Allan Wilson Centre for Molecular Ecology and Evolution

Annual Report

2007

CONTACT US

Allan Wilson Centre for Molecular Ecology and Evolution
Massey University
Private Bag 11-222
Palmerston North
New Zealand

Phone: +64 6 350 5448
Fax: +64 6 350 5626
Email: AWC@massey.ac.nz

Courier Address
Level 5
Science Tower D
Riddet Road
Massey University
Palmerston North

This report is also available in downloadable form from our website at:
http://awcmee.massey.ac.nz

CONTENTS

STAFF

Principal Investigators

David Penny – Massey University - Palmerston North, Distinguished Professor and Co-Director (Research)

Mike Hendy – Massey University - Palmerston North, Professor and Co-Director (Executive)

Charles Daugherty – Victoria University of Wellington, Professor

David Lambert – Massey University - Albany, Distinguished Professor

Peter Lockhart – Massey University – Palmerston North, Professor

Lisa Matisoo-Smith – University of Auckland, Associate Professor

Mike Steel – University of Canterbury, Professor

Associate Investigators

Craig Millar – University of Auckland, Dr

Allen Rodrigo – University of Auckland, Professor

Hamish Spencer – University of Otago, Professor

Post-doctoral and Research Fellows

Patrick Biggs – Massey University

David Chapple – Victoria University of Wellington

Lesley Collins – Massey University

Andrew Dodd – Massey University, Albany

Kirsten Donald – University of Otago

Abby Harrison – Massey University

Barbara Holland – Massey University

Simon Joly – Massey University

Martyn Kennedy – University of Otago

Erik Matsen – University of Canterbury

Heidi Meudt – Massey University

Hilary Miller – Victoria University of Wellington

Mary Morgan-Richards – Massey University

Nicky Nelson – Victoria University of Wellington

Melanie Pierson – University of Auckland

Kristina Ramstad – Victoria University of Wellington

Scott Roy – Massey University

Mark Stevens – Massey University

Rick Stoffels – University of Otago
Bhalchandra Thatte – Massey University
Steve Trewick – Massey University
Oliver Will – University of Canterbury
Michael Woodhams – Massey University
Claudia Voelckel – Massey University
Alexey Yanchukov – University of Otago

Support Staff

Susan Adams – Executive Officer, Massey University
Lorraine Berry – DNA Sequencer Technician, Massey University
Isabella Cheung- DNA Sequencer Technician, Massey University, Albany
Maurice Collins – Bioinformatics technician, Massey University
Richard Fong – DNA Sequencer technician, Massey University, Albany
Corina Jordan – Part-time Technician, Massey University
Olga Kardailsky – Part-time Research Assistant, Massey University
Sue Keall – Administration and Research Assistant, Victoria University of Wellington
Tania King – Technician, University of Otago
Trish McLenachan – Laboratory Manager, Massey University
Morore Piripi – Part-time Technician, Massey University
Violetta Pokorny – Laboratory Manager, Massey University, Albany
Dietrich Radel – Technical Assistant, Canterbury University
Judith Robins – Research Manager, University of Auckland
Karen Sinclair – Administrative Assistant, Massey University
Jing Wang – Scientific Programmer, Massey University
Tim White – Scientific Programmer, Massey University
Joy Wood – Secretary/Administrator, Massey University

Students

Gabrielle Beans-Picon – PhD, Massey University, Albany
Barbara Binney – MSc, Massey University, Albany
Whitney Bouma – MSc, Victoria University of Wellington
Sylvia Chen - MSc, Massey University
Andrew Clarke – PhD, Massey University
Lorraine Cook – Hons, Massey University
Michael Dann – MSc, Victoria University of Wellington
Beata Faller – PhD, University of Canterbury

Mareike Fischer – PhD, University of Canterbury
Ceridwen Fraser – PhD, University of Otago
Gillian Gibb – PhD, Massey University
Stephanie Godfrey – PhD, Flinders University/Victoria University of Wellington
Julia Goldberg – PhD, Massey University
Klaas Hartmann – PhD, Canterbury University
Katie Hartnup – PhD, Massey University, Albany
Jessica Haywood – PhD, University of Auckland
Simon Hills – PhD, Massey University
Melanie Hingston – PhD, University of Auckland
Peter Humpfries – MSc, Canterbury University
Michael Knapp – PhD, Massey University
Hayley Lawrence – PhD, Massey University, Albany
Carlos Lehnebach – PhD, Massey University
Simoene Linz – PhD, University of Canterbury
Angela McGaughran – PhD, Massey University
Katie McKenzie – MSc, Victoria University of Wellington
Kim Miller – PhD, Victoria University of Wellington
Elmira Mohandesan – PhD, Massey University, Albany
Jennifer Moore – PhD, Victoria University of Wellington
Shay O'Neill – MSc, Victoria University of Wellington
Stephen Pilkington – PhD, Massey University
Mort Piripi – MSc, Massey University
Renae Pratt – PhD, Massey University
Klaus Schliep – PhD, Massey University
Bastiaan Star – PhD, University of Otago
Alice Storey – PhD, University of Auckland
Meredith Trotter – PhD, University of Otago
John Waugh – PhD, Massey University, Albany
Tim White – MSc, Massey University
David Winter – PhD, University of Otago

Affiliate Members

Prof. Allan Baker - Royal Ontario Museum, University of Toronto

Dr. David Bryant - University of Auckland

Dr. Thomas Buckley - Landcare Research

Dr. Dee Denver – Oregon State University

Dr. Alexei Drummond - University of Auckland

Dr. Anne La Flamme – Victoria University of Wellington

Dr. Nicola Nelson – Victoria University of Wellington

Dr. Peter Ritchie – Victoria University of Wellington

Dr. Howard Ross – University of Auckland

Dr. Charles Semple - University of Canterbury

Dr. Peter Waddell - Massey University

Dr. Jon Waters - University of Otago

CHAIRMAN'S REPORT

Significant changes have occurred in the membership of the Governance Board of the Allan Wilson Centre. The terms of appointments of the previous Chairman, Dr Seddon Bennington, as well as three members of the Board (Dr Andy Pearce, Ms Prue Kapua and Dr Alan Dixson) came to an end in late 2006. It is therefore both appropriate and a great pleasure for me to thank and publicly acknowledge the service that each has played over the period that they served on the Board. Particular appreciation must go to Dr Bennington for the hard work and dedication that he displayed as Chairman. The Allan Wilson Centre was indeed fortunate to have people of such talent guiding its activities during its formative years.

The loss of Board members necessitated the appointment of several new members at the beginning of 2007, and pen portraits of the appointees are given elsewhere in this Report. Suffice to say that the new members, who were selected on the basis of their skills and experience, have worked hard to get up to speed in order to tackle the issues currently facing the Allan Wilson Centre. The new appointments were made by Massey University (in its role as host) after receiving nominations from each of its partners. The Governance Board decided to hold its meetings around the country to allow the researchers and the Board members an opportunity to meet each other and thereby understand more of the issues that each faces. The first meeting was held in Palmerston North and the second in Christchurch. Meetings at the other Centres are planned for next year. The importance of the Partners and their role in a successful AWC is seen by the Board as a key to future success.

A great deal of time and effort this year was devoted by the Management Team to the rebidding process. The first six years of the Allan Wilson Centre 1 (AWC1: 2002-2008) was drawing to a close and TEC funding was sought to continue and extend its very successful programmme for a further six years (AWC2). This Herculean effort was coordinated by the Co-Directors (Professors Mike Hendy and David Penny) with major input from the Principal Investigators and the Administrative Team. After the submission of the paperwork in late 2006 the Allan Wilson Centre in its entire form (Management, Investigators and the Governance Board, then recently appointed, and senior Massey Staff from the Registry) met with the Review Panel at Massey University. Suffice to say that future funding was achieved but that several issues were brought to our attention for consideration. In working through these the Governance

Board took a strong strategic approach to the research programme. It also worked closely with Management and the Host Institution to address the other issues. It is probably true to say that the Governance Board took a much more active role in the whole process than is perhaps commonplace whilst ensuring that it did not encroach inappropriately on those matters which were rightly those of Management.

Excellent relations have been fostered with the Host Institution – Massey University – and strong personal support has been received from the Vice Chancellor Professor Judith Kinnear and Deputy Vice Chancellor (Research) Professor Nigel Long. My sincere appreciation goes to each of them, also to Professor Robert Anderson (Pro Vice Chancellor of Sciences) as well as other Registry staff involved in the financial side of our activities. Each has contributed significantly to the excellent rapport that exists between the AWC and the Host. The importance of this relationship to the smooth functioning of the AWC cannot be over-emphasised.

No Annual Report from the Governance Board would be complete without acknowledgement of the outstanding leadership displayed by the Co-Directors (Professors Hendy and Penny) and the many and varied contributions of the Business Manager (Mrs Susan Adams) and her team. Keeping everything running smoothly over five centres that are spread over the length of the country represents a challenge but one, in my books, that has been met extraordinarily well. We can now look forward to more research successes as well as to those increasingly important non-scientific outputs that are now clearly desired of all of the Centres of Research Excellence. The mid-term review in 2010/2011 is now beginning to attract our attention and AWC activities will now start focussing towards this and a successful rebidding in 2013.

David A.D. Parry
Chairman
AWC Governance Board

AWC Governance Board Members

Professor Carolyn W Burns *BSc (Hons), PhD, CBE, FRSNZ*

Dr Burns is a Professor of Zoology, University of Otago, where her research centres on biological processes in lakes. Through her university teaching, membership of editorial boards of international journals in aquatic science, and work with national and international nature conservation and limnological organizations, Carolyn has promoted, supported and strengthened scientific research on indigenous flora, fauna and lakes in New Zealand and throughout the world. For many years Carolyn has played a major role in NZ science and technology, including her Presidency of the Royal Society's Academy, and membership of the NIWA Board.

Professor Garth Cooper *DPhil (Oxon), MB, ChB, FRCPA, FRSNZ*

Professor Cooper is one of New Zealand's foremost biological scientists and biotechnology entrepreneurs. Professor Cooper was named in 2003 as North and South New Zealander of the Year (jointly) and in 2005 as NZ BIO's inaugural Biotechnologist of the Year. He has served as a member of numerous committees, including the New Zealand Government's Biotechnology Taskforce; the Maori Health Committee and the Research Policy Advisory Committee of the Health Research Council (HRC) of New Zealand; the Scientific Committee of the Heart Foundation of New Zealand; and committees to recommend the award of the Oxford Nuffield Medical Fellowships, the Wellcome Trust's International Senior Fellowships, the Logan Campbell Medical Trust grants, Lottery Health (New Zealand) grants, and the Girdlers' HRC Fellowships.

Mr Rauru Kirikiri *DipTchng, BA, MA (Auckland)*

Rauru Kirikiri, has considerable public service background, both nationally and internationally with extensive Māori and science networks and experience in the assessment of research proposals and quality assurance audits in both New Zealand and Australia. He is a Consultant with RK Associates Limited and prior to this he spent 12 years as the Treaty Responsibilities Manager, Manaaki Whenua – Landcare Research, increasing Māori engagement in science research generally. Mr Kirikiri has served as a member on several Foundation for Research Science and Technology committees; Minister of Foreign Affairs and Trade's Advisory Committee of External Aid and Development; NZ Academic Audit Unit for NZVCC, Research committee on Ngā Pae o te Māramatanga (Māori Centre for Research Excellence Auckland

University); and, a Founding member of Te Ara Pūtaiao – Senior Māori Managers association for Crown Research Institutes.

Mr Jim McLean *BSc(Hons), CA*

Jim McLean, is a director of Genesis Research and Development Corporation Limited, Chairman of NZBio, the New Zealand biotechnology industry body and Deputy Chair Foundation of Research Science & Technology. He is also the Chair of HortResearch, and a member of the New Zealand Government Taskforce for the commercialisation of biotechnoloy. Jim has previously worked with firms including Ernst & Young and Dunlop New Zealand Limited. He has a BSc (Hons) in chemistry and is a chartered accountant.

Distinguished Professor David AD Parry *BSc(Hons), PhD London, DSc London, FNZIC, FNZIP, FRSNZ, CNZM*

Professor Parry is Vice President of the International Council for Science (ICSU), and President of the International Union for Pure and Applied Biophysics (IUPAB, and is New Zealand's leading researcher in the area of structural and functional studies on fibrous proteins. David Parry was Chair of the NZVCC Scholarships Committee over a nine year period.

Mr Paul Rieger *QSO, JP*

Paul Rieger, has considerable background in local government, education governance, and has made significant and enduring contributions to community, professional, social and service organisations. He is currently involved in a number of organisations including Estendart Limited, Manawatu Wanganui Regional Council, International Pacific College and the Dental Technicians Chairman (Under Health Practitioners Competence Act 2003).

Professor Des Cooper *BSc (Hon), PhD*

Professor Cooper is a geneticist with a longstanding interest in the biology of marsupials and in human reproductive disorder known as pre-eclampsia. He was Professor of Biology at Macquarie University 1984-2004 and has been Professor of Biology at the University of New South Wales since 2005. He has served on the Australian Research Council and has been a member of the Animal Research Review Panel in New South Wales.

EXECUTIVE DIRECTOR'S REPORT

Activity in my office over 2007 has been dominated by the CoRE rebid. After the submission of our rebid application in December 2006, we received and responded to referee's reports in February, presented our application to the selection committee in March, and received notification in June that our application was successful, the Allan Wilson Centre was one of the six first-round CoREs to be refunded. However the grant was significantly less than our requested budget, and there were a number of conditions attached, including a requirement to completely revise our research programme. Our Governance Board set up a sub-committee with Board members Carolyn Burns and Des Cooper, new PI Paul Rainey and the Directors to carry out this revision. The revised application (now called the "Funding Schedule" by TEC) has just been approved by our GB (on March 14, 2008) and will shortly be forwarded to TEC. I wish to acknowledge the efforts of this committee, together with the other 9 proposed PIs, who have all made significant contributions towards this revision, We now have a revised Research Plan which will carry us through to 2014, and an impetus to extend the activities of the AWC beyond that date.

A major highlight in 2007 for all in the AWC was our hosting of the very successful Evolution07, on behalf of the Evolution Societies (Society for the Study of Evolution, American Society of naturalists and Society of Systematic Biologists). This meeting in Christchurch in June was the first time the meeting had been held outside of North America and attracted almost 900 registrants, with over 600 oral presentations timetabled. The success of the meeting is due largely to the strong commitment of many AWC members, ably led by the co-chairs, David Lambert and Craig Millar. With 277 visitors from USA, 168 from Australia, 114 from Europe, and 73 from other parts of the world joining the 277 NZ scientists in attendance, we truly put the AWC and NZ Evolution research into the world spotlight. The venue at the Christchurch Convention Centre was very convenient and well organized; the 120-page timetable and abstract booklet received many compliments from our visitors. In particular I would like to thank our sponsors, large and small, for their financial support, which enabled us to keep within budget and provided the Societies with a return sufficient for them to provide further grants for young researchers attending future meetings.

Another highlight for me is our annual AWC research meeting, held at the Rugby Institute in Palmerston North. Once again we were able to attract over 90% of our researchers across all levels from Masters students to Principal Investigators. The intermingling of our researchers across the disciplines, and across all our sites is an important feature. This defines the AWC as a truly integrated national research centre, and shows we are much more "than the sum of our parts". Last year we invited the younger members of the Centre to plan and organize the programme, and the success of the meeting demonstrates the enormous pool of research talent we have attracted into the Centre, and bodes well for the future.

