Allan Wilson Centre for Molecular Ecology and Evolution

Annual Report 2002/2003

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This report is also available in downloadable form from our website at:
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Mike Hendy – Massey University, Professor and Co-Director (Executive)

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Mike Steel – University of Canterbury, Professor

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INTRODUCTION

The overarching science goal of our Centre is to give an unprecedented understanding of New Zealand's biota, its past and its future. The Centre has been established as part of the government's Centres of Research Excellence initiative and brings together senior researchers from five universities. Researchers from the Universities of Auckland, Canterbury and Otago, as well as Victoria University of Wellington join with those at the host organization - Massey University. The Centre 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. These processes were the central scientific interests of the late Allan Wilson, a New Zealander who was regarded as "the most influential figure in the empirical study of molecular evolution". As a result of government funding, the co-directors of the Allan Wilson Centre, Professors David Penny and Mike Hendy, have instigated an innovative series of research projects. These range from those on molecular rates of evolution, biodiversity, through to molecular anthropology and mathematical models.

In order to turn the potential into the actual we have four programmes, each with a coordinator.

1. Rates and modes of evolution (Project Coordinator – David Lambert). Estimating rates of evolution in kiwi and tuatara, and rates of mutation in birds - phylogenetic genomics (chloroplast and mitochondrial).

2. Understanding Biodiversity (Project Coordinator – Charles Daugherty). Morphological radiation in alpine plants, genetic variation and extinction rates – MHC and mate choice in tuatara – nocturnality in NZ lizards – temperature effects on gender in tuatara.

3. Human settlement in the South Pacific (Project Coordinator – Lisa Matisoo-Smith). Collecting human genome data in relation to the settlement of the Pacific - using commensal animals and plants to trace human settlement patterns - assessing Pacific biota and human impacts.

4. Ecological and Evolutionary Models (Project Coordinator - Mike Steel). A dynamic interaction between mathematicians and biologists to address three central objectives: New phylogenetic approaches to rapidly evolving populations – Mathematical modelling of species radiations and reticulations – Origin of life and the earliest divergences.

Centre membership, April 2002

From left to right
Back: David Lambert, David Penny, Mike Hendy, Susan Wright, Craig Millar, Charles Daugherty, Stan Moore. Front: Mike Steel, Pete Lockhart, Ross Howard, Lisa Matisoo-Smith, Hamish Spencer
Dr Howard represented Dr Allen Rodrigo who was unable to attend

VISION AND MISSION STATEMENTS

Vision Statement

"By undertaking research on the New Zealand biota, the Allan Wilson Centre will enjoy national recognition and international prominence as it contributes to the understanding of ecological and evolutionary processes."

Mission Statement

"The Allan Wilson Centre for Molecular Ecology and Evolution is a financially independent research centre undertaking innovative research across multi-disciplinary boundaries. Expertise is combined to answer fundamental questions about New Zealand's plants, animals and microbes."

DIRECTOR'S REPORT - MIKE HENDY

The First Annual Report of the Allan Wilson Centre for Molecular Ecology and Evolution is an opportunity to reflect on the significant changes that have occurred for the scientists within our Centre. The exciting research discoveries, the sequence of memorable meetings and celebrations, the commissioning of world class research equipment and facilities, the generous financial assistance delivered by the New Zealand Government's Centres of Research Excellence (CoRE) initiative, are each overshadowed by the impressive human dimension, the group of researchers who make up the Allan Wilson Centre.

In September 2002 we celebrated the opening of the Allan Wilson Centre with a moving Powhiri at Te Putahi a Toi, followed by the ribbon cutting ceremony at our new facilities (laboratories, staff offices and administrative centre) in the Science Towers at our host site, the Turitea campus of Massey University at Palmerston North. The opening was officiated by Leona Wilson, widow of Allan Wilson, who had traveled from California to join in our celebration. The premature death of Allan Wilson, a New Zealander working at Berkeley, deprived the world of a provocative developer of new methodology who foresaw the power of interpreting molecular information to challenge orthodoxy on many issues of ecology and biological history. His family granted us the privilege to associate his name with our Centre, and it is as much his inspiration and example, as it was his pioneering developments, which underpin the research we are currently undertaking.

The bold initiative of the New Zealand Government to invite scientific groups to propose Centres of Research Excellence has been a catalyst for coordinating and extending cooperative research among New Zealand scientists. The selection process through 2001/2 has measured our scientists against world-class standards and caused us to propose bolder and deeper research projects building on the informal collaborations already in existence in our country.

The success of our proposal reflects the fact that our group were already active and effective researchers. So what does the creation of the Allan Wilson Centre, with its additional funding and new equipment, add to New Zealand's research capacity? First we have an umbrella organisation, managing and empowering a coordinated research plan, enabling small and large group meetings, giving us a national and international profile. Secondly through the national recognition of the quality and importance of our research, it has boosted the enthusiasm of all researchers associated with the Centre, the research programme directors and other investigators, the post doctoral fellows, students and visitors and the technical and administrative staff.

However our original proposal group of twelve has now been reduced to ten. We were saddened and shocked to learn of the death of Professor Ryk Ward, on the eve of his departure from Oxford to Auckland, where he was about to take up the chair in Evolution. Ryk had been planning to return to his homeland, New Zealand, for some years, and working within the Allan Wilson Centre had added to this. Ryk was Programme Director and assisted in the development of our research programme three "Human settlement in the Pacific". Although directorship of this programme has passed to Dr Lisa Matisoo-Smith, the unique combination of skills and experience that he would have brought to the Centre will be difficult to duplicate, and has required us to modify the development of that programme. We are actively seeking replacements to cover those areas.

Also one of our associate investigators was recruited to a Canadian university, prior to the completion of the CoRE selection process. New Zealand has long been vulnerable to loosing its best scientists with world class research profiles, to better equipped and funded overseas laboratories. I believe that had the CoRE fund not been established, several of the other senior researchers of the Allan Wilson Centre would also have left this country.

Now, with our world-class facilities, and the profile of our cooperative research group, we are seeing a reversal of this "brain drain". We have already recruited back to New Zealand some young scientists. We are attracting a growing number of PhD and post-doctoral fellows from other countries, as well as providing new opportunities for our own recent

graduates to develop their research careers in this country. Each of our investigators are senior academics within a New Zealand university, and continue to contribute into undergraduate and graduate teaching programmes. The existence of the Centre is encouraging more students into the related disciplines, and we are also seeing graduate exchange students from other countries coming into these programmes. The RSNZ Teacher's Fellowships programme has been popular, we are supporting a number of secondary teachers who have applied to undertake a secondment within our Centre, these applications are still under review by RSNZ.

In conclusion I would like to acknowledge the bold initiatives that have led to the success of our Centre: The foresight of the Government in establishing this fund, the Royal Society of New Zealand (RSNZ) in their careful selection process followed by their helpful mentoring of our establishment, our host institution, Massey University has provided generous financial assistance, world class facilities and professional support staff, our partner institutions have negotiated agreements which facilitate research as a cooperative endeavour among the New Zealand universities. We look forward to advice and guidance from our recently established Governance Board and International Scientific Advisory Panel, to enable us to maintain and extend the effectiveness and quality of our research activities. Finally I want to acknowledge the professionalism, enthusiasm, inspiration and sheer hard work of all of our investigators, who participated in the CoRE proposal, and in the development of the Centre, to bring it to the forefront of world-class research.

Mike Hendy
Executive Director

DIRECTOR'S REPORT – DAVID PENNY

This first year has been exciting, on several fronts, for our research. The first is what has been achieved and published – ranging from of a major new book on "Phylogenetics" on the mathematical side, to a publication in Science on the biological - a paper on rates of change using ancient DNA from Antarctica. But in the longer term the increase in capacity from new people and new equipment means that our achievements this year must be exceeded in the future. We now have new postdoctoral researchers and/or graduate students in Dunedin, Christchurch, Wellington, Palmerston North, Auckland and Albany. These researchers are the real stimulus for the future. But in spite of the drive from people, modern science also needs its hardware, and it is a great stimulus to have major improvements in equipment ranging widely from New Zealand's fastest parallel computer (Helix), two new powerful DNA Sequencers, and new X-ray crystallographic equipment.

Although DNA sequence and related data is transforming many aspect of ecology and evolution, it is the biological questions that are still the driving forces. The new data allows much more powerful tests of ideas, and DNA sequence data is especially powerful when combined with the power of mathematical modeling. Within this context of DNA and mathematics, our research covers a wide range of timescales. For the here and now, our work has ranged from studies of highly endangered tuatara (with translocations) to the changing nature of RNA viruses (even within a single host).

