

On 6 June, Allan Wilson Centre scientists joined delegates to the Transit of Venus Forum, European astronomers and poets, cabinet ministers, and hundreds of locals, to witness the Transit of Venus in Tolaga Bay, and to discuss how science can help New Zealand progress on all fronts.

A sign of the progress we all want with restoration of our land and waterways was already underway for all to see – the Uawanui-a-Raumatua Ecological Restoration Project was launched by Professor Charles Daugherty, then director of the Allan Wilson Centre, together with Te Aitanga a Hauiti and the Uawa Tolaga Bay community. The Centre has paid for experienced restoration consultants, Clive Anstey and Peter Handford, to work with the community to help envision and direct the project. The magnificent day of celebration in Tolaga Bay included the opportunity to plant hundreds of trees at the Uawa River mouth.

Some may still be standing in 2117 when the next Transit of Venus occurs.

The project was oft referred to during the Forum, where delegates came back time and time again to the need to underpin our economy with a healthy environment and reform our measure of economic progress to take full account of the values of our environment. Economists and businessmen like Dr Gareth Morgan were among the most vocal advocates. Sir Paul Callaghan, initiator of the Forum, had best expressed the consensus that it is not *either* the economy *or* the environment, it has to be both, and they are mutually dependent. This was one of Sir Paul's motivations for convening the Forum – sadly he never lived to see the realisation of all his work over three years.

The magnificent day of celebration in Tolaga Bay included the opportunity to plant hundreds of trees at the Uawa river mouth.

Local farmer and Forum delegate, Bridget Parker, talked movingly about the ups and downs Tairawhiti landowners repeatedly experience, from Cyclone Bola to the recent downturn in the wine

AWC Manager, Wendy Newport-Smith, and former director, Professor Charles Daugherty at the community launch of the Uawanui Sustainability Project

industry. She had seen all her 1500 sheep float over the fences and out to sea in the never to be forgotten Cyclone. She complimented the Allan Wilson Centre on "walking the talk" – applying conservation theory to practice, and getting to know the people in the area well enough to understand local land issues, in particular those related to forest harvesting.

The young people of Gisborne and Tolaga Bay exemplified delegates' expressed hopes for New Zealanders' education and development. Science and technology take high priority at Tolaga Bay Area School and are made relevant to their lives. Students were confident and knowledgeable tour guides on the buses that took delegates up to the Bay, performed in their own original award-winning play, gave speeches, raised flags, buried time capsules, planted trees, exhibited photo essays of the Catchment, unveiled a mural, performed with the easy grace and timing that comes from hundreds of hours of rehearsal, and hosted the manuhiri with a bursting pride. Every single child, from age 5-18, had a role to play. An unseasonably warm sun shone over Tairawhiti while heavy rain and snow disabled the rest of the country, as if to reward their years of preparation.

An unseasonably warm sun shone over Tairawhiti while heavy rain and snow disabled the rest of the country, as if to reward their years of preparation.

Now the visitors have returned home to concentrate on their own personal and professional challenges, it's back to work for the people of Uawa/Tolaga Bay – and it will be hard work over many decades. Planting, weeding - endless weeding - the beginning of a new relationship with the forest owners, and no doubt many demoralizing clean-ups after future floods, hopefully none as catastrophic as Bola. But the guidance of a clear vision and practical plan, put together by the community and supported by land science experts, gives the people of Uawa/Tolaga Bay confidence that all their hard work will finally transform the Catchment into the "kind of second paradise" Joseph Banks saw there in 1769.

By Glenda Lewis

REBECCA PRIESTLEY: TUATARA TO TODAY

My first feature article was about tuatara. It was 1989 and I was in the final year of a geology degree at Victoria University of Wellington. As the only science student to front up to a meeting of potential contributors to *Salient*, the student newspaper, I was assigned to a story about the Tuatara Research Programme.

I met the team, including postdoctoral fellow Alison Cree, her supervisor Charles Daugherty and a bunch of tuatara whose names I don't recall. They were pleased that *Salient*, which usually focused on arts and politics, was interested in their work and taught me to say *Sphenodon punctatus* and how to hold a tuatara so it couldn't bite me.

I learned that the team, who were studying tuatara reproductive physiology and courtship behaviour, had successfully hatched more than 100 young tuatara from collected eggs. The hopeful plan was that tuatara could one day be bred in captivity and be used to populate islands from which rats and other pests had been eradicated. I wrote my article, calling the tuatara an "ecological treasure" and quoting Daugherty as saying the long-term prospect for eradication of rats off all of New Zealand's offshore islands, and the re-establishment of tuatara, was "pretty great."

Seeing my work in print was good, but holding a tuatara was the definite highlight, one that helped cement my decision to be a science writer.

New AWC Affiliate, Dr Rebecca Priestley

Since then, I've enjoyed researching and writing many articles about New Zealand's distinctive species and the scientists who study how they function and how they evolved.

When my own research interest expanded into the history of science, I was pleased to discover the work of Allan Wilson, and to feature him in two of my books. In my edited anthology, *The Awa Book of New Zealand Science*, Rebecca Cann and Allan Wilson reflect on their work on the "The recent African genesis of humans" in a piece first published in *Scientific American*.

Last year, Charles Daugherty called Allan Wilson "the greatest New Zealand scientist you've never heard of" but I think this is changing. Through organising lecture tours with speakers like Rebecca Cann and Chris Stringer, and by doing excellent science the country wants to hear about, the Allan Wilson Centre is doing plenty to raise the profile of this genius man who helped reveal the origins of modern humans.

Back in 1989, the possibility of eradicating pests from islands like Kapiti and Rangitoto, so we could let native species like tuatara, takahē and kokako breed without predation, was an exciting dream. These island pest eradication programmes have been hugely successful and today people are talking about the possibility of eradicating pests from large islands like Rakiura, Great Barrier and even the North and South Islands. This is a story I look forward to following – and participating in – over the coming years. This is an exciting time to become an affiliate of the Allan Wilson Centre and I'm delighted and honoured at the appointment.

By Dr Rebecca Priestley

CONTACT US

Professor Hamish Spencer,
Director
Phone: +64-3-479-7981,
Fax: +64-3-479-7584
hamish.spencer@otago.ac.nz

Ms Wendy Newport-Smith
Centre Manager
Phone: +64 6 350 5448
Fax: +64 6 350 5626
w.newport-smith@massey.ac.nz

Melanie Pierson
Pheno Researcher and Writer
Phone: +64 3 470 1939
mjp110@gmail.com

HOST INSTITUTION

Postal Address:
Allan Wilson Centre for Molecular Ecology and Evolution (AWC)
Massey University,
Private Bag 11 222,
Palmerston North, 4442

Courier Address:
Allan Wilson Centre,
Level 2,
Science Tower B,
Massey University,
Palmerston North, 4442

PARTNER INSTITUTIONS

Massey University,
Private Bag 11 222, Palmerston North

University of Otago,
P.O. Box 56, Dunedin

The University of Auckland,
Private Bag 92019, Auckland

Victoria University of Wellington,
P.O. Box 600, Wellington

University of Canterbury,
Private Bag 4800, Christchurch

Plant and Food Research,
120 Mt Albert Road, Sandringham,
Auckland 1025

Visit the Allan Wilson Centre at
http://www.allanwilsoncentre.ac.nz/