Further I wish to comment on AWC's bold venture into the next generation of high-throughput sequencers with our purchase of the Solexa and the establishment of the NZ Genome Consortium. When in 2002 we invested in two ABI 3730s, then state-of-the-art sequencers, we were investing well beyond the then predicted sequencing needs of NZ. This investment has proved to have been beneficial not just for the AWC, but for researchers across NZ as a whole. With the installation of the Solexa we anticipate another major leap in supplying the future needs of the biological research community in New Zealand as well as a major tool for our own researchers.

In January four of our original Governance Board members completed their terms. I want to acknowledge the major contributions of Seddon Bennington (former GB chair), Andy Pearce, Alan Dixson and Prue Kapua, who gave so much to the AWC through some rather difficult times, your efforts are very much appreciated. We welcome our new Board members who have already shown their commitment and given good guidance under the leadership of our new Board chair, David Parry. Also I wish to acknowledge the important work of our administrative staff, Susan, Joy and Karen. Karen finished her contract with us during the year.

Finally I want to acknowledge the efforts of all of our researchers, and in particular our current 10 Investigators who continue to lead our research centre as a world-class team. We have established a great momentum and we should be in good shape as we advance into the second round of funding in July 2008 when we invite a further 11 Investigators into the Centre.

Mike Hendy
Executive Director

RESEARCH DIRECTOR'S REPORT

We are nearing completion of the first six years of TEC funding for the Allan Wilson Center for Molecular Ecology and Evolution. As such, it is desirable to review our progress over the last six years as a basis for evaluation of our past, present and future research. Early in 2003 we set ourselves 12 criteria for evaluation, and I will use those as basis for a quick summary of our achievements. It is always desirable to set our goals to high, even for a six-year period, but our achievements in research have been outstanding. Because of new questions and improving technologies we look forward to equivalent achievements in the next 6 years.

Our first goal was to produce a world-class multidisciplinary research group with high achievement. For this our two primary criteria have been refereed papers, and the numbers of citations to our work. The AWC has well over 300 papers published in the scientific literature, with already over 2500 citations to this work, with some papers cited over 100 times. This is complemented by publications in many top journals, Science, Nature, Nature reviews Genetics, PNAS, and the Trends journals. Overall, our work sets a very high standard.

Our next goal was to produce an unprecedented level of understanding of New Zealand's biota, its past and its future, by answering fundamental questions about New Zealand's plant, animals and microbes. This has been working at two levels. Many papers on a wide variety of plants and animals show a much more dynamic view of our biota, both in arrivals and dispersal to other places. But in addition, these are now being integrated to study whether there is an ancient element to the New Zealand terrestrial biota, or whether it was totally submerged – an all our biota are subsequent immigrants. This is a key issue for future research.

We expect to contribute internationally to the understanding of complex biological processes and fragile ecosystems. Much of our work on the biota is relevant here, but in particular I will mention the theoretical research on finding the optimal solution to the problem of preserving species when costs vary but the budget is fixed. This is known as the 'Noah's Ark' problem, and the AWC has been at the forefront of turning decision making in this area into a science.

Continuing with our goals, we aimed to develop novel and innovative analytical tools to transform 'genomic information into knowledge'. This area is certainly one of our strengths in that we know of no equivalent research organization that covers the full range of mathematicians, computational biologists, and ecological and evolutionary biologists. As new types and amounts of data come available there are a range of new analyses required; from recombination in viruses, more powerful programs for coalescence, the important role of networks in detecting (for example) hybridization, and work on how to recover genealogies from genomic data.

The next goal is one of the most satisfying – to produce world-class graduates with skills for a knowledge economy, and to provide career paths for these young researchers. We have been very successful in our PhD graduates obtaining research positions in many institutions, both here and overseas. We expect that their publication record on graduation would give them the equivalent of a PBRF ranking of 'New and Emerging' active researchers. For postdocs we aim higher. It is absolutely vital that we launch our PhD graduates and postdocs into productive careers, here and overseas, in research and related areas.

The next is built in to a 'Center of Research Excellence', to establish a world-class research centre that is unique in having strong interactions between experimental and theoretical researchers.

Promoting a public awareness and interest in evolutionary biology, conservation and ecology, is one of the things that we have worked on consistently. Our activities include outreach to the public through a biennial 'Allan Wilson Lecture Series'. These started in Palmerston North, but are now throughout the country, and we arrange for buses to bring in senior High School students. This is just one example, we have people taking animals to Primary Schools, and assist in getting new information to High School teacher conferences. Especially satisfying is discussing science with communities in various corners of the South Pacific.

A long term objective has been to use DNA and protein sequence information to raise the level of understanding regarding complex biological systems. This is top level research that is less predictable than standard research, but we have had successes in areas as diverse as the possibility of autocatalytic cycles for the origin of life and using graph theory as a basis for handling more complex population genetic models. We see this as an unending task because new possibilities are always arising.

We have always had a focus on international academic exchanges. This is a two-way process with New Zealand based investigators participating in invited lectures and conferences overseas, and many people (including most graduate students) attending international conferences. Several have had important roles in evaluation of overseas science, a good sign of leading research being done in New Zealand at the top scientific level. In addition, we have had many research visitors to New Zealand, including those under our sabbatical visitors fund. Many students have come from overseas for periods of research and training. In a quite different way we have helped raise the profile of New Zealand by a series of major conferences and workshops that we have held here.

It has always been an aim behind the CoREs to enhance knowledge transfer by closer collaborations between groups from different institutions. We do this by a variety of ways including collaborations, attendance at New Zealand meetings, and by our annual conference. However, this is an area where we will see further developments during the next 6 years of funding. It probably should become a requirement for every Investigator to have collaborations with other Investigators in the AWC.

Also of importance has been to understand morphological innovation and extinction and their relationship to genetic diversity. New work evaluating the role of genetic diversity on allowing continuing adaptation to changing conditions, including climate change.

Serve as a resource for all biology groups in the South Pacific ensuring fundamental gains in knowledge. We have had a very productive relationship in this important region, and it gives the Investigators involved a deep satisfaction to observe the enthusiasm with which modern sciences are adopted. It is very much a two-way collaboration with New Zealanders learning al lot about the origins of our own biota from that of the South Pacific. No longer can New Zealanders taken a narrow view of their biota. There is still a huge potential for more collaboration in the region.

These were our goals for the first 6 years. They are a basis for the next 6 as well, and beyond. There are still going to be exciting challenges as we increase our ability to get genomic data and improve analyses. As always, the fundamental questions in biology are our main driving force.

David Penny
Research Director

RESEARCH PROGRAMME OVERVIEW

The research goal of the AWC is to combine fundamental biological questions, molecular (DNA sequence) data, and mathematics, in order to understand important processes that helped shape present day plants and animals, especially those of New Zealand. For convenience, we divide our research into four projects.

Under Rates and Modes of Evolution in Project 1 we test whether measuring rates of DNA sequence change at different times gives the expected acceleration of evolution at shorter times. A related sub-project seeks to understand how changes in the secondary and tertiary structure of proteins affects rates of evolution. Furthermore, we are testing the extent to which the measurable processes of microevolution (as measured in this Project) are sufficient for long term evolution.

Our second Project on Biodiversity is broad but focuses on New Zealand biota. We are identifying dispersal methods that have helped establish the main groups. We have unique animals from which we can learn about probable past events. The (geologically) recent uplift that gave the Southern Alps is a unique opportunity to study recent speciation as new niches become available, and in one case is challenging long held paradigms about the nature of species themselves.

Our Project 3 is on the peopling of the Pacific, identifying their origins and those of their plants and animals. Given the relatively recent date of initial occupation, and the rich archaeological record, the Pacific Islands are arguably the best place in the world to understand the processes involved in human settlement and to assess their impacts on relatively “pristine” island environments.

Finally, Project 4 on new ecological and evolutionary models uses the power of mathematics, together with a strong interaction with biologists, to develop and implement testable models for ecology and evolution. These range from short-term effects such as viral evolution, to very distant events such as optimal conditions for the origin of life. Another sub-project develops better ways for detecting hybridization from sequence data, a topic much neglected by other groups as being far too hard. Project 4 gives us a major competitive advantage with respect to other groups in the world, but needs the strong input from biologists in order to be effective.

RESEARCH HIGHLIGHTS

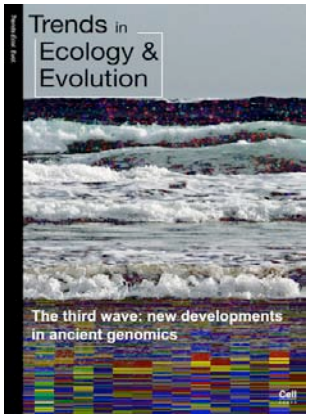
Project One

Rates and Modes of Evolution

Project coordinated by Prof David Lambert

Researchers *David Lambert, Craig Millar, Mike Hendy, Peter Lockhart, David Penny, Michael Woodhams, Andrew Dodd, Jennifer Hay, Leon Huynen, Barbara Binney, Lara Shepherd, Mary Morgan-Richards, Steve Trewick, Mark Stevens, Gillian Gibb, Renae Pratt, Julia Goldberg, Kerryn Slack, Gabrielle Beans-Picon, Elmira Mohandesan, John Waugh, Lorraine Cook*

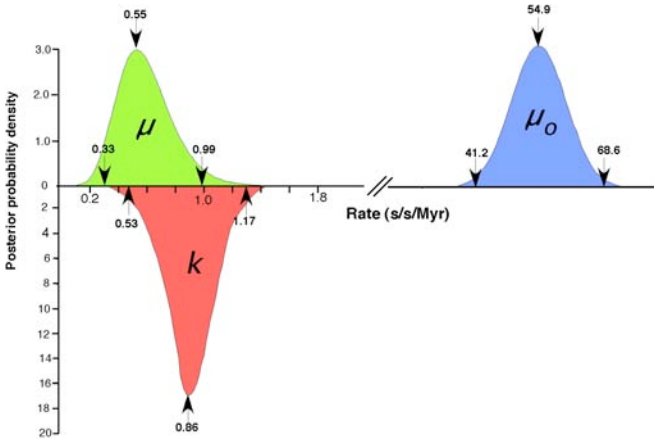
Ancient DNA methods and rates of mutation



In the last 12 months, this research field has metamorphosed into a distinctly different discipline. We are now on the verge of a 'third wave' of ancient DNA research. We have reviewed this new field and pointed out the range of potentials that it offers. In particular we have compared and contrasted the four different commercially available technologies and highlight their strengths and limitations in relation to ancient DNA and rate estimation. In addition, the results of our empirical studies estimating the rates of molecular evolution in Tuatara have recently been published in *Trends in Genetics*. We showed that tuatara have the highest rate of molecular evolution yet recorded using ancient DNA methods. This is remarkable because tuatara have a very low metabolic rates, long generation times, have remained morphologically relatively unchanged over the last 200 million years. The status as a 'living fossil' is in contrast to their high rate of molecular evolution. This result is in support of the suggestion made decades ago by Allan Wilson, that morphological and molecular evolution are decoupled.

We have now completed another major project. In a collaboration across the AWC we have been able to show that, for neutral region of the Adélie penguin mitochondrial genome, rates of mutation and evolution are not significantly different. It will be an important contribution to our understanding of how evolution actually works at the

molecular level. In addition, this work presents novel methods and approaches to the measurement of evolutionary and mutation rates.



Rates and Modes

Studies on endosymbiosis continued. We published an analysis of 200kb of sequence from the endosymbiont genome of *Rhopalodia gibba*, suggesting that nitrogen fixation for the host has driven the endosymbiotic interaction.

Project Two

Biodiversity

Project coordinated by Prof Charles Daugherty

Researchers *Charles Daugherty, Peter Lockhart, Hamish Spencer, David Chapple, Kirsten Donald, Martyn Kennedy, Sue Keall, Trish McLenachan, Hilary Miller, Olga Kardialsky, Hayley Lawrence, Corina Jordan, Joanne Hoare, Michael Knapp, Carlos Lehnebach, Libby Liggins, Katie McKenzie, Jennifer Moore, Mort Piripi, Tania King, Kristina Ramstad, Richard Carter, Angela McGaughran, Simon Joly, Matt Phillips, Claudia Voelckel, Whitney Bouma, Michael Dann, Stephanie Godfrey, Stephanie Greaves, Kim Miller, Shay O'Neill, Steven Pilkington, Jeanine Refsnider, Monica Gruber*

Origins of Biodiversity

Antibody and innate immunity receptor identification in tuatara

Toll-like receptors (TLRs) are part of an ancient superfamily of proteins called pattern-recognition receptors responsible for the recognition of structural motifs expressed by microbial pathogens. TLRs are an essential component in the innate immune system in vertebrates as they recognise and distinguish millions of pathogen-associated molecular patterns. From our studies we have demonstrated that tuatara leukocytes or "white blood cells" can respond to many distinct TLR agonists and the pattern of preferential recognition varies between individuals and seasons of the year. We believe that by identifying when the immune system works optimally, we can determine when tuatara are the least susceptible to disease.

Previous studies in our group have identified tuatara antibody antigenically. Recent work had focused on the biochemical characterization of tuatara antibody to determine the amino acid sequence. The definitive identification of antibody will allow the development of diagnostic tools to assess infection status in tuatara. Furthermore, through sequence analysis we will gain insight into how the tuatara's adaptive immune system has evolved.

Maintenance of Biodiversity

MHC and mate choice in tuatara

We have determined MHC genotypes for more than 200 tuatara from Stephens Island, including 72 mated pairs, and investigated the role of MHC genes in mate choice and mating success. Preliminary analyses of this data found a trend towards individuals preferring a functionally different MHC genotype to their own (based on MHC amino acid distance between pairs), but that male body size is the primary determinant of mating success.

Our research on identifying polymorphic vs non-polymorphic MHC genes, and on levels of MHC diversity on North Brother Island tuatara has been published.

We have screened the tuatara BAC library for additional clones that encompass the MHC region. 240 clones were identified in a primary screen, and these will now be fingerprinted to determine how they overlap with the MHC-containing clones that we have previously identified. Sequencing of BAC clones is ongoing – this work is being undertaken by collaborators at the Tokai University School of Medicine in Japan.

Tuatara reproductive ecology and mating system

We have recently finished a comprehensive assessment of the social structure and factors affecting male territory quality and aggressive behavior in the densest population of tuatara, on Stephens Island, in the Marlborough Sounds. We found that body size, body condition and individual heterozygosity did not predict territory size. Heterozygosity, body condition, and territory size had no effect on the number of females a male had access to. The only significant predictor of female access and competitive ability was male body size. Large males were more effective at 1) monopolizing areas where females were most dense and 2) guarding females by consistently winning aggressive encounters with other males. In this system, we found no evidence for alternative male reproductive strategies, and reproductive skew thus favours large, dominant males. Our finding of no relationship between territoriality and heterozygosity probably reflects the genetic background of this large, outbred population or that behavioral attributes are not appropriate fitness correlates for these long-lived reptiles.