Going backwards to hundreds or thousands of years ago, we are reconstructing the movement of peoples and their commensal plants and animals across the South Pacific. Here, for example, we are finding that the DNA evidence integrates very well with archeological and other evidence, and allows powerful testing of earlier ideas. Extended sequencing to complete mitochondrial genomes of Pacific rat will allow the same resolution as with humans. On a similar time scale, using ancient DNA from subfossil bones, we can

estimate changes in DNA sequence over very short periods of evolutionary time, promising new precision in measurement. A really exciting find is that ancient DNA can be used to sex moa bones, and is leading to a major increase on understanding of the species in this group. At slightly longer times we are finding dynamic processes of both adaptation and speciation within the New Zealand biota over the last series of Ice Ages. It is here that new work on the theory and programs for networks is particularly important for studying the complex relationships that occur in nature, not everything should be forced onto trees.

Thus far these examples are on a relatively short evolutionary timescale, and we are finding the traditional methods of analysis of evolutionary trees need rethinking in several ways. Networks is one example already mentioned, but even the optimality criteria we use may need modification, and in some cases our results imply that the research community has been using methods that are unnecessarily computer intensive – even though the methods are still complex from a computational view.

To continue our story further back in time, we are getting a good picture of the origins of the New Zealand biota, with some very old elements that may have been here since Gondwana days, but with many newer entrants over the last 5-20 million years. Further back, we are now able to resolve many aspects of bird and mammalian relationships, and this extends the time frame back to at least 100 million years for each of birds and mammals. Although this is the zone of classical phylogeny, we still find that improved mathematical analysis allows potential gains in computation for phylogeny. Long sequences are needed, and the congruence between nuclear and mitochondrial genes is essential. It is especially interesting that over this time scale new genetic mechanisms, such as imprinting, have evolved and our work contributes to understanding the processes involved.

Understanding the very deepest divergences among living organisms, to the beginnings of life, are among the hardest challenges in science. We are improving methods for finding related genes in organisms that diverged very early from common forms of life. Our mathematical modeling is crucial for sorting out what is possible from what is not. This

both places limits on ideas whilst at the same time pointing to productive areas of experiment.

In two areas we have not yet been able, because of loss of researchers, to make the progress we hoped for. Following the slow change in 3-D structure through evolutionary time - evolution in four dimensions – is still a priority. Without knowledge of changes in 3D structure it is difficult to be confident in inferring the deep relationships between phyla and kingdoms, let alone estimating their times of divergence. Although many aspects of our project on the origin of Polynesian peoples and biota have developed, the death of Ryk Ward has left an important gap in the study in the distribution of autosomal marker genes. A new project on the utility of small mites for tracing human dispersal offers the potential for another marker.

It is great to enjoy the success and achievements of the past year, but the challenge is now for the future. I look forward to year two of our operation. The development of Centers of Research Excellence was a bold step by Government – it is up to the researchers to make it work even better. We have jumped through countless hoops in order to be selected, and we were selected because we can do even better than we were doing already. Along with excellence goes responsibility. We need to make a difference for research in Molecular Ecology and Evolution in New Zealand and the world. We need to extend our circle of collaborations within New Zealand, and the new program of 'affiliate of the Allan Wilson Center' is one way forward. May we live in exciting times.

David Penny
Research Director

OPENING OF THE ALLAN WILSON CENTRE

Below is the address given by Mrs Leona Wilson (widow of Allan Wilson) at the ribbon-cutting ceremony associated with the official opening of the Allan Wilson Centre on 12 September 2002.

Thank you for inviting me to come help celebrate the official opening of this new centre of scientific excellence. I wish that Allan had lived to share in this day and to see the institute named in his honor.

It was a tragedy not only for our family but for the scientific community that Allan died so young when he might have contributed so very much more. He was only 56 when he died in 1991. Until the very end he was thinking about ideas that needed testing. Allan had a very far ranging mind, great intellectual curiosity and was always looking for connections of all sorts. There was almost nothing that did not interest him. That was why he contributed to so many different fields and had students from so many different disciplines. On the other hand, he was also very modest and was always downplaying his achievements so he might have been somewhat embarrassed by all of this attention. He had a wonderful sense of humor so he might have possibly joked about it.

Allan was born in Ngaruawahia in 1934 and raised on a dairy farm in Pukekohe. His brother and niece are here today as well as his closest childhood friend, Jim Johnston and his wife Dorothy. Allan was proud to have been a New Zealander. The New Zealand that he admired was one of early egalitarianism, early votes for women and very early efforts at social justice. He used to tell me that New Zealand never had a servant class as England did. But he also told me about the discrimination and poor treatment of the Maoris in his town when he was growing up in the 30's and 40's. He was very ashamed of that. He hated racism, narrow nationalism and class ridden societies. Long before it was fashionable, he had many women and African-American students in his laboratory.

Allan was unusual in that he was a genuinely kind and generous person (both generous and generous spirited). Though he was a wonderful husband, father, teacher and Professor, he somehow managed to find time and patience for others. I remember one particularly tragic young man who was mentally ill. Though he was no longer even a student in the Department, he would phone us in the middle of the night. Though Allan had to teach early in the morning, he was invariably patient and compassionate, speaking with him for long periods of time. He allowed others to intrude on his time as well. He was always bringing people home for meals on short notice.

Molecular evolution is a contentious field but Allan was never involved in the type of acrimonious behaviour that was so often directed at him. He was very proud of the high quality and careful research that emanated from his lab. He relied more on data rather than preconceived notions and assumptions to evaluate ideas. Now that 11 years have passed, Allan's students and colleagues scattered at Universities and Research Institutions worldwide have shown that most of his ideas have proved correct. These people are continuing his legacy and he will live on through their work. I know that he would be very proud.

I feel lucky that I had such a rich life with Allan, rich in intellectual stimulation, culture, friends, travel and the chance to visit and live in so many different countries. I cherish our long marriage, our two wonderful children and the continuing contact that I have maintained with Allan's students and colleagues. Congratulations on the opening of this Centre. May it have a long and productive life. I look forward to hearing about the wonderful research that you will produce

Official opening : Minister Pete Hodgson, Mrs Leona Wilson, Prof David Penny, Prof Mike Hendy

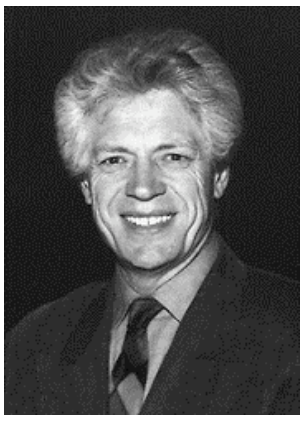
GOVERNANCE AND MANAGEMENT

Governance

The past year has seen the formation of the Allan Wilson Centre Governance Board with the first meeting due to be held in early August 2003. The Governance Board has been formed to oversee the strategic directions of the Centre, to approve budgets and project expenditure. It is intended the Governance Board will be made up of persons primarily from outside of the Host Institution and the Partner Institutions, with a maximum of seven (7) members.

The members of the Governance Board have been selected for their expertise in particular professional fields. Partner institutions and members of the Allan Wilson Centre Research Management Board were invited to put forward up to three nominations for those to sit on the Governance Board. Nominations were forwarded to the Vice-Chancellor of the Host Institution. The Vice-Chancellor of the Host Institution, who considered all nominations and, following independent advice, approached those to be nominated. The members of the Governance Board were appointed by the Vice-Chancellor of the Host Institution, ensuring a balanced representation of skills across the Board. In the event that a member of the Governance Board resigns from their position on the Governance Board, subsequent appointments will be made by the Vice-Chancellor of the Host Institution on advice from members of the Governance Board.

Those who have accepted appointments to the Allan Wilson Centre Governance Board are:



Dr Seddon Bennington

Dr Seddon Bennington returned to New Zealand after eight years as Pittsburgh's Carnegie Science Center's director, to accept the director's position at New Zealand's national museum, Te Papa Tongarewa, in Wellington. Dr. Roderick Deane, Te Papa chair, says Bennington was selected to direct the museum--dedicated to New Zealand's heritage and culture--because of his

"distinguished record of leadership in the museum and art gallery world… Dr. Bennington is a scientist with a very strong commitment to and knowledge of the arts."