We have also used behavioral data and genetic paternity analyses to further characterize the unknown mating system tuatara at high and low population densities (on Stephens Island). We investigated the phenotypic traits (including body size, body condition, tail length, and ectoparasite load) that affect male reproductive success. Our behavioural data reflect a seasonally monogamous system with low levels of polyandry and polygyny that is consistent with a male mate guarding hypothesis. Male reproduction is highly skewed (only 25-30% of males are successful) and, concordant with our investigation of the tuatara spatial structure, body size was the primary predictor of male reproductive success. We found weak positive size-assortative mating at high densities, but not at low densities where more small males were successful. This is indicative of a male preference for large females that breaks down

when intrasexual competition is reduced. Although our sample sizes were small, we did not find multiple paternity in any clutch, including that of a polyandrous female. This warrants further investigation into the mechanisms underlying tuatara fertilization.

Restoration of Rangitoto Islands

What are the biological effects of global warming?

(i) Tuatara populations

The sex ratio of breeding individuals is a key determinant of population demography. This ratio results from the initial sex ratio of offspring, and subsequent differences in the survival of prebreeding males and females in the population. In species with temperature-dependent sex determination (TSD), including some reptiles, fish, and invertebrates, the initial sex ratio of offspring is closely linked to environmental conditions. Ambient thermal regime and habitat attributes that allow for behavioural modification of nest temperatures are important in determining sex ratios in species with TSD. Air temperature is predicted to increase between 1.4 and 5.8°C in the next 100 years. The demographic implications of TSD under shifting climatic conditions have rarely been investigated in reptiles. We continue to investigate interactions between nest site choice and sex ratio in tuatara. Data collation from five field seasons of nesting are complete, and analyses have begun.

(ii) Restoration of Rangitoto Islands

At the heart of conservation lies the need to address the causes of decline of threatened populations and to increase the number and size of remaining populations. In New Zealand, the chief cause of decline is predation by introduced mammalian pests, which is addressed by an extensive programme of eradication and regular monitoring. Translocation of native reptiles and birds to predator free habitats are common practice to increase the number of populations. Often this requires harvesting eggs from the wild for artificial incubation, captive rearing the resulting offspring for a time (head-starting), and subsequently releasing these juveniles into the wild. Historical and contemporary data were used to investigate the growth and survival of head-started tuatara, which were raised from artificially incubated eggs harvested during five nesting seasons, while in captivity and after release into the wild. We aimed to: 1) assess the success of artificial incubation and head-starting by analysing growth and survival of juveniles, both during captivity and after release into the wild; 2) investigate if growth of captive and translocated animals is comparable in order to assess the success of translocated populations. Key findings were that survival of juveniles during head-starting was comparable to survival of wild adults, and was higher in groups of

around 60 hatchlings than in a larger group. Both during head-starting and after translocation, growth was greater than estimates of juvenile growth in the wild. Eleven years after release juveniles are being recaptured that have not been seen since translocation and rates of recapture have not diminished. Growth of translocated animals was comparable to animals held in captivity, suggesting abundant resources are available on the islands to which they were translocated. In the short term (i.e. less than 15 years) artificial incubation and head-starting have no discernible detrimental effects on growth and survival of juvenile tuatara. Ultimately, the success of these techniques is dependent on these juveniles reproducing in the wild. Potential future research includes using the largest tuatara population as a model system to estimate capture probabilities of juveniles and quantify which traits are important fitness surrogates. Head-starting attempts should include eggs incubated in natural nests to increase the size of the dataset to compare with artificially incubated juveniles. Conservation recommendations include continuation of the head-starting programme, albeit with group sizes limited to a maximum of 60 hatchlings.

(iii) Translocating tuatara to the mainland

Conservation on mainland New Zealand is defined by pest control programmes and predator proof fencing, which have arisen to combat the suite of mammalian pest species now occurring there. Translocations are an integral part of species conservation and ecological restoration of mainland islands. Investigation into factors that influence translocation success, especially in the presence of managed levels of predators, is an emerging area of research. Tuatara (*Sphenodon punctatus*) were forced off the mainland of New Zealand and onto offshore islands with the introduction of mammalian predators. A translocation of 70 adult tuatara from Stephens Island to Karori Wildlife Sanctuary, Wellington, in December 2005 allowed investigation into whether tuatara can co-exist with controlled levels of mice by evaluating survival and condition of the founder population. Sixty tuatara were released in a mouse-proof exclosure within the sanctuary and ten outside this, in the main sanctuary, in the presence of mice. Survival was high with 80% of the tuatara released being sighted during the first year post-release, and more are likely to have survived. Individuals of both sexes showed increases in mass. Adult tuatara are able to survive in the presence of controlled levels of mice, however the survival of juveniles and eggs requires further investigation. Translocation of individuals in groups with known neighbours did not reduce post-translocation dispersal compared to those in randomly assorted groups. Territory sizes were significantly larger than those on Stephens Island. Juveniles made use of the gaps created within the dense population on

Stephens Island by removal of adults for translocation, and began establishing territories. Whether they are able to defend these territories long-term against larger males is uncertain. The threatened tuatara tick (*Amblyomma sphenodonti*) was also translocated with its host, the tuatara. Ticks are unlikely to have survived the translocation. By one year post release, few tuatara still had ticks, and numbers of ticks on tuatara were extremely low. Nymphs detached prior to the end of the study, but reattachment opportunities are reduced in the translocated population due to reduced density of tuatara and dispersal away from burrows. Success of translocations of tuatara to the mainland will be contingent on reproductive success in the presence of mice. Protocols for translocations that reduce subsequent dispersal are desirable for tuatara reproduction, and for the reproduction and conservation of tuatara ticks, however taking animals with known neighbours is not a time or cost effective way to achieve a reduction in dispersal.

Tuatara arriving from Stephens Island to be released into Karori Wildlife Sanctuary, accompanied by representatives from Ngati Koata and Wellington Tenths Trust, KWS staff, and AWC members Sue Keall, Nicky Nelson, Jen Moore, and Kim Miller. Photo Kristina Ramstad

Parasitology of tuatara

The conservation of threatened vertebrate species and their threatened parasites requires a careful understanding of the factors that influence their distribution and dynamics. We investigated the seasonal dynamics, lifecycle and spatial variation in ectoparasite infestation of a threatened reptile, the tuatara (*Sphenodon punctatus*) on Stephens Island, New Zealand. Tuatara are host to three ectoparasite species, the tuatara tick (*Amblyomma sphenodonti*, Dumbleton 1943) and two species of trombiculid mites (*Neotrombicula naultini* and *N. sphenodonti*). We examined the lifecycle and seasonal dynamics of ectoparasite infestation in a mark-recapture study in three sites in closed canopy forest from November 2004 to March 2007. Tick loads were lowest over summer, and peaked from late autumn (May) until early spring (September), whereas mite loads were highest in the summer months, peaking in March. The attachment, mating and engorgement of female ticks were highest from September to November, with larval tick loads subsequently peaking in March. Subsequent increases in nymphal tick loads occurred in September, and adult tick loads increased in May. Our findings suggest that ticks have a two-year lifecycle with on-host diapause over winter for most life stages. We also surveyed eight sites across Stephens Island in March 2006 to investigate the spatial distribution of parasites. Ticks were more abundant in pastures than shrub or forests, while mites were more prevalent in forest habitats than pastures or shrub habitats. A combination of host behaviour and microclimatic factors influence the survival and transmission of tuatara ectoparasites.

A pair of ticks mating on a tuatara host. Photo Stephanie Godfrey

(v) Nest site choice of tuatara

Although parental care is generally rare among reptiles, nest-guarding occurs in some species and is generally attributed to defence against nest predation. Nest-guarding

also occurs in the tuatara (*Sphenodon punctatus*), but nest predation does not appear to be a significant threat to nesting success in this species. We studied a population of colonial-nesting tuatara on Stephens Island, New Zealand over four years and tested the hypothesis that female tuatara guard their nests to defend them from excavation by conspecific females. We located 73 nests for which females could be assigned based on observations during oviposition. Nearly 25% of these nests were subsequently excavated by another female, but only 56% of the nests were guarded by the females that constructed them. Guarded nests were less likely to be excavated than unguarded nests. Females were more likely to guard their nests, and guarded nests for longer, as the activity of other females on the date of oviposition increased. Nest-guarding in tuatara appears to be adaptive in that it reduces the likelihood of nest excavation by other females, but social interactions may influence females' propensity to guard, as guarding behaviour was influenced by the activity of conspecifics at the time of oviposition.

Microsatellite diversity and fitness of skinks

We have completed sampling of 15 populations of 3 species (*Cyclodina alani, C. whitakeri* and *Oligosoma suteri*) , with a total of over 500 animals. Minimally-invasive methods for DNA collection were unsuccessful. High levels of genetic structuring among populations of Whitaker's skinks were detected, but the biological significance of this differentiation is unclear. Preliminary analysis suggests that bottleneck effects are strong in each of 3 translocated populations evaluated, and that genetic diversity is continuing to erode in at least one of these populations.

Egg laying skink (Oligosoma suteri) on Middle Island. Photo Sue Keall

Loss of Biodiversity

Estimate genetic variation and extinction probabilities in Taiko

This project has now been totally completed. This project has been highly successful and has been a collaboration between the Department of Conservation, Chatham Island iwi and the Allan Wilson Centre. The information from this programme is now being used by the Department of Conservation to manage the species.

Identifying Biodiversity

Alpine flora

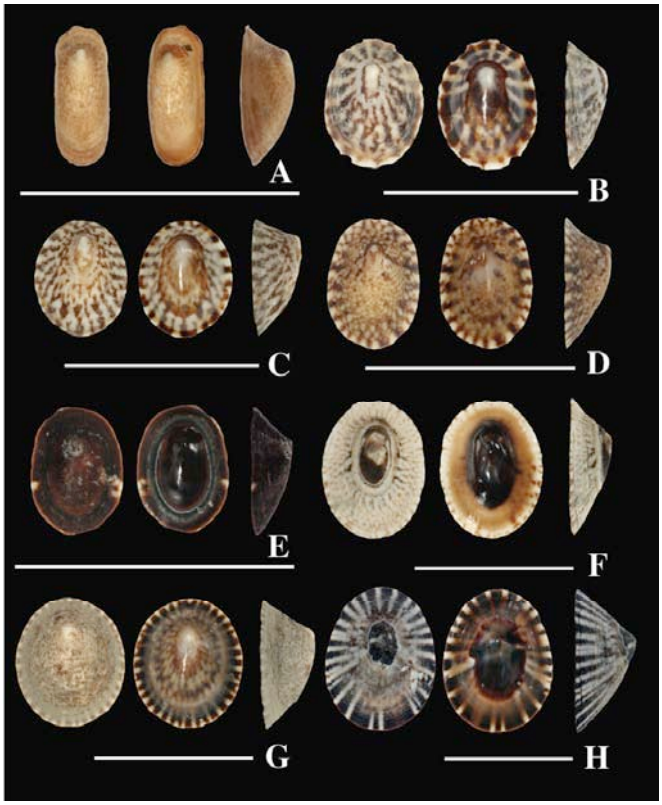
Work has continued on studies of alpine flora, studies on *Ourisa* and *Ranunculus.* Our research has considered the issue of evaluating the importance of hybridisation during plant evolution and the problem of reconstructing the evolutionary history of groups and delimiting species.

Skink phylogeny

New Zealand boasts one of the world's most diverse temperate assemblages of herpetofauna (~80+ species), particularly given its latitude and relatively small land mass. The endemic skink radiation in New Zealand comprises two genera (*Oligosoma* and *Cyclodina*) and 40+ species. A molecular phylogeny has been completed for all species in the New Zealand skink radiation based on mitochondrial and nuclear DNA sequences. This phylogeny is currently being prepared for publication. Phylogeographic studies have also been completed for all widespread New Zealand skink species (*C. aenea, C. ornata, C. whitakeri, C. macgregori, C. alani, O. nigriplantare, O. chloronoton, O. lineoocellatum, O. infrapunctatum, O. maccanni, O. zelandicum, O. otagense, O. waimatense, O. suteri, O. smithi, O. moco,* and *O. inconspicuum*). These phylogeographic studies have either been published, accepted for publication, or are currently being prepared for publication. Parallel morphological and taxonomic work is also being completed, with four new skink species described to date.

Phylogeography of the common skink complex

This project investigated the relative roles of different climatic and geological processes in the recent evolutionary history of New Zealand using phylogeographic methods and the New Zealand common skink (*Oligosoma nigriplantare*) as a model taxon. *Oligosoma nigriplantare* consists of two subspecies; *O. n. nigriplantare* found in the Chatham Islands, and *O. n. polychroma* that is distributed throughout the southern half of the North Island, much of the South Island and Stewart Island. Using phylogenetic and molecular analyses of mitochondrial DNA (ND2 and ND4) we found a high level of divergence (~9%) between *O. n. nigriplantare* and *O. n. polychroma*, suggesting that *O. n. nigriplantare* and *O. n. polychroma* should be recognised as separate species. Divergence time estimates indicated *O. nigriplantare* colonised the Chatham Islands within the last ~6.4 million years via transoceanic dispersal. Patterns were revealed of both isolation by distance and restricted geneflow using analysis of molecular variance and nested clade analysis across the Chatham Islands, consistent with the history of sea level changes in the archipelago. Across the range of *O. n. polychroma,* five geographically distinct clades were revealed. The phylogeographic pattern and inferred age of these clades suggests mountain building during the Pliocene along active fault lines promoted their divergence 3.98-5.45 million years ago. A short interspersed nuclear element polymorphism in the myosin gene intron (*MYH-2*) confirmed a pattern of restricted geneflow between lineages on either side of the Southern Alps. The straits between the main islands of New Zealand accounted for much less of the variation found within *O. n. polychroma*, most likely due to the repeated emergence of inter-island landbridges during the Pleistocene that facilitated geneflow. Overall, this research has found evolutionary independence of groups within the common skink species complex, providing valuable insight for the conservation management of this species. In the future, investigating the phylogeography of co-occurring species will reveal further details on the nature of these phylogeographic patterns and the processes driving evolution in New Zealand.



Variation in shell form and colour of *Notoacmea* limpets. A and B are *N. scapha*; C, D, G and H are further different *species; E & F are a 6th species.*

Variation within a Species and Similarity between Different Species

The first paper concerning the small intertidal limpets known under the name *Notoacmea helmsi* was published. These limpets occupy a wide variety of habitats in New Zealand and manifest a confusing variety of shell forms (see photo). Analyses of DNA sequences revealed that this species ac tually comprises several morphologically cryptic species. One particularly interesting case is the species *N. scapha*, which consists of individuals with two obviously different shell types. One of these forms is a plastic response to living on eelgrass (*Zostera*) fronds: these individuals have narrow, parallel-sided shells. *N. scapha* is not restricted to living on eelgrass, however, and individuals living on nearby dead cockle shells are larger, with an oval outline. Another species, which does not currently have a valid scientific name, has an oval shell that is very similar to the latter form of *N. scapha*. But it is easily distinguished by its behaviour: it rapidly crawls away from direct light. So far as we are aware, this case if the first in which behaviour can be used to separate cryptic species in molluscs.

Host-switching in Lice

Lice in the genus *Pectinopygus* parasitize a single order of birds (Pelecaniformes). Host-parasite coevolution between these lice and their hosts was studied using a range of methods, all of which agreed that there has been extensive cospeciation in this system. Nevertheless, the results are sensitive to the selection of different phylogenetic hypotheses and analytical methods for evaluating cospeciation. Perfect congruence

between phylogenies was not found in this association, probably as a result of occasional host switching by the lice. Errors due to phylogenetic reconstruction methods, incorrect or incomplete taxon sampling, or to different loci undergoing different evolutionary histories cannot be rejected, however, thus emphasizing the need for improved cophylogenetic methodologies.

Traditional Ecological Knowledge

Biodiversity Research and Links to Māori

Over the years the AWC has become increasingly aware of the need to bring its interactions with Māori under one umbrella and ensure that all projects reap the benefit of positive interactions with iwi. The AWC is committed to providing increased opportunity for participation of Māori in molecular ecological research that is important to New Zealand. To this end, the AWC has employed Dr Kristina Ramstad as a postdoctoral to develop collaborative research with Māori and conduct research of direct relevance to Māori. She works across the whole AWC research programme in collaboration with various researchers both within and outside the AWC.

Develop research project(s) that are collaborative with and directly relevant to Māori iwi - Conservation genetics of Little Spotted Kiwi

Dr. Kristina Ramstad and Little Spotted Kiwi (Apteryx owenii) on Kapiti Island. Photo Kim Miller

This study will measure genetic diversity within and genetic divergence among Little Spotted Kiwi (LSK) populations at microsatellite loci, mtDNA, and MHC genes. The data will inform translocation practices to mitigate potential founder effects. This project has received the endorsement of Kaitiaki o Kapiti Trust, Waiorua Bay Trust, Te Runanga o Ati Awa ki Whakarongotai Inc. (Te Ati Awa), Te Atiawa Manawhenua ki te Tau Ihu Trust, and Wellington Tenths Trust (Te Atiawa).

Sample collection is finalized and labwork is ongoing. To date we have tested 5 brown kiwi microsatellite primer sets for use in LSK; we have found one of these to be polymorphic in LSK. We have also isolated and amplified MHC genes in LSK.

- Traditional knowledge & sustainable muttonbirding on Motungārara Island

This is a collaborative project with Nga Takiwa o te Atiawa Whānau to (1) conduct a flora and fauna survey, (2) determine if muttonbirding is sustainable, (3) produce a management plan, and (4) record TEK of muttonbirding on/for Motungārara in Queen Charlotte Sound.

Amelia Geary and Sooty Shearwater (Puffinus griseus) on Motungārara Island, Queen Charlotte Sound. Photo Kristina Ramstad

Project Three

Human settlement of Aotearoa/New Zealand

Project coordinated by Dr Lisa Matisoo-Smith

Researchers *Lisa Matisoo-Smith, David Penny, Pete Lockhart, Judith Robins, Simon Hills, Abby Harrison, Melanie Pierson, Andrew Clarke, Alice Storey, Melanie Hingston, Trish McLenachan*

The general objective of Project 3 is to better understand the timing and process of prehistoric human migration and the effects of humans on Pacific island environments. We investigate the trail of human settlements in the Pacific through fully integrated DNA studies of not only humans but their commensal and domesticated plants and animals. Analyses of modern human genetic variation focusing on mtDNA, Y-chromosome and Hepatitis B variants across and among Pacific populations provide vital evidence of human adaptation and evolution in the unique Pacific environments, in addition to contributing to issues of health and wellbeing of Pacific peoples. Both the commensal approach we employ and the methods of analysis we are developing and using are innovative and multidisciplinary – bringing together fields as diverse as anthropology, mathematics, botany, zoology and bioinformatics all investigating questions from a molecular perspective. Our research is also multicultural in that we work closely with *iwi* and other indigenous populations in the Pacific. We have a particularly strong working relationship with the School of Biological Sciences at the University of the South Pacific, Suva, Fiji, with a two way flow of researchers. This is expected to become an important base for understanding South Pacific biodiversity, especially in relation to New Zealand.

Analyses of human genetic variation in the Pacific – mtDNA, Y-chromosome and hepatitis B studies

This topic is being addressed with a number of different datasets including analyses of complete mitochondrial genomes of Pacific populations and comparisons with other populations in the wider region (eg Taiwan). We have applied new methods of analysis (the MinMax squeeze) to this dataset in order to better understand the various possible scenarios of population migration and interaction.

Research collaborations between the AWC, Cambridge University and medical workers in Papua New Guinea and the Fiji School of Medicine are addressing not only evolutionary questions (what Y chromosome variation can tell us about population

origins and histories), but also have significant medical contributions, for example understanding the transmission and evolution of Hepatitis B.

Ancient DNA analyses of Pacific populations, most importantly the DNA of the Lapita skeletons recently recovered from Vanuatu, allow us to identify the mitochondrial haplotypes of the first Lapita colonists to settle Remote Oceania. In addition to studying the Teouma remains, we are also looking at ancient DNA in other Lapita and Lapita derived populations in the Pacific.

Commensal approach to tracking human migrations

Human migrations are tracked through the analyses of genetic variation in animals (rats, pigs, dogs and chickens) and plants (sweet potato and bottle gourd) that were transported by Pacific peoples as they settled the region. The rat work has progressed extremely well, with another successful collection trip to Papua New Guinea being undertaken in 2007. Samples were collected from Emirau Island, in the St Matthias group, PNG in April 2007. Genetic analyses of these samples are underway. Analyses of the samples collected in New Guinea in 2006 are complete and we have identified some significant patterns in distribution of Haplotypes II and III in Near Oceania, that may have implications for tracking the movement(s) of Lapita site in Near Oceania, on Emirau Island, PNG. The site, called Erarae, has secure radiocarbon dates of 3350 BP and has provided a range of early Lapita artifacts including pottery, fishhooks, and shell beads, but unfortunately no faunal remains. The local community of Emirau was involved in all aspects of fieldwork and are anticipating our return to continue research in 2008.

We have continued to develop DNA methods for identifying rat remains from archaeological sites and from living populations in and around Papua New Guinea where the task is difficult due to the large number of rat species occurring there. We published a paper on mitochondrial DNA methods for species identification including barcoding (using both short and the usual longer COI sequences) which assessed its usefulness for ancient rat samples. Continued work obtaining comparative samples from Island Southeast Asia and the Pacific has also resulted in the construction of an impressive database of three regions of mtDNA sequences for a number of Rattus species which is regularly updated and part of the DNA surveillance programme. Six new whole mt genomes have been sequenced and with this data we have been able to address the issue of the dating of divergences within the Rattus genus.

We continue to address the question of pig introductions and dispersals in the Pacific, and are working on the pig bones that are reportedly recovered from early Holocene (pre-Lapita) contexts in New Guinea. In addition to checking for the "Pacific Clade" markers identified previously, we are also having the bones radiocarbon dated to confirm their actual age.

Collection and DNA extraction from archaeological chicken bone from across the Pacific and from Asia and South America continued to produce very exciting results. We identified the earliest chicken bone reported from South America, providing the first conclusive evidence for a pre-contact Polynesian introduction of chickens to the Americas, we continue to look for further evidence of Polynesian presence. Rat bone has been collected from coastal middens in Chile and we are currently collaborating with Chilean colleages to obtain other biological material that might provide markers of Polynesian contact.

The plant side of the commensal project is also extremely productive with both the primary phases of the sweet potato and bottle gourd research complete. The primary phase has highlighted several potentially exciting areas for future research and ancient archaeological samples of both kumara and bottle gourd are being obtained for future analyses.

Project Four

New Ecological and Evolutionary Models

Project coordinated by Prof Mike Steel

Researchers *Mike Steel, Mike Hendy, Allen Rodrigo, David Penny, Charles Barbara Holland, Hamish Spencer, Rick Stoffels, Tim White, Lesley Collins, Bhalchandra Thatte, Michael Woodhams Klaas Hertmann, Peter Humpfries, Sylvia Chen, Klaus Schliep, Bastiaan Star, Jessica Hayward, Anna Santure, Meredith Trotter, Erik Matsen, Scott Roy, Oliver Will, Alexey Yanchukov, Mareike Fischer, Ceridwen Fraser, Simoene Linz*

Natural Selection and Genetic Variation

Several papers were published with these theoretical papers investigating how different forms of natural selection may be able to maintain genetic variation in natural populations. Genetic variation is ubiquitous in natural populations and yet our theories about the population-genetic forces acting on this variation do not appear to predict the patterns we observe in this variation. The well-known Harvard geneticist and social commentator, Richard Lewontin, has described the mismatch between theory and observation as the "paradox of variation" and argued it is the central problem in population genetics.

One aspect of our research investigated the consequences of a common form of natural selection, frequency-dependent selection, which occurs when the fitness of a phenotype depends on how common it is in the population. We found that frequency-dependent selection was better at maintaining large numbers of alleles than constant selection (i.e., when fitnesses are not affected by abundance). Nevertheless, much of this variation appeared to be transient, slowly working its way to extinction. The patterns of variation generated in our simulations were, however, a good fit with those found in natural populations. Thus, although the largest levels of variation observed in many natural populations cannot be explained solely in terms of their frequency-dependent fitnesses, it is likely that this form of selection is a significant part of the story.

A second aspect of our investigations concerned the effect of selection act differently in different parts of a population: effectively, the population is subdivided into two (or more) sub-populations or demes, in which selection occurs separately before some individuals migrate among the demes. As in the case of frequency-dependent selection, we found that population subdivision also allows more alleles to co-exist.

Thus, making our models more realistic – by introducing frequency-dependent selection and population subdivision – leads to predictions that greater variation is likely to be observed. And, pleasingly, these predictions are more in accord with numerous observations.

Phylogenetic diversity and biodiversity conservation

AWC Researchers at University of Canterbury have continued to develop new methods for quantifying phylogenetic diversity, and for designing more efficient conservation strategies for its conservation. This work included funding from Google for the development of software, as well as a free online software 'Tuatara' developed by researchers in Vancouver in collaboration with AWC. This package (which can be downloaded at http://mesquiteproject.org/packages/tuatara/) allows for species to be assessed according to their expected contribution to future phylogenetic diversity, from estimated extinction risks.

Phylogenetic theory and methods

AWC investigators, postdocs and students were at the forefront of a 4-month programme on phylogenetics hosted by the Isaac Newton Institute for Mathematical Sciences in Cambridge, UK. The programme (Sept-Dec. 2007) was co-organised by AWC PI Mike Steel, and involved more than 200 leading experts in phylogenetics – both mathematicians and biologists. Particular breakthroughs have been in developing better methods for analyzing reticulate (hybrid) evolution, and for incorporating population genetics into phylogenetics (such as using gene trees to infer species trees). Five AWC PhD students, two former AWC postdocs, two AWC AIs and three AWC PIs attended the INI programme, and a special issue of the journal IEEE/ACM *Transactions in Bioinformatics and Computational Biology* will publish some of the paper arising from the meetings. For outreach, the international mathematics online magazine PLUS has profiled the programme in a recent review (http://plus.maths.org/issue46/features/phylogenetics/2pdf/index.html/op.pdf).

Reconstruction of pedigrees from genomes

We have continued fundamental research into the feasibility of reconstructing detailed population history from full genomic data. This work has involved close links between Jotun Hein (Oxford University, Statistics) and the Biomathematics group at Canterbury, and led to a successful bid to EPSRC funding further develop statistical and combinatorial approaches for pedigree reconstruction.

Mathematical Models

Studies on the evolutionary properties of molecules, their relationship to models, and the impact of model misspecification on phylogenetic inference continued. Our finding that changes in the proportions of variable sites in different lineages greatly reduced reconstruction accuracy was presented at three international meetings and submitted for publication.

RESEARCH EXCELLENCE

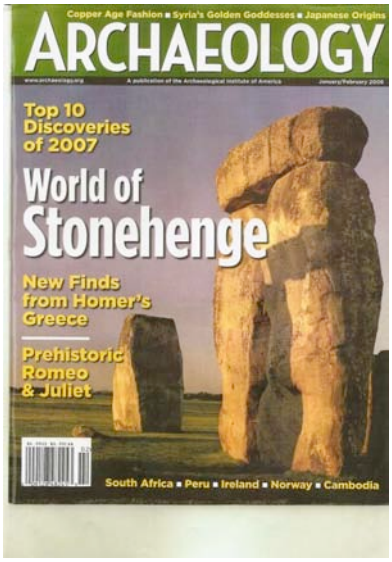
Multidisciplinary research programme

The overarching science goal of the Centre is to give an unprecedented understanding of New Zealand's biota, its past and its future. The Centre is multidisciplinary in that it comprises world-class evolutionary biologists, mathematicians, and ecologists working together to unlock secrets of our plants, animals, and microbes. How did they get here? How fast does evolution happen? What underlying genetic and ecological processes explain the evolution of our biota? How might these processes affect us in the future?

Whilst the biogeography of New Zealand is unique, it provides models for investigating general processes that underpin the nature of complex biological systems, biodiversity and ecosystems. An innovative series of research projects range from molecular rates of evolution, biodiversity, through to molecular anthropology and mathematical models.

Dr Bill Martin of the University of Dusseldorf and Editor-in-Chief of the journal Molecular Biology and Evolution described the interdisciplinary strategy of forging a successful marriage between biology and mathematics in the AWC as a “unique success” and a “good example for similar initiatives in other countries, and surely a key to the AWC’s international visibility. The leading role that New Zealand plays in this field is well-known and self-evident to all us specialists”.

High research capability



Researchers in Project 3 identified the earliest chicken bone reported from South America, providing the first conclusive evidence for a pre-contact Polynesian introduction of chickens to the Americas and published this result in PNAS. This discovery was highlighted in Archaeology Magazine as one of the top 10 archaeological discoveries in 2007. Based on this finding we are now looking for further evidence of Polynesian presence on the coast of South America. Rat bone has been collected from coastal middens in Chile and we are currently collaborating with Chilean colleagues to obtain other biological material that might provide markers of Polynesian contact.

KNOWLEDGE TRANSFER

Postgraduate and Postdoctoral Training

The CoREs have a strong role in the training of postgraduate students and in exposing students to career opportunities. The number of students trained in the AWC has grown over the life of the Centre and this number is predicted to continue to grow.

The AWC hosts a number of research students enrolled at various overseas universities, who come to the Centre for some of their research work, staying with the Centre for up to a year. Comments received indicate that the students value their time at the AWC; the access to facilities, expertise, ability to attend top conferences. The ease with which AWC students secure postings in top international laboratories is a further indication of the high calibre of AWC students and their training. In some instances our students travel overseas to undertake some of the postgraduate research, traveling to work with acknowledged experts in their field.

Students chosen to enter the AWC postgraduate programme have strong all-round skills. Students are encouraged to consider more than their immediate research training but also their future within the scientific community and to identify additional skills which will assist them to reach their potential.

Awards

Prof Peter Lockhart was made a Fellow of the Royal Society of New Zealand.

Prof Peter Lockhart was awarded a Microsoft Research Fellowship to work at the Newton Institute for Mathematical Sciences.

PhD student, David Winter (University of Otago), won one of the Society for Systematic Biology's Awards for Graduate Student Research. This award was for US$1700 towards David's field expenses for collecting land snails in the Cook Islands.

Mark Stevens received the Entomological Society of New Zealand's 21st Anniversary Research Award. Value of award $1600.

PhD student, Julia Goldberg, was awarded the Student poster prize in the Island Biogeography Symposium at the 3rd Biennial Conference of the International

Biogeography Society, Tenerife, Canary Islands, January 2007 for a poster titled "The Chatham Islands: ancient rocks - new biota".

Academic Publications

Over the period which this report covers 90 papers were published in international, refereed journals by Centre staff and students.

Conferences/Workshops

The AWC hosted a highly successful Evolution 2007 conference at the Christchurch Convention Centre, 16-20 June. Evolution 2007 was a joint annual meeting of the Society for the Study of Evolution (SSE), the Society for Systematic Biology (SSB), and the American Society of Naturalists (ASN). This was the first tem the meeting was held outside of the United States or Canada.