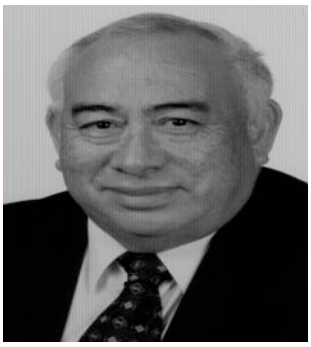
Dr Alan Dixson

Director of the Center for the Reproduction of Endangered Species (CRES) at the San Diego Zoo, Dr Dixson has spent his career studying the reproductive biology of African primates. He brings to the Board experience in management of a major international research organisation, as well as a commitment to understanding biodiversity in all its forms and using that knowledge to support conservation.

Dr Andy Pearce

Chief Executive of Landcare Research New Zealand Ltd, an environmental research company with an annual turnover of NZ$43 million and 400 staff. Landcare Research undertakes work for a wide range of private and public sector clients in New Zealand and Australia, and in a wide range of Asian and Pacific countries for bilateral and multilateral development agencies.

Dr Ngatata Love



Professor Love has previously held directorships in Air New Zealand, Huttons New Zealand Ltd and Moana Pacific Fisheries as well as Chairing the Natural Heritage Foundation. Current positions include Chairperson of the Wellington Tenths Trust, Commissioner in the New Zealand Law Commission and an academic appointment in the Department of Management at Victoria University of Wellington.

Sir Neil Waters

Sir Neil has a high profile in New Zealand academia and is a retired Vice Chancellor of Massey University. Professor Waters is a former Chairman of the Boards of NZQA and FRST, Deputy VC University of Auckland, Professor of Chemistry University of Auckland.

Professor David Lambert and Ngati Whatu kaumatua Dr Takutai Moana Wikiriwhi at the blessing ceremony which formed part of the official opening the Molecular Ecology laboratory on the Albany campus of Massey University. This laboratory houses equipment purchased by the Allan Wilson Centre with funds secured through the Centres of Research Excellence initiative.

Scientific Advisory Panel

Membership of the Scientific Advisory Panel is by invitation of the Co-Directors after consultation with the Management Board. The Scientific Advisory Panel provide the Research Management Board with advice and information on scientific, technical, research and related matters to the Allan Wilson Centre, as and when requested by the Research Management Board. The Scientific Advisory Panel may have other roles as approved by the Research Management Board.

Those who have accepted appointment to the Allan Wilson Centre Scientific Advisory Panel are:

Professor Bill Amos
Dept of Zoology, Cambridge

Dr Wame Baravilala
Fiji School of Medicine

Professor Andreas Dress
University of Bielefeld, Germany

Professor Susan Holmes
Stanford University, USA

Professor John Jungck
Beloit University, USA

Professor Patrick Kirch
UC Berkeley

Professor Axel Meyer
University of Konstanz, Germany

Dr Eugene Myers
Celera, USA

Professor Vincent Moulton
Uppsala University, Sweden

Professor Simon Tavare
University of Southern California

A member of the Scientific Advisory Panel will visit the Centre every six months, with all members visiting the Centre during the first six years of the formation of the Centre. The Scientific Advisory Panel member will participate in a Research Management Group meeting and thereafter visit each investigator at their employing institution. The Scientific Advisory Panel member is charged with preparing a report with reference to the research

being undertaken in the Centre. This report will be presented to the Governance Board for their consideration.

Prof Axel Meyer visited the Allan Wilson Centre in April 2003, attending a Research Management Meeting and meeting with each investigator in their institution of employment. Professor Meyer has been charged with preparing a report outlining his findings. This report has yet to be received.

Management

Research in the Centre is managed through the Research Management Group. This group meets at least six monthly and is made up of the co-directors of the Centre and the programme co-ordinators of each of the four programmes. The Business Manager is present at all meetings.

Day-to-day management is undertaken by the Co-directors and the Business Manager in the form of the Allan Wilson Centre Management Group. This group meets at least once a week with meetings chaired (in year one only) by the Assistant Vice-Chancellor (Research) of Massey University.

The Massey University Advisory Board is chaired by the Pro-Vice Chancellor of the College of Sciences and its membership is the Directors of the Allan Wilson Centre, the Head of the Institute of Molecular BioSciences and the Vice-Chancellor (or her nominee). This group meets at least six-monthly and is charged with the responsibilities of ensuring the activities of the Centre are of benefit to the University, oversight of financial performance and to provide assistance and guidance as required.

RESEARCH MANAGEMENT GROUP PROFILES

Scientific Director, Professor **David Penny**, has held office as President of the Society of Molecular Biology and Evolution an international society (currently 891 members) which publishes the high impact journal Molecular Biology and Evolution (MBE) with 525 institutional subscribers. One of Prof Penny's achievements was to initiate the process that lead to MBE being the first scientific journal to have all its previous and current publications available on the world wide web. He has also been President of the New Zealand Association of Scientists. During his term he initiated and organised funding for the annual Science Communicator's Award. In 1998 Professor Penny was chairman of the External Review Committee of the Institute of Statistical Mathematics (ISM) of Japan, and in 2001 was a member of the committee reviewing priorities of the Causes of Biodiversity research programme of the DFG (German Scientific Research Funding Agency.) In 2000 Prof Penny was awarded the Marsden Medal in recognition of the contribution he has made to science in New Zealand. He is a Fellow of the Royal Society of New Zealand.

Prof Penny maintains an oversight of the scientific activity of all programmes, organises outputs, coordinate modifications to the programmes and collates scientific reports.

Executive Director, Professor **Mike Hendy**, was Acting Dean of the new Faculty of Information and Mathematical Sciences at Massey University for 12 months, and was Discipline Leader (mathematics) at Palmerston North. He has extensive experience in PhD student administration, as a member of Massey University's Doctoral Research Committee for 12 years, and has been on the University's Scholarships Committee for four years. He also served for 6

years on the executive of the New Zealand Mathematical Society. He was a member of the International Programme Committee for the inaugural Workshop on Algorithms in Bioinformatics (WABI) held in Denmark, 2001. He was also a member of the Vice Chancellor's Research Advisory Committee (1995-6) which drafted the Intellectual Property Policy for Massey University. In 2000 Professor Hendy was appointed as Mercator Professor (funded by the DFG) to the University of Greifswald, to assist in the development and teaching of the first undergraduate degree in BioMathematics in Germany. He is a Fellow of the Royal Society of New Zealand.

Prof Hendy recommends management policy, maintains a financial oversight of activities, staffing, IP and resources.

Professor **David Lambert** from Massey University is a principal investigator in the Centre and leads Project One – Rates and Modes of Evolution. He has over 25 years experience in the area of molecular ecology and evolution. Prof Lambert is a fellow of the Royal Society of New Zealand, has published over 100 research papers and obtained $3.8 million in grants since 1995. The latter includes seven Marsden grants, five as principal investigator. He has a particular interest in rates of mutation and evolution and objectives 1 and 2 derive from an active research programme that has been part of a long-term collaboration with Dr Millar from the University of Auckland.

Professor **Charles Daugherty** from Victoria University of Wellington is a principal investigator in the Centre and leads Project two – Biodiversity and is an international expert in scientific basis of conservation. Prof Daugherty's research interests focus on evolutionary and population biology of vertebrates, conservation genetics, and ecological restoration. The conservation biology of tuatara is a longstanding interest, and recent

studies with graduate students have examined the ecological relationships of tuatara to seabirds and rats, temperature-dependent sex determination, and the re-establishment of tuatara in nature. He is a Fellow of the Royal Society of New Zealand, and is a member of the Council of the Marsden Fund.