Again, a highly successful annual Phylogenetic meeting was held on the Volcanic Plateau during February.

During the period of this Report 129 presentations were given by AWC staff and students.

Collaborative research arrangements

The AWC investigators have a large number of collaborations both within and outside of New Zealand. These collaborations are strengthened through the hosting of sabbatical visitors within the Centre and the reciprocal arrangements made for the hosting and training of students associated with the Centre and the collaborator. On many occasions this collaboration is strengthened further when a graduate is placed within the laboratory of the collaborator for their postdoctoral period.

Prof Peter Lockhart organised a meeting of the New Zealand Plant Species Radiation Network, at which they discussed the potential of new sequencing DNA technologies for future collaborative studies.

Profile of the Allan Wilson Centre

It is vital that the Centre maintain a high profile throughout the world and this is achieved through a number of means. Those in the Centre who present their work at conferences are required to introduce the Centre during their first few slides. The

Centre has a number of initiatives to raise its profile continually; these include a semi-annual newsletter sent to all New Zealand secondary schools and the sponsoring of stationery at international conferences.

The profile of the Centre continues to grow in the islands of the South Pacific as it develop collaborations with the major educational institutions in the area.

International Collaborations

International connections are vital for the success of the AWC research programme as we seek to understand important biological processes. Relationships with tertiary institutions in the South Pacific, especially the University of the South Pacific in Fiji, have strengthened as we develop and are awarded joint grant applications for the development of a capacity in molecular systematics in Fiji. As a result of funding from NZAid, Massey University, University of the South Pacific and the Allan Wilson Centre continued efforts finally came to fruition in 2007 with the opening of a molecular systematics lab at the University of the South Pacific and with the first postgraduate students beginning their studies in this new facility. Weekly video conferences have been held since opening to facilitate co-supervision from New Zealand. Dr Richard Winkworth, formerly from Lockhart's lab is heading activities in the lab at USP. We published work on Pacific *Agathis* in collaboration with the University of the South Pacific – the findings of which argue against the complete submergence of New Zealand during the Oligocene

AWC investigators, postdocs and students were at the forefront of a 4-month programme on phylogenetics hosted by the Isaac Newton Institute for Mathematical Sciences in Cambridge, UK. The programme (Sept-Dec. 2007) was co-organised by AWC PI Mike Steel, and involved more than 200 leading experts in phylogenetics – both mathematicians and biologists. Particular breakthroughs have been in developing better methods for analyzing reticulate (hybrid) evolution, and for incorporating population genetics into phylogenetics (such as using gene trees to infer species trees). Five AWC PhD students, two former AWC postdocs, two AWC AIs and three AWC PIs attended the INI programme, and a special issue of the journal IEEE/ACM *Transactions in Bioinformatics and Computational Biology* will publish some of the paper arising from the meetings. For outreach, the international mathematics online magazine PLUS has profiled the programme in a recent review (http://plus.maths.org/issue46/features/phylogenetics/2pdf/index.html/op.pdf).

Hilary Miller continued her collaboration with Professor Scott Edwards at the Department of Organismic and Evolutionary Biology, Harvard University, visiting his lab for 3 weeks in September. Charles Daugherty, Nicky Nelson and Sue Keall advise staff at the San Diego Zoo on tuatara husbandry and breeding, and hosted the Zoo's Director of Conservation and Research, Centre for Reproduction of Endangered Species (CRES), Andy Philips, and CRES scientist Tom Jensen, during their visit to Victoria University to develop a collaborative programme into kiwi research.

Relationships with end-users

Advice and service has been given to the Department of Conservation on conservation management issues. In particular these related to:

- Tuatara Recovery Group
- Little Barrier Island tuatara population captive breeding programme – genetic management
- Whitaker's skink recovery programme – genetic management
- Scientific advice on proposed translocation of tuatara from Stephens Island to East Island
- Management of tuatara egg incubation programme to support conservation of rare island populations
- Conservation genetics of little spotted kiwi
- Nicky Nelson a nominated member of Wellington Conservation Board

Collaboration with Department of Conservation and other external stakeholders have contributed to:

- Leadership and logistical organisation of tuatara translocations - Brothers Island tuatara from Wellington Zoo to Long Island, Marlborough Sounds; Common tuatara from Stephens Island to Karori Wildlife Sanctuary
- Tuatara head-start programme - Nga Manu Nature Reserve, Waikanae; Auckland Zoo; Hamilton Zoo.

Service to Professional Organisation:

- Society for Research on Amphibians and Reptiles in New Zealand – Nicky Nelson and Sue Keall are elected members of council.

Public Outreach

Sue Keall and Charles Daugherty continue to educate school and community groups in the Wellington region about tuatara research in the AWC and how new knowledge and techniques are being applied to conservation of the species. A large number of media articles, for both print and electronic media, have been produced highlighting research in the AWC.

CONTRIBUTION TO NATIONAL GOALS

Of the National Goals relevant at the time of CoRE selection, some are more relevant to the AWC than others and focus on our unique vision and activities.

Innovation

The "Albany Genetic Service" was established to conduct a range of genetic contract work conducted by the AWC research group at Albany. The service includes canine pedigree verification tests, microsatellite DNA isolation, genotyping of wildlife, avian sexing and species identification tests using DNA barcoding methods.

Highlights for 2007 included growth in the service, particularly in relation to avian sexing and prospects that further legislation will make pedigree verification for dogs compulsory. In relation to the latter, we are now very well placed to be the major if not only service for such tests. This year we met with representative from the Prime Minister's Department and advised them on genetic test to determine canine breeds. This is now feasible using genotyping markers and some encouraging papers have been recently published to that effect. In the event of legislation for at least some dog breeds to be identified genetically, we are also very well placed. We have developed the appropriate laboratory methods to collect data using local dog breeds. We aim to strengthen our range of analytical methods, particularly those needed for the determination of parentage and breeds in New Zealand dog populations and the identification of avian species.

Economic Development

A recent report titled "The Economic Impact of CRC's in Australia: Delivering Benefits for Australia" found that the average time between the formation of a CRC and the commencement of economic impacts was nine years. The AWC is in its sixth year of operation.

The AWC Genome Facility is New Zealand's leader in commercial DNA Sequencing and Genotyping. Over the period there has been a substantial increase in the number of sequences and genotypes processed by the facility. The Facility has recently purchased a Solexa Genome Analyser. At the moment we are trailing the service and it is anticipated that in 2008 we will process samples from both national and international customers.

Fulfilling the obligations of the Treaty of Waitangi

The AWC is committed to providing increased opportunity for participation of Māori in molecular ecological research that is important to New Zealand. To facilitate this the AWC is developing collaborative research with Māori and conducting research of direct relevance to Māori. This will add to the actions exemplifying the Centre's commitment to the Treaty of Waitangi.

Katie Hartnup is a PhD student working on the identity, sex and provenance of feathers used in the construction of Maori cloaks and kete.

Katie has established relationships with museums, both in New Zealand and overseas in order to gain access to Maori cloak and kete samples in their collections. Currently, sampling has been restricted to feather cloaks,

although relationships established with museums will allow further sampling in the future from dog skin (kuri) cloaks and flax rain capes. Textile conservator and project collaborator, Rangi Te Kanawa has been instrumental in liaising with museums.

A number of activities were undertaken during the period to improve links between Māori communities and researchers in molecular ecology. These included:

- Developed an interest page for Māori and Pacific Island communities on the AWC website.
- Published an article in Mana Magazine on the Tuatara Traditional Ecological Knowledge Project, highlighting the role of AWC scientists in the project.
- Contributed a piece to *Te Pūtara*, ERMA's newsletter, about the AWC and inviting iwi to collaborate with us in research.
- Organized a session for the AWC 2007 Annual Meeting entitled "*Building collaborative relationships with Māori and Pacific Island communities".*

- Worked with Te Ropu Awhina Putaiao (Victoria University) to design a course in *Whakapapa and DNA Research* for Te Wānanga Pūtaiao (science school) with Ngāti Kahungunu, Pukemokimoki Marae, Maraenui.
- Secured plans for a joint hui between ERMA and the AWC on "*Cultural Perspectives and Cutting Edge Technologies in Molecular Research*".
- Secured plans with Ngā Pae o te Maramatanga for a jointly sponsored pre-doctoral research internship program for Māori and indigenous students - contingent upon adequate additional CORE funding in 2008.
- Advising and mentoring iwi in development of tuatara conservation education programmes:
    - Ngati Koata, Nelson. N. Nelson member of Spinyback Tuatara Education and Conservation Charitable Trust Board
    - Te Atiawa, Seahorse World Aquarium, Picton

Tamariki doing a DNA extraction with Dr. Kristina Ramstad as part of the course in Whakapapa and DNA Research for Te Wānanga Pūtaiao (science school) with Ngāti Kahungunu, Pukemokimoki Marae and Te Ropu Awhina Putaiao (Victoria University).

PUBLICATIONS

Total number of publications for the 2007: 90

Bordewich, M., Linz, S., St. John, K., and Semple, C. 2007. A reduction algorithm for computing the hybridization number of two trees. Evolutionary Bioinformatics 3, 86-98.

Bruneau, A., J. R. Starr, and S. Joly. 2007. Phylogenetic relationships in the genus *Rosa*: New evidence from chloroplast DNA sequences and an appraisal of current knowledge. Systematic Botany 32:366-378.

Chan, Z., L. Collins and N. Kasabov, (2007) Bayesian Inference of Sparse Gene Network. Biosystems. 87 (2-3): 299-306.

Chen XS, Rozhdestvensky TS, Collins LJ, Schmitz J, and Penny D. 2007. Combined experimental and computational approach to identify non-protein-coding RNAs in the deep-branching eukaryote *Giardia intestinalis*. Nucl. Acids Res. 35:4619-4628.

Chor B, Hendy MD, and Penny D. 2007. Analytic solutions for three taxon ML trees with variable rates across sites. Discrete Applied Mathematics 155:750-758.

Collins, L. J., and P. J. Lockhart. 2007. Evolutionary properties of sequences and ancestral state reconstruction. in D. A. Liberles, ed. Ancestral Sequence Reconstruction. Oxford University Press.

Convey P, Gibson JAE, Hodgson DA, Pugh PJA, Stevens MI (2007) New terrestrial biological constraints for the reconstruction of Antarctic glaciation – Online Proceedings of the 10th ISAES (http://pubs.usgs.gov/of/2007/1047/), edited by A.K. Cooper and C.R. Raymond et al., USGS Open-File Report 2007-1047, Extended Abstract 053, 1-4.

Convey P, Stevens MI (2007) Antarctic Biodiversity. *Science* 317(5846): 1877-1878 [ISI 30.03]

Donald, K., A. Sijnja, and H. Spencer. 2007. Species assignation amongst morphologically cryptic larval *Digenea* isolated from New Zealand topshells (Gastropoda: Trochidae). Parasitology Research 101:433-441.

Dress, A., and M. Steel. 2007. Phylogenetic diversity over an abelian group. Annals of Combinatorics 11:143-160.

Egel R, and Penny D. 2007. On the Origin of Meiosis in Eukaryotic Evolution: Coevolution of Meiosis and Mitosis from Feeble Beginnings. in Egel, R, and Lankenau, D-H, eds. Recombination and Meiosis. Springer, Berlin.

Gartrell, B.D., Youl, J.M., King, C.M., Bolotovski, I., McDonald, W.L., and Nelson, N.J. 2007. Failure to detect *Salmonella* species in a population of wild tuatara (*Sphenodon punctatus*). *New Zealand Veterinary Journal 55(3):* 134-136.

Gascuel, O., and M. Steel. 2007. Reconstructing Evolution. New Mathematical and Computational Advances. Pp. 318. Oxford University Press, Oxford.

Gibb GC, Kardailsky O, Kimball RT, Braun EL, and Penny D. 2007. Mitochondrial genomes and avian phylogeny: Complex characters and resolvability without explosive radiations. Molecular Biology and Evolution 24:269-280.

Goode MG, and Rodrigo AG. 2007. SQUINT: a multiple alignment program and editor. Bioinformatics 23:1553-1555.

Greaves SNJ, Chapple DG, Gleeson DM, Daugherty CH, and Ritchie PA. 2007. Phylogeography of the spotted skink (*Oligosoma lineoocellatum*) and green skink (*O. chloronoton*) species complex (Lacertilia: Scincidae) in New Zealand reveals pre-Pleistocene divergence. Molecular Phylogenetics and Evolution 45:729-739.

Greenslade P, Stevens MI, Edwards R (2007) Invasion of two exotic terrestrial flatworms to subantarctic Macquarie Island. *Polar Biology* 30: 961-967 [ISI 1.50]

Grunewald, S., M. Steel, and M. S. Swenson. 2007. Closure operations in phylogenetics. Mathematical Biosciences 208:521-537.

Hare, K.M. 2007. Physiology does not always reflect ecology: a plea for natural

history data. *New Zealand Journal of Zoology 34:* 264 (abstract).

Hare, K.M., Hoare, J.M. and Hitchmough, R.A. 2007. Investigating natural population dynamics of *Naultinus manukanus* to inform conservation management of New Zealand's cryptic diurnal geckos. *Journal of Herpetology 41(1):* 81-93.

Hare KM, Pledger S, Thompson MB, Miller JH, and Daugherty CH. 2007. Low cost of locomotion in lizards that are active at low temperatures. Physiological and Biochemical Zoology 80:46-58.

Hartmann, K., and M. Steel. 2007. Phylogenetic diversity: From combinatorics to ecology. Pp. 171-196 in O. Gascuel, and M. A. Steel, eds. Reconstructing Evolution. New Mathematical and Computational Advances. Oxford University Press, Oxford.

Hayward J, Taylor J, and Rodrigo A. 2007. Phylogenetic Analysis of Feline Immunodeficiency Virus in Domestic Feral and Companion Cats of New Zealand. Journal of Virology 81:2999-3004.

Hoare, J.M., Adams, L.K., Bull, L.S., and Towns, D.R. 2007. Attempting to manage complex predator-prey interactions fails to avert imminent extinction of a threatened New Zealand skink population. *The Journal of Wildlife Management 71(5):* 1576-1584.

Hoare, J.M., Pledger, S. and Nelson, N.J. 2007. *Featured Article for June 2007.* Chemical discrimination of food, conspecifics and predators by apparently visually-oriented diurnal geckos, *Naultinus manukanus*. *Herpetologica 63(2):* 184-192.

Hoare JM, Shirley P, Nelson NJ, and Daugherty CH. 2007. Avoiding aliens: Behavioural plasticity in habitat use enables large, nocturnal geckos to survive Pacific rat invasions. Biological Conservation 136:510-519.

Holland, B., G. Conner, K. Huber, and V. Moulton. 2007. Imputing Supertrees and Supernetworks from Quartets. Systematic Biology 56:57-67.

Holland, B.R., C.L. Schardl and J. Schmid. 2007. Endophyte survival without sex. In: The proceedings of the 6th International Endophyte Symposium. Eds A.J. Popay and E.R. Thom. 151-154.

Horrocks, M., J. Grant-Mackie, E. Matisoo-Smith. Introduced taro (*Colocasia esculenta*) and yams (*Dioscorea* spp.) in Podtanean (2700-1800 yr BP) deposits from Mé Auré Cave (WMD007), Moindou, New Caledonia. *Journal of Archaeological Science (2007)* doi:10.1016/j.jas.2007.03.001.