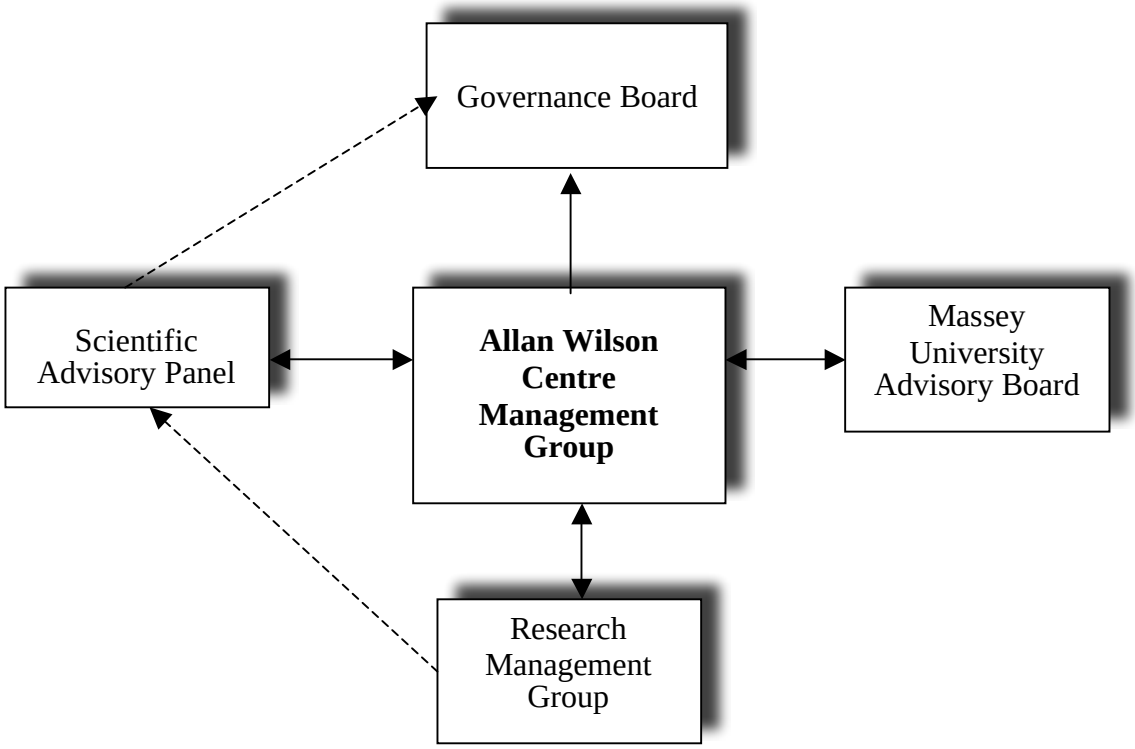
Following the untimely death of Professor Ryk Ward, Dr **Lisa Matisoo-Smith** of the University of Auckland has been appointed a principal investigator and leads Project Three – Human settlement in Aotearoa/New Zealand. Dr Matisoo-Smith is involved in a number of research projects focussing on genetic variation in ancient and modern animal populations. Her main interest is in analysis of genetic variation in domestic and commensal animals in the Pacific and the implications for understanding prehistoric human mobility and contact, and ecological impact in the region. This work often focuses on ancient DNA from archaeological remains. She is also interested in evidence of early animal domestication and other animal human interactions in the Asia/Pacific region and is currently involved in research on the Settlement of New Zealand, research on Ancient DNA analyses as evidence of human presence and research projects on genetic variation in a range of species.

Prof **Mike Steel** of Canterbury University leads Project Four – New Ecological and Evolutionary Models. Prof Steel is the Director of the Canterbury University Biomathematics Research Centre. Together with colleagues at Massey and overseas, he has pioneered the development and application of many techniques for reconstructing and analysing phylogenetic trees and modelling DNA evolution.

Over the last decade he has published approximately 70 papers, and been awarded 3 Marsden Fund grants. In 1999 was awarded the New Zealand Mathematical Society's Medal for Mathematical Research, 'for his fundamental contributions to the mathematical understanding of phylogeny, demonstrating a capacity for hard creative work in combinatorics and statistics and an excellent understanding of the biological implications of his results.' He is an associate editor of Systematic Biology, and on the editorial board of Journal of Computational Biology. With Prof. Edward Holmes (Oxford) he is co-ordinating a NIH-funded multi-year workshop at DIMACS (Rutgers University) on 'phylogenetic trees and rapidly evolving diseases'.

Tuatara, the genus under investigation in Project Two by Prof Charles Daugherty and his staff and students

ORGANISATIONAL CHART



Partnership Arrangements

An Agreement has been signed between the Host Organisation, Massey University, and the Allan Wilson Centre Partner Organisations viz. The University of Auckland, Victoria University of Wellington, Canterbury University and Otago University. This document forms the basis for all interactions between the entities.

THE YEAR IN REVIEW

The Allan Wilson Centre for Molecular Ecology and Evolution was formed in July 2002. The first year has seen the development of administrative procedures, the formation of the Governance Board and the Scientific Advisory Panel. Dedicated space for the Centre was allocated on the fifth floor of Science Tower D on the Palmerston North campus of Massey University and this area was remodelled to meet Centre requirements. Partner organizations have also provided dedicated space for their Centre investigators. The past year has seen the advertising of vacancies and the subsequent appointment of researchers and associated staff to the Centre.

The Centre was officially opened on Thursday 12 September 2002 with Mrs Leona Wilson (widow of Prof Allan Wilson) with Mr Gary Wilson (bother of Allan Wilson) in attendance. The Centre was officially opened by The Hon Pete Hodgson, the Minister for Research, Science and Technology.

The Centre has been formed as a result of funding received from the New Zealand Government's Centres of Research Excellence initiative. As well as operational funds the Centre received over five million dollars to purchase capital equipment. During the past year tenders have been released for the larger items of equipment, with the majority of required items purchased during this period.

The Allan Wilson Centre hosted the Annual New Zealand Phylogenetics meeting organised by staff of the Centre which took place at the Edward Percival Field Station in Kaikoura from 10 to 14 February 2003. A one-week Phylogenetics Workshop was run by those in the Centre in April 2003. A Workshop to introduce New Zealand's fastest supercomputer, Helix (built in October 2002 using CoRE funds, and ranked 304 on the international 500 Top Computers listing), to potential users was held on the Albany campus of Massey University 27 to 31 January 2003.

The Centre ran a DNA Technology Workshop at the Fiji School of Medicine over the period 2-5 September with four persons travelling to Fiji to present the Workshop. Enrolees came from many Fijian organizations including the Ministry of Health, the Secretariat for the South Pacific, the University of the South Pacific and the Fijian School of Medicine.

2003 has seen the formation of a Plant Species Radiation Group which is associated with Programme 2. Headed by A/Professor Peter Lockhart, this group seeks to understand how global plant biodiversity arose and is maintained. Plant species which are genetically similar, but morphologically and ecologically diverse, arise and go extinct over short periods of geological time; this group will investigate this phenomenon with particular emphasis on New Zealand species. Further information on this group can be found at http://awcmee.massey.ac.nz/~NZ_Plant_Species_Radiation_Group/. Applications have been made to prestigious funding bodies in an attempt to source additional funding for these investigations.

An artistic impression of moa and their habitat. Picture presented to the journal Nature for consideration as a cover shot for their issue which will include a ground-breaking paper authored by David Lambert and Craig Millar.

RESEARCH HIGHLIGHTS

Project One

Rates and Modes of Evolution

Researchers David Lambert, Craig Millar, Peter Lockhart, Jennie Hay, Leon Huynen, Peter Ritchie, Jennifer Anderson, Gillian Gibb, Gwilym Haynes, Lara Shepherd, Oliver Berry, Hayley Lawrence, Hillary Miller, Mary Morgan-Richards, Steve Trewick

Project one is focused on the rates and modes of evolution issue. The objectives include studies of both plants and animals. Understanding evolutionary rates is important because it will enhance the accuracy of models of evolution and help explain the processes responsible for evolutionary divergence generally. Precise evolutionary rates will allow accurate estimates of divergence times, as well as accurate temporal reconstructions of the evolutionary history of specific groups of organisms. Therefore historical processes can be identified in studies of contemporary gene flow, a result having significant conservation and management implications. This research project aims to expand on novel approaches, already initiated by members of the Allan Wilson Centre for Molecular and Evolution.

Directly measuring rates of evolution

With the advent of ancient DNA technology, we are now able to genetically sample populations of animals and plants through time. Evolutionary rates, rather than being estimated indirectly from the fossil record, can now be directly measured using ancient remains of known age. Our earlier research has shown that the Adélie penguins of Antarctica represent a unique model system that allows us to sample ancestral genomes, and quantify rates of genome evolution over thousands of years.

Once accurate evolutionary rates have been calculated for tuatara and kiwi, we will compare these to penguins, consequently estimating rate variation across vertebrates. In the longer term, a fundamental goal will be to compare rates of evolution and mutation

(delayed objective 2) because a central principle in molecular evolution is that these rates should be very similar, for neutral DNA sequences.

At an organization level, a new Molecular Ecology Laboratory has been built on the Albany campus of Massey University. In large part, equipment located in this laboratory has been supplied by the Allan Wilson Centre. The new laboratory complex was opened recently by the Honourable Marian Hobbs, Minister of the Environment 8th July, 2003. This, together with an associated ancient DNA facility has enabled researchers to complete a number of technically challenging projects of important international significance. These include work on ancient moa of New Zealand resolving a series an important evolutionary questions concerns these unique giant flightless birds. The work will appear soon in the world's leading journal *Nature*.

When does plant radiation occur?

A shortcoming of recent molecular systematic studies into plant evolution has been the inability to identify accurately when plant diversification occurs. Whilst temporal estimates based on sequence divergences often suggest species diversification within the Pleistocene, variances on these estimates preclude inferences being made more precisely. Of particular interest for example is whether or not diversification occurs at glacial/interglacial boundaries - when many new habitats become available.

A problem in identifying fast evolving regions is that chloroplast genome evolution, like protein evolution appears to exhibit covarion properties of substitution. That is, empirically it seems that regions that are fast evolving in one plant group may not have the same substitution properties in another. The reason for this is unclear. However, it may in part be explained by differences in the thermostability of genome regions and in particular, properties of DNA strand separation. In current work we are investigating levels of local destabilization across sequenced chloroplast genomes and comparing these levels in the same regions from different genomes.

Of particular interest is whether deviation from common properties in the same regions are responsible for differences in the clock-like rate of nucleotide substitution in different plant groups at the same loci.

It is hoped that understanding the relationship between genome thermostability and mutation rate will allow predictions to be made of the expected sequence variation in chloroplast genomes from different radiating plant groups. If so, then we plan to determine the chloroplast genomes of representative model plant groups in New Zealand, and use these genomes to select the most appropriate regions for sequencing large numbers of accessions. Our intention is to use this approach together with molecular dating techniques and biogeographic calibrations that are unique to new Zealand to improve temporal estimates of species divergence.

The problem of Proteome diversity

Reconstructing evolutionary history for anciently diverged organisms is not easy. European and USA genome projects have brought good news and bad news for phylogeny research. The good news is that comparative sequencing efforts have identified unexpected homologies and provided significant insight into the origins of life – particularly in respect of eukaryote evolution. By overturning some previously considered robust phylogenies, these studies have highlighted our ignorance about the importance of the fit between data and evolutionary models; and also the need for improving current understanding of the dynamics of protein and RNA evolution. In respect of the latter, we are investigating the protein-protein interactions within different sub-cellular compartments (organelles, nuclear compartments and bacterial cells) and how differences in interactions impact on phylogenies for anciently diverged organisms. We are investigating the relationship between substitution properties of sequences such as distributions, proportions of variable sites and compositional heterogeneity.

Objective 1: To determine rates of evolution in kiwi and tuatara

Tuatara. We have focussed on the control region as it is an excellent marker for measuring rates of evolution and allows a direct comparison to our earlier penguins work. To date, we have sequenced the entire tuatara control region (~1000bp), including the HVRI, of 50 modern tuatara samples from 26 island populations. In addition, we have successfully extracted ancient DNA from five sub-fossil bones, amplified and sequenced the tuatara control from one individual, and partial mitochondrial cytochrome b and control region, in addition to nuclear genotypes from two individuals.

Following collaboration with Te Papa we have assembled a comprehensive database of living and ancient tuatara samples available to us.

Brown kiwi: To date, we have sequence 654 bp of cytochrome *b* for 25 ancient kiwi bones and skin samples. A comparison of these sequences with 60 sequences from modern brown kiwi demonstrates that 44% of the cytochrome *b* sequence variation in kiwi has been lost. This is primarily because many populations of brown kiwi are very genetically distinctive and the loss of these populations has resulted in the loss of unique variation. We have designed PCR primers that enable us to sequence 358 bp of the HVRI of the mitochondrial control region in brown kiwi and we are thus making good progress in our goal of estimating evolutionary rate in this species.

Objective 2: To estimate rates of mutation in birds

This objective did not commence in Year One but is due to commence in Year Two.

Objective 3: To understand the relationship between the dynamics of plant genome evolution and mutation rates

This objective was not scheduled to commence in 2002. However, some preliminary work has been undertaken. There has been the initiation of a collaboration with researchers at the UC Davis Genome Center. Specifically, using the approach of Benham (1996) our colleagues at UC Davis made calculations of local thermostability properties for nucleotide sequence positions in the tobacco chloroplast genome. To analyze these data our colleagues

at the University of Tubingen have modified their comparative genome viewer Cgviz. We are now at the point where we can make genome-genome comparisons.

Objective 4: The problem of Proteome-diversity

We have begun sequence determinations for Rpo, Tufa and SecA genes. In collaboration with the University of Dueseldorf we have been using two novel analytical approaches to investigate the covarion substitution properties of different chloroplast proteins on a well established phylogeny. These two approaches that have been developed are based on d_{cov} distances. The results for the known phylogeny appear very promising in that they suggest that most chloroplast genes evolve by a covarion model.

One of the tools we are using in the current work is the capture-recapture estimation methods for proportion of variable sites. Perl scripts have been written to help with simulation and information loss studies to investigate this phenomenon. Currently analyses and simulations are underway. Once the effect of the bias p_{var} estimation is better understood we will be able to interpret observations that suggests the proportion of variable sites varies differs in orthologues contained in different cellular compartments (e.g. organelles, bacteria). Ultrastructure and biochemical data suggests the presence of a nitrogen fixing organelle in a diatom *Rhopalodia gibba*. Sequence analysis of 16sDNA and *nif*D genes confirm this result. Although there is great interest in this finding additional results are required by Nature before acceptance.

The Honourable Marian Hobbs, Minister for the Environment and Prof David Lambert at the official opening of the Allan Wilson Centre Molecular Ecology Laboratory on the Albany campus of Massey University, 8 July 2003.

Project Two

Biodiversity

Researchers Charles Daugherty, David Lambert, Peter Lockhart, Hamish Spencer, Craig Millar, Kirsten Donald, Nicky Nelson, Sue Keall, Trish McLenachan, Olga Kardialsky, Leon Perrie, Ravikumar Gaddam, Kelly Hare, Joanne Hoare, Michael Knapp, Carlos Lehnebach, Mort Piripi, Hannah Riden, Anna Santure, Cielle Stephens, Kevin Woo

This project is aimed at understanding of New Zealand's biodiversity and the processes that have shaped it. The objectives focus on the processes of morphological innovation and extinction and their relationship to genetic diversity.

DNA studies show that the biota, and its relationship to that of other South Pacific islands are more complex than once thought. The older descriptive studies continue and are important, but answers require a shift to research aimed at understanding ecological and genetic processes in action. We need far more sequence data for all main biological groups to properly evaluate New Zealand's role as a source for dispersing biota to other South Pacific lands, as well as for evaluating the true conservation status of its many endangered and vulnerable species. Genomic data are also expected to help locate geographic regions of genetic diversity within New Zealand, and to identify the genes involved in the morphological innovations that are so characteristic of New Zealand's many species radiations.

Objective 1: To test for adaptation: morphological innovation in alpine plants

The formation of the "New Zealand Plant Species Radiation Group" – an interdisciplinary group of scientists from New Zealand and overseas colleagues who are collaborating on plant species radiation research in New Zealand, was initiated. Details of research activities are given at http://awcmee.massey.ac.nz/~NZ_Plant_Species_Radiation_Group.

Sequencing and fingerprinting efforts have focused on alpine buttercups (*Ranunculus*) and willowherbs (*Epilobium*). Both groups are cosmopolitan in their global distribution with

centres of diversity in New Zealand. In the former case, three diverged alpine lineages in New Zealand have now been found to show patterns of paraphyly in which geographically localised species are derived from more widespread generalist species. Sequencing of geographically widespread accessions support an hypothesis of certain geographic regions in New Zealand being glacial refugia (nunataks) during the Pleistocene. Additional markers are being sought to test this idea further before publication of our findings.

The *Ranunculus* work is also part of an international effort to investigate alpine radiation in different world regions, and researchers from the Australian National University, Yan Tai University (China) and the Vienna Botanical Institute (Austria) are involved. At present approximately 400 accessions have been sequenced for their nITS regions as part of this joint project across 3 labs.