Hughes, J., M. Kennedy, K.P. Johnson, R.L. Palma and R.D.M. Page. 2007. Multiple cophylogenetic analyses reveal frequent cospeciation between pelecaniform birds and *Pectinopygus* lice. *Systematic Biology* 56: 232-251.

Irimia M, Maeso I, Penny D, Garcia-Fernandez J, and Roy SW. 2007. Rare coding sequence changes are consistent with ecdysozoa, not coelomata. Molecular Biology and Evolution 24:1604-1607.

Irimia M, Penny D, and Roy SW. 2007. Coevolution of genomic intron number and splice sites. Trends in Genetics 23:321-325.

Irimia M, Rukov JL, Penny D, and Roy SW. 2007. Functional and evolutionary analysis of alternatively spliced genes is consistent with an early eukaryotic origin of alternative splicing. BMC Evolutionary Biology 7:188.

Joly, S., and A. Bruneau. 2007. Delimiting species boundaries in *Rosa* sect. *Cinnamomeae* (Rosaceae) in eastern North America. Systematic Biology 32:819-836.

Joly, S., M. I. Stevens, and B. J. van Vuuren. 2007. Haplotype networks can be misleading in the presence of missing data. Systematic Biology 56:857-862.

Knapp, M., R. Mudaliar, D. Havell, S. J. Wagstaff, and P. Lockhart. 2007. The Drowning of New Zealand and the problem of *Agathis*. Syst. Biol. 56: 862 - 870.

Kneip, C., P. Lockhart, C. Voss, and U. G. Maier. 2007. Nitrogen fixation in eukaryotes - New models for symbiosis. BMC Evolutionary Biology 7: 55.

Jansen van Vuuren B, Mortimer E, Stevens MI, Marshall DJ, Convey P, Daniels SR, Chown SL (2007) Molecular data can help to unveil biogeographic complexities since the Miocene: lessons from ameronothroid mites and isotomid springtails – Online Proceedings of the 10th ISAES (http://pubs.usgs.gov/of/2007/1047/), edited by A.K. Cooper and C.R. Raymond et al.,

USGS Open-File Report 2007-1047, Extended Abstract 008, 1-4.

Larkum, A., P. Lockhart, and C. Howe. 2007. The origin of plastids: A shopping bag model. Photosynthesis Research 91:272-272.

Larson, G., T. Cucchi, M. Fujita, E. Matisoo-Smith, J. Robins, A. Anderson, B. Rolett, M. Spriggs, G. Dolman, T. H. Kim, N. T. D. Thuy, E. Randi, M. Doherty, R. A. Due, R. Bollt, T. Djubiantono, B. Griffin, M. Intoh, E. Keane, P. Kirch, K. T. Li, M. Morwood, L. M. Pedrina, P. J. Piper, R. J. Rabett, P. Shooter, G. Van den Bergh, E. West, S. Wickler, J. Yuan, A. Cooper, and K. Dobney. 2007. Phylogeny and ancient DNA of *Sus* provides insights into neolithic expansion in island southeast Asia and Oceania. Proceedings of the National Academy of Sciences of the United States of America 104:4834-4839.

Lehnebach, C. A., A. Cano, C. Monsalve, P. McLenachan, E. Horandl, and PJ. Lockhart. 2007. Phylogenetic relationships of the monotypic Peruvian genus *Laccopetalum* (Ranunculaceae). Plant Systematics and Evolution 264:109-116.

Liggins, L., Chapple, D.G., Ritchie, P.A. and Daugherty, C.H. 2007. Phylogeography of the New Zealand common skink, *Oligosoma nigriplantare polychroma*. *New Zealand Journal of Zoology 34:* 267 (abstract).

Lim SG, Cheng Y, Guindon S et al. 2007. Viral Quasi-Species Evolution During Hepatitis Be Antigen Seroconversion. Gastroenterology 133:951-958.

Longson CG, Hare KM, and Daugherty CH. 2007. Fluctuating asymmetry does not reflect environmental stress during incubation in an oviparous lizard. New Zealand Journal of Zoology 34:91-96.

MacAvoy ES, McGibbon LM, Sainsbury JP, Lawrence H, Wilson CA, Daugherty CH, and Chambers GK. 2007. Genetic variation in island populations of tuatara (*Sphenodon spp*) inferred from microsatellite markers. Conservation Genetics 8:305-318.

Martin, W., M. Roettger, and P. J. Lockhart. 2007. A reality check for alignments and trees. Trends in Genetics 23:478-480.

Matisoo-Smith, E. 2007. Animal translocations, genetic variation and the human settlement of the Pacific. Chapter 10. Pp. 147-157 in J. S. Friedlaender, ed. Genes, Language and Culture History in the Southwest Pacific. Oxford University Press, Oxford.

Matisoo-Smith, E. 2007. Lapita: A genetic perspective. Pp. 233-258 in S. Chiu, and C. Sand, eds. From Southeast Asia to the Pacific: Archaeological perspectives on the Austronesian expansion and the Lapita Cultural Complex. Academia Sinica.

Matisoo-Smith, E. 2007. The Peopling of Oceania. Chapter 14. Pp. 147-157 in M. H. Crawford, ed. Anthropological Genetics: Theory, Methods and Applications. Cambridge University Press, Cambridge.

Matisoo-Smith, E., K. Roberts, N. Welikala, G. Tannock, P. Chester, D. Feek and J. Flenley. Recovery of DNA and pollen from New Zealand lake sediments, *Quaternary International*. Dpo:10.1016/j.quaint.2007.09.013.

Matsen, F. A., and M. Steel. 2007. Phylogenetic mixtures on a single tree can mimic a tree of another topology. Systematic Biology 56:767-755.

McDowall RM, Stevens MI (2007) Taxonomic status of the Tarndale bully *Gobiomorphus alpinus* (Teleostei: Eleotridae), revisited – again. *Journal of the Royal Society of New Zealand* 37: 15-29 [ISI 1.0]

Meudt, H. M., and Clarke, A. C. 2007. Almost Forgotten or Latest Practice? AFLP applications, analyses and advances. *Trends in Plant Science* **12:** 106–117.

Miller, H.C., Andrews-Cookson, M.A., and Daugherty, C.H. 2007. Two patterns of variation among MHC class I loci in tuatara (*Sphenodon punctatus*). *Journal of Heredity 98:* 666-677.

Miller, H.C. and Daugherty, C.H. 2007. A tale of two islands: MHC variation in tuatara (*Sphenodon*). *New Zealand Journal of Zoology 34:* 267-268 (abstract).

Miller HC, Conrad AM, Barker SC, and Daugherty CH. 2007. Distribution and phylogenetic analyses of an endangered tick, *Amblyomma sphenodonti*. New Zealand Journal of Zoology 34:97-105.

Miller, K.A. and Nelson, N.J. 2007. Genetic differentiation between disjunct populations and implications for the conservation of Whitaker's skink (*Cyclodina whitakeri*). *New Zealand Journal of Zoology 34:* 268 (abstract).

Miller, K.A., Shao, M., and Martin-DeLeon, P.A. 2007. *Hyalp1* in Murine Sperm function: Evidence for unique and overlapping functions with other Reproductive Hyaluronidases. *Journal of Andrology 2007 28:* 67-76.

Moore JA, Hoare JM, Daugherty CH, and Nelson NJ. 2007. Waiting reveals waning weight: Monitoring over 54 years shows a decline in body condition of a long-lived reptile (tuatara, *Sphenodon punctatus*). Biological Conservation 135:181-188.

Morley, C. G., P. McLenachan, and P.J. Lockhart. 2007. Evidence for the presence of a second species of mongoose in the Fiji Islands. Pacific Conserv. Biol. 13:29-34.

Moulton, V., C. Semple, and M. Steel. 2007. Optimizing phylogenetic diversity under constraints. Journal of Theoretical Biology 246:186-194.

Nakano, T., and H. Spencer. 2007. Simultaneous polyphenism and cryptic species in an intertidal limpet from New Zealand. Molecular Phylogenetics and Evolution 45:470-479.

Penny D, and Phillips MJ. 2007. Evolutionary biology - Mass survivals. Nature 446:501-502.

Penny, D., B. Holland, and M. Hendy. 2007. Phylogenetics: Parsimony, Networks and Distance Methods. Pp. 489-532 in D. Balding, M. Bishop, and C. Cannings, eds. Handbook of Statistical Genetics, 3rd Ed. Wiley InterScience, Chichester, UK.

Pledger, S., Geange, S., Hoare, J.M., and Perez Matus, A. 2007. *Resource Selection : Tests and estimation using null models* (Wellington, Victoria University of Wellington), 22pp.

Poole A, and Penny D. 2007. Engulfed by speculation. Nature 447:913-913.

Poole AM, and Penny D. 2007. Evaluating hypotheses for the origin of eukaryotes. Bioessays 29:74-84.

Poss M, Idoine A, Ross HA, Terwee JA, VandeWoude S, and Rodrigo A. 2007. Recombination in feline lentiviral genomes during experimental cross-species infection. Virology 359:146-151.

Ramstad, K.M., Nelson, N.J., Paine, G., Beech, D., Paul, A., Paul, P., Allendorf, F.W. and Daugherty, C.H. 2007. Māori traditional ecological knowledge complements science in conservation of tuatara (*Sphenodon*). *New Zealand Journal of Zoology 34:* 269-270 (abstract).

Ramstad, K.M., Woody, C.A., Habicht, C., Sage, G.K., Seeb, J.E. and Allendorf, F.W. 2007. Concordance of nuclear and mitochondrial DNA markers in detecting a founder event in Lake Clark sockeye salmon. Pages 31-50 *in* C.A. Woody, editor. Sockeye salmon ecology, evolution, and management. American Fisheries Society, Symposium 54, Bethesda, Maryland.

Ramstad KM, Nelson NJ, Paine G, Beech D, Paul A, Paul P, Allendorf FW, and Daugherty CH. 2007. Species and cultural conservation in New Zealand: Maori traditional ecological knowledge of Tuatara. Conservation Biology 21:455-464.

Refsnider, J.M., Nelson, N.J. and Keall, S.N. 2007. Manipulative females: intra-sexual interactions in nest site choice, nest guarding, and nest defence in tuatara. *New Zealand Journal of Zoology 34:* 270-271 (abstract).

Robins, J. H., M. Hingston, E. Matisoo-Smith, and H. A. Ross. 2007. Identifying *Rattus* species using mitochondrial DNA. Molecular Ecology Notes 7:717-729.

Rodrigo AG, Ewing G, and Drummond A. 2007. The evolutionary analysis of Measurably Evolving Populations using serially sampled gene sequences. Pp. 30-62 in Gascuel, O, and Steel, MA, eds. Reconstructing Evolution. New Mathematical and Computational Advances. Oxford University Press, Oxford.

Roy SW, and Penny D. 2007. A very high fraction of unique intron positions in the intron-rich diatom *Thalassiosira pseudonana* indicates widespread intron gain. Molecular Biology and Evolution 24:1447-1457.

Roy SW, and Penny D. 2007. Intron length distributions and gene prediction. Nucl. Acids Res. 35:4737-4742.

Roy SW, and Penny D. 2007. On the incidence of intron loss and gain in paralogous gene families. Molecular Biology and Evolution 24:1579-1581.

Roy SW, and Penny D. 2007. Patterns of intron loss and gain in plants: Intron loss-dominated evolution and genome-wide comparison of *O. sativa* and *A. thaliana*. Molecular Biology and Evolution 24:171-181.

Roy SW, and Penny D. 2007. Widespread Intron Loss Suggests Retrotransposon Activity in Ancient Apicomplexans. Mol Biol Evol 24:1926-1933.

Roy SW, Penny D, and Neafsey DE. 2007. Evolutionary conservation of UTR intron boundaries in Cryptococcus. Molecular Biology and Evolution 24:1140-1148.

Shavit, L., D. Penny, M. D. Hendy, and B. R. Holland. 2007. The Problem of Rooting Rapid Radiations. Molecular Biology and Evolution 24:2400-2411.

Shepherd LD, and Lambert DM. 2007. The relationships and origins of the New Zealand wattlebirds (Passeriformes, Callaeatidae) from DNA sequence analyses. Molecular Phylogenetics and Evolution 43:480-492.

Slack KE, Delsuc F, McLenachan PA, Arnason U, and Penny D. 2007. Resolving the root of the avian mitogenomic tree by breaking up long branches. Molecular Phylogenetics and Evolution 42:1-13.

Spencer, H., J. M. Waters, and T. E. Eichhorst. 2007. Taxonomy and nomenclature of black nerites (Gastropoda : Neritimorpha : *Nerita*) from the South Pacific. Invertebrate Systematics 21:229-237.

Star, B., R. J. Stoffels, and H. G. Spencer. 2007. Evolution of Fitnesses and Allele Frequencies in a Population with Spatially Heterogeneous Selection Pressures. Genetics 177:1743-1751.

Star, B., R. J. Stoffels, and H. G. Spencer. 2007. Single-Locus Polymorphism in a Heterogeneous Two-Deme Model. Genetics 176:1625-1633.

Steel, M. 2007. Tools to construct and study big trees: A mathematical perspective. Chapter 7. Pp. 97-112 in T Hodkinson, J. Parnell, and S. Waldren, eds. Reconstructing the Tree of Life: Taxonomy and Systematics of Species Rich Taxa. CRC Press, Taylor and Francis Group, Boca Raton, Florida.

Steel, M., A. Mimoto, and A. Mooers. 2007. Hedging Our Bets: The Expected Contribution of Species to Future Phylogenetic Diversity. Evolutionary Bioinformatics 3:237-244.

Steel, M., and F. A. Matsen. 2007. The Bayesian "star paradox" persists for long finite sequences. Molecular Biology and Evolution 24:1075-1079.

Steel, M., and L. A. Szekely. 2007. Teasing apart two trees. Combinatorics, Probability and Computing. 16, 903--922

Stevens MI, Hogendoorn K, Schwarz MP (2007) Evolution of sociality by natural selection on variances in reproductive fitness: evidence from a social bee. *BMC Evolutionary Biology* 7: 153 [ISI 4.46]

Stevens MI, McCartney J, Stringer IAN (2007) New Zealand's forgotten biodiversity: new techniques reveal new records for 'giant' springtails. *New Zealand Entomologist* 30: 79-84.

Stevens MI, Winter D, Morris R, McCartney J, Greenslade P (2007) New Zealand's giant Collembola: new information on distribution and morphology for *Holacanthella* Börner, 1906 (Neanuridae: Uchidanurinae). *New Zealand Journal of Zoology* 34: 63-78 [ISI 0.59]

Stevens MI, Frati F, McGaughran A, Spinsanti G, Hogg ID (2007) Phylogeographic structure suggests multiple glacial refugia in northern Victoria Land for the endemic Antarctic springtail *Desoria klovstadi*, (Collembola, Isotomidae). *Zoologica Scripta* 36: 201-212 [ISI 2.34]

Stevens MI, Hunger SA, Hills SFK, Gemmill CEC (2007) Phantom hitch-hikers mislead estimates of genetic variation in Antarctic mosses. *Plant Systematics and Evolution* 263: 191-201 [ISI 1.239]

Storey, A. A., J. M. Ramirez, D. Quiroz, D. V. Burley, D. J. Addison, R. Walter, A. J. Anderson, T. L. Hunt, J. S. Athens, L.