Analytical work has focused on the problem of the mathematical description of species radiation. Findings from median network studies using multiple gene trees as a starting point for this type of construction are in preparation. Work on the biogeographic interpretation of split graphs (split decomposition) was recently submitted for publication.

We confirmed the close phylogenetic relationship between species of the New Zealand *Pachycladon* complex and *Arabidopsis thaliana*. by sequencing of pistillata and GpdH genes. Current work is investigating the extent to which the Pachycladon group is amenable to genetic study. Phylogenetic studies are also underway involving multi-locus characterisation (Gpdh, nITS, pistillata, phytD) of close relatives of *Arabidopsis thaliana* and species of the *Pachycladon* complex.

Objective 2: To investigate the relationship between genetic variation and extinction

Blood samples have been collected from 86 Taiko (*Pterodroma magentae*), representing the majority of samples required to compete the initial phase of the project. 79 of the blood samples have been sexed using the CHD gene.

PCR primers have been designed to amplify the HVRI region of the mitochondria genome from seven Taiko samples, allowing us to identify ancient DNA material and to thereby assess their past levels of genetic variability. We have also collected 16S and cytochrome *b* mitochondrial sequence data from Taiko samples.

Consultations has been completed with the Chatham islands community and we are now seeking to produce a partial genomic library of Taiko.

Objective 3: Quaternary Plant Extinction & Stepping Stone Hypotheses

The objective did not commence in Year One, nor will it commence in Year Two.

Objective 4: MHC and mate choice in tuatara

Genes associated with immune function are thought to help determine mate choice in many species of vertebrates. Natural selection may favour the high levels of variation found in the genes of the Major Histocompatibility Complex (MHC). This study aims to identify the levels and patterns of variation at these loci and then use the information to help understand their role in the evolution of a New Zealand icon species, tuatara. Blood samples have been collected to initiate this study, and work is now beginning to develop techniques for examining the genes directly.

Objective 5: Nocturnality in New Zealand lizards

Lizards, like other ecothermic or 'cold-blooded' animals, prefer warm temperatures where their metabolic processes are most active. It is thus paradoxical that many species, including about half of the lizard fauna of New Zealand, are nocturnal, when temperatures are coo. This study aims to unravel this paradox and understand why and how ectotherms function so well apparently sub-optimal conditions. To date field research on oxygen consumption measurements of three species of geckos from Stephens Island has been completed. Geckos have also been collected from Stephens Island for lab-based experiments on locomotor efficiency and metabolic conditioning. The laboratory experiments on these animals will be completed by early November.

Objective 6: Co-evolution of trematodes and topshells

We have collected Australian species of *Austrocochlea*, and examined them for trematode parasites. Tissue samples of the snails have also been collected for subsequent genetic analysis. Preliminary phylogenetic analysis of the snails show a number of surprising results: the taxonomy of the New Zealand species does not correspond to their phylogenetic relationships; one Australian species is apparently derived from neozelanic ancestors; one species is found in both New Zealand and Chile in spite of a short veliger stage, the duration of which is insufficient to allow dispersal across the Pacific. Analysis of the New Zealand trematodes indicates that the snail *Diloma subrostrata* is host to (at least) two quite different trematodes.

Objective 7: Effects of global warming on tuatara populations

The sex of tuatara is determined by the temperatures at which their eggs incubate. Warm temperatures produce males, and cool temperatures produce females. Global warming may threaten small island populations of tuatara, because it could mean that populations produce only male animals. We are investigating the risks that global warming poses to these populations. After one season, our study of natural nesting in tuatara has resulted in the following: 419 permanently marked female tuatara at nesting areas, data loggers in 46 nests recording hourly temperatures for 12 months, mothers identified for 31 of the 46 nests, and temperature data loggers inserted at 14 locations and two depths associated with nesting areas. Estimates of adult tuatara sex ratio on Stephens Island are 1:1 in forest habitat, but a male-biased sex ratio in pasture.

Project Three

Human settlement of Aotearoa/New Zealand

Researchers Lisa Matisoo-Smith, David Penny, Judith Robins, Simon Hills, Abby Harrison, Lorraine Berry, Melanie Pierson, Andrew Clarke

Following the untimely death of Professor Ryk Ward (the initial programme co-ordinator) in February 2003 we have had to re-asses the objective initially put forward for this project.

We are seeking to use detailed molecular studies of island biota across the Pacific to update the "Theory of Island Biogeography". We believe that biological case studies from New Zealand, together with new phylogenetic methods, will reinvigorate the theory and help us to understand how molecular diversity of Pacific biota has been influenced by the geographic, climatic and ecological contrasts within the Pacific region.

We are studying commensal organisms that accompanied Polynesian settlers to this country. The goal is to document, with a high degree of certainty, the migration pathways of those early Polynesian settlers and to use these to inform the New Zealand public and scientists alike. The genetic analyses of Pacific island plant, animal and human populations will not only provide answers to questions regarding Pacific prehistory, early contact history, and the impact of humans on isolated Pacific ecosystems, but will contribute to the wider evolutionary questions addressed in the overall programme. This project focuses on the who, when and where of human arrival and impact in Aotearoa/New Zealand, which ties in to the “how” questions being addressed in the other projects of the Centre.

Objective 1: The settlement of the Pacific

A major effort has been to sequence ten complete mitochondrial genomes. This work is in conjunction with Oxford University. Additional samples are being collected in collaboration with the Fiji School of Medicine.

Objective 2: Use of commensal animals and plants to trace human settlement patterns

Samples of kiore (*Rattus exulans*) have been negotiated from Island SE Asia and the Pacific. Rat samples from Micronesia, and dog and pig samples from Mussau (a Lapita site in the Bismarck Archipelago) and Mangaia, Cook Islands have also been obtained. Negotiations with the Museum of South Australia are taking to acquire tissue samples from Indonesia, New Guinea and Thailand. Staff continue to sequence rat, dog and pig samples from around the Pacific and SE Asia.

Objective 3: Pacific biodiversity and human impacts

Markers are bring identified for both kumara (sweet potato) and the New Zealand gourd (hue). Both plants are suggested to have been brought back from South America by early Polynesian navigators. The first stage is to develop new molecular markers to help establish the origin of each variety. This is going well. We have access to an important sweet potato collection from Papua New Guinea and access to additional gourd collections has been arranged.

Lisa Matisoo-Smith with some of her mummified rats

Project Four

New ecological and evolutionary models

Researchers Mike Steel, Mike Hendy, Allen Rodrigo, David Penny, Barbara Holland, Wim Hordijk, Rissa Ota, Howard Ross, Tim White, Lesley Collins, Paul Gardner, Howard Ross, Fred Delsuc, Dietrich Radel, Philip Daniel, Greg Ewing, Matt Goode, James Matheson

Rather than applying existing methods to new types of data, we seek to exploit the dynamic interaction that exists in this group between mathematicians and biologists. Our group is regarded internationally as one of the few that has consistently developed new methods for analysing molecular data and applied them to address fundamental evolutionary questions. Our selection of objectives covers problems that we see will occupy centre stage over the next decade. These include fundamental and difficult questions – from handling thousands of sequences in a population, to the origin of life, and techniques for resolving deep divergences in the tree of life. However we will also develop methodology useful for questions of relevance to New Zealand flora and fauna - methods to represent the hybrid origins of alpine plants, and for determining the manner and timing of various colonisation episodes. Other objectives include the development of new techniques for estimating evolutionary rates, for detecting selection, and for analysing gene order data.

Objective 1: New phylogenetic approaches to rapidly evolving populations

Methods have been developed to jointly estimate host and pathogen population parameters using a genealogy-based approach. Using coalescent-based estimation of host and viral population parameters on serial samples of viral sequences drawn from different hosts for an ancestral infection graph showed horizontal and vertical transmission events between hosts.

Book chapters have been completed outlining operational aspects of Matrix Represenation with parsimony (MRP) and MRC, and describing a new algorithm for handling ancestral

dates. A phase transition for the random cluster model on phylogenetic trees has been developed with planned application to data.

Objective 2: Mathematical modelling of species radiations, extinction and reticulation

Improved techniques for determining rates of evolution using serially sampled sequences have been developed. A two-island model for inferring effective population sizes, migration and mutation rates, using a coalescent-based Bayesian Monte Carlo Markov Chain (MCMC) with serial samples, and asymmetric migration rates has been developed together with a likelihood-based method for estimating a common mutation rate across viruses sampled serially from different hosts.

A new software package, Spectronet, incorporating techniques for analysing and displaying phylogenetic networks has been released. A paper modelling reticulate evolution is in preparation.

Objective 3: Develop phylogenetic bioinformatics

Although this objective was not scheduled to commence in Year One we have undertaken some preliminary research in this area. Techniques for dealing with large numbers of short sequences and continuum relationship between MP and ML, large MP trees were investigated. A branch and bound method for searching for the Maximum Likelihood phylogenetic tree has been tested on small models, and will be presented at the European Conference on Computational Biology in Paris in 2003.

The combinatorics of gene duplication trees together with a duplication algorithm was developed.

A new algorithm has been developed to integrate time into phylogenies. A technique to use inferred ancestral sequences to uncover gene homologs has been developed and proven successful.

Objective 4: Develop simulation to study the origin of life and earliest divergences

A phase transition for the random cluster model on phylogenetic trees has been developed with a planned application to data. A simulation study has shown that for some early conditions for RNA nucleotides are optimal.

Project Two, Objective 7: Installing a PIT tag (electronic ID) in a female tuatara on Stephens Island

Project Two, Objective 7: Sue Keall shows Wellington school pupils a tuatara as part of a conservation education seminar during Secondary School Pacific Nations visit to Victoria University

PRESENTATIONS

Total: 68

Daugherty, C. *Ecological restoration in New Zealand.* Guest Lecture at the San Diego Zoo. 2 May 2003.

Daugherty, C. *The fall and rise of New Zealand Herpetofauna.* Conference Presentation (invited - keynote address). International Herpetological Symposium, St. Louis, Missouri, USA. 19 July 2002.

Delsuc, F. *Bayesian Posterior Probabilities and Maximum Likelihood Bootstrap proportions: Oranges versus Apples?* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Delsuc, F., Penny, D., Lockhart, P.J. and E. J.P. Douzery. Model sensitivity of likelihood based phylogenetic methods based on empirical examples. Evolution2003, California State University, Chico. 23 June.

Gardner, P. *RiboRace: Evolving RNA in-silico*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Gibb, G. 2002. *Mutation and lineage diversity in the mitochondrial control region of Adelie penguins*. 5th Annual Molecular Ecology Conference.

Hare, K. and Daugherty, C. *How do nocturnal lizards function at cool night temperatures?* 10th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, Whakatane, New Zealand. 2 February 2003.

Hare, K. *How do nocturnal lizards function at cool night temperatures?* Annual Meeting of Ichthyologists and Herpetologists, Manaus, Brazil. 29 June 2003.

Haynes, G. 2002. *Genetic Divergence without speciation: nuclear genetic studies of Adelie penguins in Antarctica*. 5th Annual Molecular Ecology Conference.

Hendy, M. *Analytic solutions and bounds for maximum likelihood tree searches*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Hendy, M. *Hadamard conjugation: an analytic tool for phylogenetics 1*. l'Institut Henri Poincarre, University of Paris. 27 May 2003.

Hendy, M. *Hadamard conjugation: an analytic tool for phylogenetics 2*. l'Institut Henri Poincarre, University of Paris. 5 June 2003.

Hendy, M. *Combinatorics of tandem duplication trees.* Bioinformatics Group, Universitat Tuebingen, Germany. 30 May 2003.

Hendy, M. *Combinatorics of tandem duplication trees.* Mathematics Department, Universitaet Bielefeld, Germany. 3 June 2003.

Hendy, M. *Hadamard conjugation: an analytic tool for phylogenetics 3*. l'Institut Henri Poincarre, University of Paris. 6 June 2003.

Hendy, M. *Workshop Mathematics of Evolution and Phylogeny*. l'Institut Henri Poincarre, University of Paris. 19 June 2003.

Hendy. M. *Hadamard conjugation: an analytic tool for phylogenetics 4*. l'Institut Henri Poincarre, University of Paris. 13 June 2003.

Hoare, J., Keall, S., Nelson, N., Daugherty, C., Mitchell, N. and Pledger, S. *Declining body condition prompts concern for the*

Brothers Island tuatara, Sphenodon guntheri. Annual Meeting of Ichthyologists and Herpetologists, Manaus, Brazil. 27 June 2003.

Hoare, J., Keall, S., Nelson, N., Mitchell, N. and Daugherty, C. *A long-term trend of decline in body condition of the Brothers Island tuatara, Sphenodon guntheri*. 10th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, Whakatane, New Zealand. 2 February 2003.

Holland, B. *Combining spectral analysis with the parametric bootstrap to determine how well the best model fits the data.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Huynen, L., Millar, C.D. and D.M. Lambert 2003. *Nuclear DNA Detects Species Limits in Ancient Moa*. Evolution 2003, State University of California, Chico, California.

Lambert, D.M. 2002. *Adélie penguins, ancient DNA and evolution in the Antarctic.* Invited Keynote address, Centre for Gene Research Annual Student Colloquium.

Lambert, D.M. 2003. *Ancient DNA Studies from the 'Southern End of the World'*. 60th Annual Cawthron Lecture, Nelson.

Lambert, D.M. 2003. *Ancient DNA Studies from the 'Southern End of the World.* Invited Keynote Speaker, BioLive 2003, Waikato University, Hamilton.

Lambert, D.M. 2003. *Biological Information and Knowledge: Ancient DNA and Ecology* 2003. Plenary Talk, New Zealand Bioinformatics Conference, Te Papa, Wellington.

Larkum, T., Jermiin, L., and Lockhart, P. *The evolution of chlorophylls and bacteriochlorophylls.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Lockhart P. Organiser: US Evolution Meeting Symposium *"Phylogenetic Networks"* Urbana, July 2002

Lockhart P. *Chloroplast Origins* Gordon Conference on Theoretical Biology, Tilton, USA, June 2002

Lockhart P. *New Zealand as a model system for studying plant biodiversity,* BioQuest: Beloit, USA June 2002

Lockhart P. *New Zealand Plant Species Radiation*, Founding meeting of the New Zealand Plant Species radiation group (**http://awcmee.massey.ac.nz/~NZ_Plant_Species_Radiation_Group**) Christchurch, Nov 2002.

Matheson, J. *Using cellular automata to simulate evolutionary problems.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Matisoo-Smith, E. *Polynesian Origins: The kiore story*. Public Lecture, Auckland War Memorial Museum. 28 May 2003.

Matisoo-Smith, E. and Robins, J. *From the Beginning - MtDNA variation in Rattus exulans from island Southeast Asia and the Pacific*. Indo-Pacific Prehistory Association Annual Conference, Taipei, Taiwan. 10 September 2002.

Matisoo-Smith, E. and Robins, J. *The Commensal Model Continues - Rattus exulans mtDNA variation from Island Southeast Asia through to Polynesia – Implications for Human Settlement of the Pacific*. American Association of Physical Anthropologists Annual Meeting, Tempe Arizona. 23 April 2003.

Matisoo-Smith, E. and Robins, J.. *The Commensal Model Continues - Rattus exulans mtDNA variation from west to east.* New Zealand Archaeology Annual Conference, Arrowtown, NZ. 26 April 2003.

Mitchell. N. and Nelson, N. *Using metabolism to model physiological processes - a case study examining temperature dependent sex determination in tuatara.* International Roundtable of Comparative Developmental Physiology, Texas, USA. 1 June 2002.

Mitchell. N., Allendorf, F. and Keall, S. *What are the consequences of male biased sex ratios for the world's rarest tuatara?* Society for Conservation Biology Annual Meeting, Kent, U.K. 1 June 2002.

Nelson, N. *Sex determination and incubation of tuatara, Sphenodon punctatus*. 10th Biennial Conference of the Society for Research on Amphibians and Reptiles in New Zealand, Whakatane, New Zealand. 1 February 2003.

Nelson, N. *Temperature-dependent sex determination in natural nests of tuatara*. Conference Presentation (invited - keynote address). International Herpetological Symposium, St. Louis, Missouri, USA. 19 July 2002.

Ota, R. *Theoretical and applied results that show that Bayesian posterior probabilities on phylogenies are too liberal*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Penny, D. *Areas of Ignorance*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Penny, D. DNA and the origins of Polynesian peoples. DNA50 Lecture, New Zealand parliament. April.Phillips, M. *Phylogeny from morphological data*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Penny, D. Workshop on The Geometry of Trees. American Institute of Mathematics, Palo Alto, California. 1 June.