Huynen, and E. A. Matisoo-Smith. 2007. Radiocarbon and DNA evidence for a pre-Columbian introduction of Polynesian chickens to Chile. Proceedings of the National Academy of Sciences 104:10335-10339.

Thatte, B. D. 2007. A correct proof of the McMorris-Powers' theorem on the consensus of phylogenies. Discrete Applied Mathematics 155:423-427.

Trewick, S. 2007. Stick insects. Te Ara - the Encyclopedia of New Zealand. http://www.TeAra.govt.nz/TheBush/InsectsAndOtherInvertebrates/StickInsects/en.

Trewick, S. A. 2007. DNA Barcoding is not enough: mismatch of taxonomy and genealogy in New Zealand grasshoppers (Orthoptera: Acrididae). Cladistics 23:1-15.

Trewick, S. A., A. M. Paterson, and H. J. Campbell. 2007. Hello New Zealand. Journal of Biogeography 34:1-6.

Trotter, M. V., and H. G. Spencer. 2007. Frequency-Dependent Selection and the Maintenance of Genetic Variation: Exploring the Parameter Space of the Multiallelic Pairwise Interaction Model. Genetics 176:1729-1740.

van den Heuvel, M. R., Michel, C., Stevens, M. I., Clarke, A. C., Stölting, K. N., Hicks, B. J., and Tremblay, L. A. 2007. Monitoring the effects of pulp and paper effluent is restricted in genetically distinct populations of common bully (*Gobiomorphus cotidianus*). *Environmental Science & Technology* **41:** 2602–2608.

Votier, S.C., M. Kennedy, S. Bearhop, R.G. Newell, K. Griffiths, H. Whitaker, M.S. Ritz and R.W. Furness. 2007. DNA from southern hemisphere skua species fails to discriminate between birds occurring in Europe. *Ibis* 149: 619-621.

White W, Hills S, Gaddam R, Holland B, and Penny D. 2007. Treeness Triangles: Visualizing the Loss of Phylogenetic Signal. Mol Biol Evol 24:2029-2039.

Whitfield, J. B., and P. J. Lockhart. 2007. Deciphering ancient rapid radiations. Trends in Ecology & Evolution 22:258-265.

Woodhams M, Stadler P, Penny D, and Collins L. 2007. RNase MRP and the RNA processing cascade in the eukaryotic ancestor. BMC Evolutionary Biology 7:S13.

Zhang, S.G., Schwelin A, Jin HP, Collins LJ, and Bradshaw RE: (2007) A fragmented aflatoxin-like gene cluster in the forest pathogen Dothistroma septosporum. Fungal Genetics and Biology 44(12):1342-1354.

PRESENTATIONS

Total number of presentations for the period: 129

Adams, S., Clarke, A. and Ramstad, K.M. Managing indigenous research collaborations: the influence of the Treaty of Waitangi when undertaking research in New Zealand. (Poster) Australasian Research Management Society, 19-21 September 2007, Adelaide, Australia.

Bean Picon, G.A. and Lambert, D.M. Is mitochondrial DNA diversity an indicator of population size in Adélie penguins? Contributed presentation to Evolution 2007, Christchurch, New Zealand, 16-20 June, 2007.

Biggs, P. and Collins, L. Next Generation Sequencing at the Allan Wilson Centre. 3rd MapNet in Hamilton, New Zealand. 8 November.

Carter, R.J. Range expansion and polyploidisation in New Zealand alpine Ranunculus. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Chapple, D.G., Daugherty, C.D. and Ritchie, P.A. Comparative phylogeography of the New Zealand skink fauna: a synthesis. Evolution 2007, Christchurch, New Zealand. 16-20 June

Chapple, D.G., Daugherty, C.H. and Ritchie, P.A. Origin and evolution of the New Zealand skink fauna. 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Clarke, A.C., Green R.C., Holland, B.R., McLenachan, P.A. and Penny, D. Prehistoric human contact between Polynesia and South America? DNA analysis of the sweet potato and the bottle gourd. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Clarke, A. C. 2007. Using DNA to track the dispersal of kūmara in the Pacific. Presented at the Kumara and Kawa Hui. 24–26 May 2007, Pokai Marae, Tikapa, Ruatoria, New Zealand.

Collins, L.J. and Penny, D. The RNA infrastructure of the eukaryotic cell. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Collins, L. and Biggs, P. Bioinformatics for Next Generation Sequencing: Reality Bites but we can bite back. Australian Bioinformatics Conference - Brisbane, Australia. June.

Cook, L., Trewick, S. and Morgan-Richards M. 'Gene Flow in Two Species of Cave Weta in the Waikato Karst System. Molecular Ecology Meeting, December 2007

Daugherty, C.H. Conservation heroes. Parasites, Conservation and Evolutionary Ecology Symposium, 21-22 June 2007, Flinders University, Adelaide, Australia.

Daugherty, C.H. and Ramstad, K.M. Māori and Western world views shape a strong environmental ethic in Aotearoa/New Zealand. Invited symposium speaker, 29th General Assembly of the International Union of Biological Sciences, 12 May 2007, Washington DC, USA.

Dodd, A., Millar, C.D., Woodhams, M.D., Hendy, M.D. amd Lambert, D.M. Heteroplasmy and mutation rates: technical and theoretical considerations. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Donald, K.M., Kennedy, M. and Spencer, H. Explaining the biogeography of South pacific topshells. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Fischer, M. and Steel, M. Expected anomalies in the fossil record. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Fraser, C., Spencer, H.G. and Waters, J.M. Phylogeography of bull kelp (Durvillaea) and associated invertebrate fauna around the Southern Ocean: are kelp rafts effective vectors of marine dispersal? . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Gibb, G.C., Goldberg, J., Trewick, S. and Penny, D. Pigeon evolution: integrating barcoding to the tree of life. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Gleeson, D.M., Birkett, A., Berry, O. and Chapple, D.G. Population genetic structure of Oligosoma otagense (Otago skink) with comparisons to O. grande (grand skink) populations and the long-term genetic management of both species. 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Godfrey, S.S., Moore, J.A., Bull, C.M. and Nelson, N.J. Parasite dynamics of tuatara. Parasites, Conservation, and Evolutionary Ecology; Connecting some disparate threads, 21-22 June 2007, Flinders University, Adelaide, Australia.

Godfrey, S.S., Moore, J.A., Bull, C.M. and Nelson, N.J. Social connectivity and parasite dynamics in tuatara (Sphenodon punctatus). Wildlife Disease Association International Conference, 12-17 August 2007, Estes Park, Colorado, USA.

Godfrey, S.S., Bull, M., James, D. and Murray, K. Social network structure and parasite transmission in a group living lizard, the gidgee skink, Egernia stokesii. Australian Society of Herpetologists Conference, 4-7 December 2007, Albany, Western Australia.

Goldberg, J. and Trewick, S. Talitropsis and relative dimensions in space: phylogeography of a New Zealand cave cricket (Orthoptera: Raphidophoridae). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Goldberg, J. The Chatham Islands: ancient rocks - new biota. 5th Southern Connection Congress, Adelaide, Australia, January 2007

Goldberg, J. The Chatham Islands: ancient rocks - new biota. 3rd Biennial Conference of the International Biogeography Society, Tenerife, Canary Islands, January 2007

Greaves, S.N.J., Chapple, D.G., Gleeson, D.M., Daugherty, C.H. and Ritchie, P.A. Pleistocene glacial cycles result in contrasting, superimposed phylogeographic patterns in the New Zealand speckled skink, Oligosoma infrapunctatum. Evolution 2007, 16-20 June 2007, Christchurch.

Hartnup, K., Sheperd, L., Huynen, L. and Lambert, D. Kakahu: unraveling the history of Maori cloaks using ancient DNA. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Hartmann, K. and Steel, M. Phylogenetics and biodiversity conservation. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Hayward, J., Taylor, J. and Rodgrigo, A.G. Molecular epidemiology of feline immunodeficiency in domestic cats (Felis catus) of New Zealand. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Hendy, M.D. and Woodhams, M.D. Modelling mitochondrial heteroplasmy. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Hills, S.F.K. Fossils, morphology and genetics: evolution in a group of marine molluscs. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Hingston, M., Robins, J.H., Matisoo-Smith, E. and Ross, H. Inferring Lapita colonization of the Pacific by phylogenetic analysis of commensal rats (Rattus exulans). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Holland, B.R. Inferring hybridisation from gene trees in the presence of phylogenetic error. Dumont D'Urville Workshop on Applied Evolutionary Bioinformatics, Kaikoura. (June, 2007)

Holland, B.R. Improving phylogenetic resolution in AFLP fingerprinting studies Evolution, Joint annual meeting of the SSE, SSB and the ASN, Christchurch.. (June, 2007)

Holland, B.R. Detecting hybridisation in collections of gene trees Annual NZ Phylogenetics Meeting, Whakapapa..(February, 2007)

Holland, B.R. Appropriate models for heterogeneous multi-gene data sets Isaac Newton Institute Phylogenetics Programme. Workshop on Current Challenges in Phylogenetics.. (September 2007)

Holland, B.R., Clarke, A.C. and Meudt, H.M. Improving phylogenetic resolution in AFLP fingerprinting studies by tuning automated scoring parameters. . Evolution 2007, Christchurch, New Zealand. 16-20 June

Joly, S. and Lockhart, P.J. Distinguishing hybrisiation and lineage sorting. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Kennedy, M. Morphological convergence in two groups of cormorants. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Knapp. M., Stockler, K., Mardulyn, P., Havell, D., McGlone, M.S. and Lockhart, P.J Riddle of the New Zealand beech gaps. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Lambert, D.M. and Millar, C.D. Recovering historic (hDNA) and ancient DNA (aDNA): Implications for DNA barcoding. Plenary Presentation at the Second International Barcode of Life Conference, Taipei, Taiwan 18-20' September 2007.

Lambert, D.M. Sameness and difference in a digital age: Ancient DNA from Antarctic penguins and extinct New Zealand birds. Plenary Presentation, Symposium Nature, Named and Ordered, Dunedin, New Zealand, 30 August, 2007.

Lambert, D.M. Molecular approaches to extinct species, populations and genomes – from the 'Southern End of the World'. Biodiversity Extinction Crisis Conference - A Pacific Response, Society for Conservation Biology, Sydney, Australia 10-12 July, 2007.

Lawrence, H., Taylor, G.A., Millar, C.D. and Lambert, D.M. Conservation genetics of the world's rarest seabird. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Lehnebach, C.A., Joly, S., Havell, D., Garnock-Jones, P. and Lockhart, P.J. Species delimitation in New Zealand plant species radiation. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Liggins, L., Chapple, D.G., Daugherty, C.D. and Ritchie, P.AS. Microevolution of the common skink species complex (Oligosoma nigriplantare) in relation to the New Zealand landscape. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Lockhart, P.J. On the nature of heterotachy. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Liggins, L., Chapple, D.G., Ritchie, P.A. and Daugherty, C.H. Phylogeography of the New Zealand common skink, Oligosoma nigriplantare polychroma. 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Liggins, L. Phylogeography of the New Zealand common skink (Oligosoma nigriplantare polychroma) reveals substantial genetic structuring and a pattern of restricted geneflow coincident with the Alpine Fault. The Miss E. L. Hellaby Indigenous Grasslands Research Trust's 12th triennial seminar, 8-10 December, 2007, Dunedin (invited seminar).

Lockhart, ,P.J. On the nature of heterotachy. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Lockhart, P.J. Reconstructing the evolutionary history of species radiations. European Society for Evolutionary Biology (Uppsala), 24th August.

Lockhart, P.J. From Linnaean hierarchies, to trees and microevolutionary processes. Symposium: Nature named & ordered - Linnaeus 300 years on. Otago Museum (Dunedin); 30th August

Lockhart, P.J. Phylogenetic models and the origins of chloroplasts. Spitalfields Day on Phylogenetics, Newton Institute for Mathematical Sciences, Cambridge. 6th December

Lockhart, P.J. Heterotachy and its impact in phylogenetic inference. Role of models in Phylogenetics, Newton Institute for Mathematical Sciences, Cambridge. 17 December.

Matisoo-Smith, E.A., Robins, J., Storey, A., and Hingston, M. Maui's Ark – commensal models for the human settlement of the Pacific. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Matisoo-Smith, E.A. The Settlement of the Pacific and the Origins of Lapita: A Biological Perspective. School of Environmental Science and Geography, University of Papua New Guinea. April.

Matisoo-Smith, E.A. 'mtDNA evidence for the spread of Pacific rats through Oceania?', Rats, Humans, & Their Impacts on Islands: Integrating Historical and Contemporary Ecology, University of Hawaii, Manoa, Honolulu, HI, 26-30 March, 2007

Matisoo-Smith, E.A. 'The commensal model for human settlement of the Pacific 10 years on - What can we say and where to now?', Annual Meeting of the Society of American Archaeology Conference, Island Zooarchaeology session, Austin, Texas, April 25-29, 2007

Robins, J.H., Storey, A.A., Hingston, M. 'Maui,s Ark: Commensal models for the human settlement of the Pacific', Evolution Meeting, Christchurch, NZ, June 16-20, 2007

Matisoo-Smith, E.A., Robins, J.H., Storey, A.A., Hingston, M. 'Pigs and dogs and rats and chickens? Origin, distributiona nd definition of the Lapita larder.', Lapita - Antecedents and Successors, Honiara, Solomon Islands, 4-7 July, 2007

Matisoo-Smith, E.A., Robins, J.H., Hingston, M. 'An Update on the Teouma Burials', Lapita - Antecedents and Successors, Honiara, Solomon Islands, 4-7 July, 2007

Matisoo-Smith, E.A., Robins, J.H., Storey, A.A., Hingston, M. 'What can DNA (ancient and modern) tell us about Lapita and post-Lapita origins and interactions?', VII International Rapanui Conference, Gotland, Sweden, 20-25 August, 2007

Matisoo-Smith, E.A. 'Of Rats and Women: MtDNA variation in commensal animals - what can it tell us about Pacific prehistory?', Interdisciplinary studies on past societies of South Pacific: Assessments and prospects, Nanterre, Paris, France, 16-17 August, 2007

Matisoo-Smith, E.A. 'Tracking Ancient Pacific Colonizers and Their Animals Using Mitochondrial DNA', International Symposium "The Great Navigators in the Pacific" Celebrating the 30th Anniversary of the National Museum of Ethnology, Osaka, Japan, September 22-23, 2007

Matsen, F.A. and Steel, M.A. Glimpses into the strange world of phylogenetic mixtures. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

McGaughran A., Redding G.P.P., Stevens M.I., Convey P. (2007) Temporal variation in activity of Gomphiocephalus hodgsoni (Hexapoda: Collembola) at Cape Bird (Ross Island), Antarctica. Second International Symposium on the Environmental Physiology of Ectotherms and Plants; University of Otago, New Zealand, July 2007.

Meudt, H.M., Lockhart, P.J. and Garnock-Jones, P. Reconstructing species radiations in New Eland alpine flora. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Millar, C.D., Dodd, A., Anderson, J., Gibb, G.C., Ritchie, P.A., Baroni, C., Woodhams, M.D., Hendy, M.D. and Lambert, D.M. Was Kimura correct – are rates of neutral mutation and evolution equal? . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Miller, H.C. Evolution of MHC genes in tuatara (Sphenodon). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Miller, H.C. and Daugherty, C.H. A tale of two islands: MHC variation in tuatara (Sphenodon). 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Miller, H.C., Moore, J.A. and Daugherty, C.H. MHC diversity and mate choice in an archaic reptile. (Poster) 11th Congress of the European Society of Evolutionary Biology, 20-25 August 2007, Uppsala, Sweden.

Miller, K.A. and Nelson, N.J. Genetic differentiation between disjunct populations: implications for the conservation of Whitaker's skink (Cyclodina whitakeri). 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Miller, K.A., Chapple, D.G., and Ritchie, P.A. Identifying ESUs from multiple genetic markers: a case study using Whitaker's skink. Evolution 2007, 16-20 June 2007, Christchurch.

Miller, K.A. and Nelson, N.J. Disjunct populations and genetic differentiation: implications for the wild and captive management of Whitaker's skink (Cyclodina whitakeri). Invited presentation to the New Zealand Department of

Conservation, Wellington Conservancy, 14 March 2007, Wellington.

Mitchell, N.J., Kearney, M.R., Nelson, N.J. and Porter, W.P. Are islands safe havens for tuatara under climate change? Australian Society of Herpetologists Conference, 4-7 December 2007, Camp Quaranup, Albany, Western Australia.

Mohandesan, E., Lambert, D. and Millar, C. Estimating the mutation rate in mitochondrial genome of Tuatara (Spehnedon punctatus). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Moore, J.A., Nelson, N.J. and Daugherty, C.D. Multiple paternity in an ancient reptile, the tuatara. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Moore, J.A., Nelson, N.J. and Daugherty, C.H. Multiple paternity in an ancient reptile, the tuatara. Parasites, Conservation and Evolutionary Ecology Symposium, 21-22 June 2007, Flinders University, Adelaide, Australia.

Morgan-Richards, M. and Trewick, S. New Zealand stick insects. . Evolution 2007, Christchurch, New Zealand. 16-20 June

Millar, C.D., Dodd, A., Anderson, J., Gibb, G.C, Ritchie, P.A. Baroni, C. Woodhams, M.D., Hendy, M.D. and Lambert, D.M. Was Kimura correct – are rates of neutral mutation and evolution equal? Contributed presentation to Evolution 2007, Christchurch, New Zealand 16-20th June, 2007

Nelson, N.J., Refsnider, J.M. and Keall, S.N. Nest guarding affects fitness of tuatara. Parasites, Conservation and Evolutionary Ecology Symposium, 21-22 June 2007, Flinders University, Adelaide, Australia.

Nelson N.J., Towns, D., Hartley, S., and Bell, J. Project work produced by students of the Masters of conservation biology degree (VUW & UNSW). Society of Conservation Biology Regional Conference. The Biodiversity Extinction Crisis: An Australian Project and Pacific Response, July 2007, Sydney, Australia.

Nelson, N.J. How are our tuatara translocations going after a decade? Karori Wildlife Sanctuary Member's Seminar Series, Victoria University of Wellington School of Education, 27 November 2007.

Osborne, T., Lockhart, P.J. and Winder, L. Population genetics, landscape genetics and phylogeography of the Fiji frogs (Genus: Platymantis). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Penny, D. All organisms carry their history in their genes. BioLive: Exploring Biological connections, Victoria University of Wellington, Wellington, New Zealand. 1-4 July.

Penny, D. Parsimony and likelihood under a range of models and datatypes. . Evolution 2007, Christchurch, New Zealand. 16-20 June..

Penny, D. and Collins, L. The RNA infrastructure of the ancestral eukaryote. American Genetics Association Symposium on Genome Evolution - Indiana USA.

Penny, D. and Collins, L. The RNA infrastructure of the Eukaryotic cell. International Society for Evolution Conference - Christchurch NZ. June.

Pierson, M.J., Fris, B., Penny, D. and Gemmell, N. Human mtDNA phylogenies and Pacific prehistory. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Piripi, M.M. Development of microsatellite markers in a rare New Zealand pant (Ranunculus crithmifolius var. paucifolius). . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Porter, G., Nelson, N.J., Moore, J.A. and McKenzie, K. Are tuatara mating on the mainland? Biolive, 1-4 July 2007, Victoria University of Wellington, Wellington.

Porter, G., Nelson, N.J., Moore, J.A. and McKenzie, K. Are tuatara mating on the mainland? The Biodiversity Extinction Crisis (Society for Conservation Biology, Australasia Section), 10-13 July 2007, University of New South Wales, Sydney, Australia.

Pratt, R. C., Morgan-Richards, M., Trewick, S. A. 2007. Witness to the sinking ark or victims of the Pacific flypaper? Phylogenetic relationships of Anostsotmatid crickets . Presented at the Evolution 2007 Conference. 16-20 June 2007, Christchurch, New Zealand.

Pratt, R. C., Morgan-Richards, M., Trewick, S. A. 2007. Gondwanan relics or

neighbours from across the ditch? Origins of New Zealand Anostostomatidae. Presented at the 5th International Southern Connections 2007 Conference. 21-25 January 2007, Adelaide, Australia.

Ramstad, K.M., Nelson, N.J., Paine, G., Beech, D., Paul, A., Paul, P., Allendorf, F.W. and Daugherty, C.H. Māori traditional ecological knowledge complements science in conservation of tuatara (Sphenodon). 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Ramstad, K.M., Woody, C.A. and Allendorf, F.W. Increased weapon size and reduced visual displays: evidence for a glacial ecotype of sockeye salmon. Evolution 2007, 16-20 June 2007, Christchurch.

Ramstad, K.M., Moore, J.A. and Refsnider, J.M. Fierce females: variation in intra-sexual aggression among tuatara. (Poster) Evolution 2007, 16-20 June 2007, Christchurch.

Ramstad, K.M., Woody, C.A. and Allendorf, F.W. Spawning color divergence reflects local adaptation among sockeye salmon. (Poster) 11th Congress of the European Society of Evolutionary Biology, 20-25 August 2007, Uppsala, Sweden.

Ramstad, K.M., Moore, J.A. and Refsnider, J.M. Fierce females: variation in intra-sexual aggression among tuatara. (Poster) 11th Congress of the European Society of Evolutionary Biology, 20-25 August 2007, Uppsala, Sweden

Ramstad, K.M. Population structure and local adaptation of Lake Clark sockeye salmon. Applied Conservation Genetics Workshop, Victoria University of Wellington, February 2007, Wellington, New Zealand.

Refsnider, J.M., Nelson, N.J. and Keall, S.N. Manipulative females: intra-sexual interactions in nest site choice, net guarding, and nest defence of tuatara. 12th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, 9-11 February 2007, Dunedin.

Robins, J.H., McLenachan, P.A., Craig, l., Matisoo-Smith, E. and Phillips. M.J. The evolution of mitochondrial genomes of 5 Rattus species. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Rodrigo, A.G. and Steel, M.A. Likelihood supertrees. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Rodrigo, A. Statistical phylogenetics. Lectures at the Bioinformatics Summer School, Australian National University.

Rodrigo, A. Big Trees. Isaac Newton Institute for the Mathematical Sciences, Cambridge, UK..

Rodrigo, A. Measurably Evolving Populations. University of Oxford.

Rodrigo, A. Quantifying changes in evolutionary parameters. Algorithms in Phylogeny Meeting, CRS, Montpellier, France.

Rodrigo, A. Measurably Evolving Populations. Imperial College, London. .

Schliep, K.P., Holland, B.R., Hendy, M. and Penny, D. Phylogenetic applications of mixture models and networks. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Shavit, L., Holland, B.R., Penny, D. and Hendy, M.D. Lineage specific evolution. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Spencer, H., and Kennedy, M. Discordant biogeographial patterns in New Zealand landsnails. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Spencer, H. Theoretical aspects of intergenerational influences. 5th International Congress on Developmental Origins of Health & Disease, Perth, Australia. November 2007.

Spencer, H. Effects of Genomic Imprinting on Quantitative Traits. 3rd International Conference on Quantitative Genetics, Zhejiang University, Hangzhou, China. August 2007.

Star, B. and Spencer, H.G. Recurrent mutation in a spatial single-locus selection model. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Steel, M. Stars, nets and the 'war on error': six mathematical challenges.Isaac Newton Institute, September 7th, 2007

Steel, M. Compatibility, misleading distances, and the Noah's Ark problem. Natural History Museum, London, October 4, 2007

Steel, M. Combinatorial and stochastic approaches in phylogenetics. Heriott Watt University, Edinburgh, October 24, 2007

Steel, M. Phylogenetics: Interactions between mathematics and evolution. Leeds University. School of mathematics and statistics seminar, October 2007

Steel, M. Combinatorial approaches in phylogenetics. Oxford University. Combinatorics group, November 27, 2007

Steel, M. Phylogenetic diversity and the Noah's Ark problem. Ecology Centre, Brisbane University, Australia, August 2007.

Steel, M. Phylogenetic diversity theory ad computational challenges. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Stevens, M.I. 'Canaries in the undergrowth' – using phylogenetic diversity of 'giant' springtails (Collembola: Uchidanurinae) of New Zealand and Australia as a surrogate for biodiversity indication. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Stoffels, R.J. and Spencer, H.G. Some properties of negative frequency-dependent selection at MHC loci. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Summerhayes, G., Matisoo-Smith, E.A., Specht, J., Mandui, H. 'Observations of a Lapita site in Emira, PNG', Lapita - Antecedents and Successors, Honiara, Solomon Islands, 4-7 July, 2007.

Trewick, S.A., Gibb, G. 2007. Assembly of the New Zealand Avifauna. Invited paper, Australasian Ornithological Congress December 2007, Perth, Australia.

Trewick, S.A., Goldberg, J., Paterson, A.M. and Campbell. H.J. Speciation rates: contracts across the New Zealand archipelago. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Trotter, M. and Spencer, H. Frequency-dependent selection with mutations. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Voelckel, C., Heenan, P. and Lockhart, P.J. Speciation in Pachycladon – a microarray approach. Evolution 2007, Christchurch, New Zealand. 16-20 June.

Waugh, J. Barcoding the birds of New Zealand. . Evolution 2007, Christchurch, New Zealand. 16-20 June.

Woodhams, M.D., Hendy, M.D. Dodd, A. and Lambert, D.M. Measuring pedigree evolution rates in Adélie penguins from mitochondrial heteroplasmy. Contributed presentation to Evolution 2007, Christchurch, New Zealand, 16-20 June, 2007.

ADDITIONAL FUNDING SECURED DURING PERIOD

Total additional funds secured during the period: +$450,000

Godfrey, S.S. ARC/NHMRC Research Network for Parasitology - Research Exchange Grant. AUD $3,750 for travel to work with Prof Jens Krause at University of Leeds and Dr Dick James at University of Bath.

Godfrey, S.S. Elain Martin Travel Fund (Flinders University). AUD $2,000 for conference travel to U.S.A.

Godfrey, S.S. Australian Society of Herpetologists Conference Travel Award. AUD $400.

Godfrey, S.S. Holsworth Wildlife Research Endowment. AUD $2,000 for conference travel to U.S.A.

Gruber, M. Dan F. Jones Scholarship. $750.

Gruber, M. Averil Brent Scholarship. $2,500.

Keall, S.N. The Gibson Group Ltd. $200. Donation toward tuatara research programme.

Lambert, D. Bank of New Zealand $40,000 for the 'Kiwi Genome Project'.

Lambert, D. Massey Foundation $20,000 for the 'Kiwi Genome Project'.

Liggins, L. Australasian Student Assistance Grant. $500 awarded to assist travel to Evolution 2007 conference in Christchurch, June 2007.

Matisoo-Smith, E.A. from University of Auckland Faculty of Arts research fund for Investigations into Polynesian contact with South America. $22,000.

Millar, C. School of Biological Sciences Contestable Travel Fund $500. Contribution to attend Evolution.

Millar, C. Faculty Research Development Funds $28,423. DNA barcoding the birds of New Zealand and Antarctica.

Millar, C. University of Auckland Research Fund $5,100. Testing the role structural versus regulatory genes play in adaptive evolution: a novel use of microarray technology.

Miller, K.A. Australasian Student Assistance Grant. $500 awarded to assist travel to Evolution 2007 conference in Christchurch June 2007.

Miller, K.A. University of Wellington Faculty Research Grant. $1,800. 28 September 2007.

Miller, K.A. Department of Conservation Grant. $10,000 for study on "Genetic diversity of translocated New Zealand skinks: Impacts of management".

Moore, J.A. Victoria University of Wellington Faculty Research Grant. $1,650.

Nelson, N.J. Victoria University of Wellington Research Fund. $20,800. How do genes and temperature determine sex of tuatara?

Ramstad, K.M. Bank of New Zealand Save the Kiwi Trust Research Grant. $10,000. Conservation genetics of little spotted kiwi. Collaboration with Hugh Robertson, Dept of Conservation.

Ramstad, K. Department of Conservation - $12,000 for labwork and collection of samples

Ramstad, K. Bank of New Zealand Save the Kiwi Trust - $10,000 for lab consumables

Ramstad, K. Te Ropu Awhina Putaiao, Victoria University - $4,000 summer student support

Ramstad, K. Victoria University, School of Biological Sciences - $1,800 for A Geary's fieldwork

Ramstad, K. San Diego Zoo - $2,000 for A Geary's fieldwork

Stevens. M. NZ FRST Research Fellowship (bridging). Value of grant NZ$37,920

Stevens, M. Mini-PEET Award from the Society of Systematic Biologists to help

with expenses associated with travel to extend taxonomic knowledge, project undertaken at the Museum National d'Histoire Naturelle (in 2008). Value of award US$2800.

Stevens, M. Entomological Society of New Zealand's 21st Anniversary Research Award. Value of award $1,600.

Stevens, M. Understanding, valuing and protecting Antarctica's unique terrestrial ecosystems: Predicting biocomplexity in Dry Valley ecosystems. International Polar Year (IPY) funding administered by FRST and Antarctica New Zealand (Waikato Univ., with a MoU with Massey Univ). Value to AWC $40,000 per year over 3 years.

Stevens, M. Sir Robin Irvine scholarship, administered by Antarctica New Zealand (to assist PhD student research - A. McGaughran). Value NZ$40,000 + full logistic support per year.

Stevens, M. Australian Antarctic Division, Antarctic Science Project No. 2355. Molecular studies of the origins and dispersal patterns of invertebrates in the Antarctic and Subantarctic. Collaborators: Dr. Michael Charleston (Univ. of Sydney), Dr. Peter Convey (BAS), Dr. Ian Hogg (Univ. of Waikato), and Ms Penny Greenslade (Australian National Univ.). Logistic funding AU$38,000.

Winter, D**.** Society for Systematic Biology's Awards for Graduate Student Research. Award for US$1700 towards field expenses for collecting land snails in the Cook Islands.

Voelckel, C. Extension Feodor-Lynen Fellowship from November 2007 until October 2008, 15,500 euros.

DIRECTORY

Management Office
Science Tower D. level 5
Massey University
Private Bag 11-222
Palmerston North
New Zealand
Tel: +64 6 350 5448
Fax: +64 6 350 5626

Host Institution
Massey University
Private Bag 11-222
Palmerston North
New Zealand

Solicitors
Park and Associates
Wellington

Partner Institutions
The University of Otago
P O Box 56
Dunedin
New Zealand

The University of Auckland
Private Bag 92019
Auckland
New Zealand

Victoria University of Wellington
P O Box 600
Wellington
New Zealand

Canterbury University
Private Bag 4800
Christchurch
New Zealand