Penny, D., Delsuc, F., and. Phillips, M.J. *RY coding overcomes biases in mitochondrial data.* Evolution 2003, California State University, Chico. 23 June.

Ritchie, P.R. *Ancient DNA of Adelie penguins*. 49th Annual Meeting of the Genetics Society of Australia, Sydney, Australia.

Robins, J. *The Commensal Model Continues - Rattus exulans mtDNA variation from east to west.* 2003 Annual Conference of the New Zealand Archaeological Association, Alexandria, New Zealand. April 2003.

Rodrigo, A. *Phylogenetics and Anti-Virus Therapeutics*. Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Ross, H. *Using the maximum clique to construct a supertree.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Ross, H. *Using the maximum clique to construct a supertree.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Shepherd, L.D., Millar, C.D., Ballard, G., Ainley, D.G. Wilson, P.R., Haynes, G.D., Baroni, C. & Lambert, D.M. 2003. *Nuclear Gene Microevolution over a 6000+ Year Period*. Molecular Biology and Evolution Meeting, Newport Beach, California.

Spencer, H.G. *Maternal Selection with Genomic Imprinting.* Talk at *Evolution 2003*: Joint Meeting of the Society for the Study of Evolution, the Society of Systematic Biologists and the American Society of Naturalists, California State University, Chico, June 2003.

Spencer, H.G. *Did Eugenics Rest on an Elementary Mistake?* Department of Biology, Dickinson College, Pennsylvania. September 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Department of Biology, Appalachian State University, Boone, North Carolina. September 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Department of Ecology and Evolutionary Biology, University of Arizona, Tucson. October 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Population Genetics Group, Department of Molecular Biology and Genetics, Cornell University, Ithaca, New York. September 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Department of Ecology and Evolutionary Biology, University of Arizona, Tucson. October 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Department of Biology, Appalachian State University, Boone, North Carolina. September 2002.

Spencer, H.G. *Genetic Conflict and the Origin of Genomic Imprinting.* Population Genetics Group, Department of Molecular Biology and Genetics, Cornell University, Ithaca, New York. September 2002.

Spencer, H.G., A.E. Weisstein & M.W. Feldman. *Genetic Conflict and the Imprinting of Sex-linked Genes.* Talk at Evolution '02: Joint Meeting of the Society for the Study of Evolution and the Society of Systematic Biologists, University of Illinois, Urbana-Champaign, June 2002.

Steel, M. *Information theory, the logarithmic conjecture, and the unexpected benefits of Lagavulin for reconstructing the distant past.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

Steel, M. *Combinatorial aspects of phylogenetics. Invited speaker at a workshop on fixed-parameter algorithms.* Schloss Dagstuhl, Germany.

Steel, M. *Cyclic permuations, phase transitions, and phylogenetic oranges.* (Keynote speaker) at Workshop on new directions in phylogenetics and genomics. Universitat Tuebingen, Germany. July 2003.

Steel, M. *Cyclic permutations, phase transitions, and phylogenetic oranges.* Invited presentation at workshop on Graphs and Biology Universitat Bielefeld. June 2003.

Steel, M. *Information theoretic limits for molecular evolution and how to peel phylogenetic oranges.* (Keynote speaker) International conference on phylogenetics and genomics. Henri Poincare Institute, Paris, France. June 2003

Steel, M. *Phase transitions in phylogeny.* Kaikoura 03 International conference on Phylogenetics, Kaikoura, New Zealand. February 2003.

Weisstein, A.E., & H.G. Spencer. *Control of Gene Expression? A Population-genetic Model of the Evolution of Imprinting.* Talk at Evolution '02: Joint Meeting of the Society for the Study of Evolution and the Society of Systematic Biologists, University of Illinois, Urbana-Champaign, June 2002.

White, T. *Efficiently implementing maximum parsimony search on parallel computer architectures.* Annual New Zealand Phylogenetics Meeting, Kaikoura, 9-14 February 2003.

PUBLICATIONS

Total: 62

Asmussen, M.A., Cartwright, R.A. amd Spencer, H.G. (2003). Frequency-dependent selection with dominance: a window into the behaviour of the mean fitness. *Genetics* (in press).

Biek,R., Rodrigo, A.G., Holley, D. Drummond, A., Anderson, Jr., C.R., Ross, H.A. and Poss M.(2003). Epidemiology, genetic diversity, and evolution of endemic FIV in a wild population of cougars. *Journal of Virology* (in press).

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Bromham, L. and Penny. D.(2003). The Modern Molecular Clock. Nature Reviews - *Genetics* 4:216-224.

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Drummond, A.J., Pybus, O.G., Rambaut, A., Forsberg, R., and Rodrigo, A.G. (2003). Measurably evolving populations. *Trends in Ecology and Evolution*.(in press).

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Hare, K. and Daugherty. C. (2002). ncubation regime affects juvenile morphology and hatching success, but not sex, of the oviparous lizard Oligosoma suteri (*Lacertilia*: *scincidae*). *Conservation Biology* 16 (4): 887-894.

Hendy, M.D. and Holland, B.R. (2003). Upper bounds on maximum likliehood for phylogeneic trees. *Proc Europ Conf Comp Biol* (in press).

Holland, B.R., Huber, K.T., Dress, A. and Moulton, V. (2002). Delta Plots: A Tool for Analyzing Phylogenetic Distance Data. *Molecular Biology and Evolution* 19:2051-2059.

Holland, B.R., Penny, D. and Hendy, M.D. (2003). Outgroup Misplacement and Phylogenetic Inaccuracy Under a Molecular Clock - A Simulation Study. *Systematic Biology*. 52(2): 229-238.

Huber, K.T., Langton, M., Penny, D. Moulton, V and Hendy, M.. (2002). SpectroNet: a package for computing spectra and median networks. *Applied BioInformatics* 1: 159-161.

Hurles, M.E., Matisso-Smith, E., Gray,R.D., and Penny, D. (2003). Untangling Polynesian origins: the edge of the knowable. *Trends in Ecology and Evolution* (in press).

Huynen, L., Millar, C.D., Scofield, R.P. and Lambert, D.M. (2003). Nuclear DNA sequences detect species limits in ancient moa. *Nature* (in press).

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Penny, D. and Poole, A.M. (2003). Lateral gene transfer: some theoretical aspects. *New Zealand Bioscience*. (in press.).

Penny, D., Hendy, M. and Poole. A. (2003). Testing fundamental evolutionary hypotheses. *Journal of Theoretical Biology* 223: 377-385.

Penny, D., Murray-McIntosh, R. and Harrison, G.L. (2002). Estimating the number of females in the founding population of New Zealand:Analysis of mtDNA variation. *J. Poly Soc* 111:207-221.

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Ritchie, P.A., Anderson, I.A. and Lambert, D.M. (2003). Evidence for specificity of psittacine beak and feather disease viruses among avian hosts. *Virology* 306: 109-115.

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Robins, J.H., Matisoo-Smith, E., Ross, H. (2003) The origins of the feral pigs on the Auckland Islands - A mtDNA analysis. *Proceedings of the Royal Society of New Zealand* 33: 561-569.

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Ross, H.A., Lento, G.M., Dalebout, M.L., Goode, M., Ewing, G., McLaren, P., Rodrigo, A.G., Lavery, S. and Baker, C.S. (2003). Predicting Demographic Group Structures Based on DNA Sequence Data. *Molecular Biology and Evolution* 20: 1168-1180.

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Spencer, H.G., Feldman, M.W., Clark, A.G. and Weisstein, A.E. (2003). The effect of genetic conflict on genomic imprinting and modification of expression at a sex-linked locus. *Genetics* (in press).

Stockler, K., Daniel, I.L. and Lockhart, P.J. (2002). New Zealand Kauri (Agathis australis (D.Ddon) Lindl., Araucariaceae) Survives Oligocene Drowning. Academic Press: *Molecular Phylogenetics and Evolution* 24: 180-193.

Watson, E.E. and Penny, D. (2003). DNA and people: From East Africa to Aotearoa New Zealand. *New Zealand Science Review* 60: 29-35.

Weisstein, A.E., and Spencer, H.G. (2003). The evolution of genomic imprinting via variance minimization: An evolutionary genetic model. *Genetics* (in press).

Winkworth, R.C., Grau, J., Robertson, A.W. and Lockhart, P.J. (2002). The origins and evolution of the genus Myosotis L. (Boraginaceae). Academic Press: *Molecular Phylogenetics and Evolution* 24: 180-193.

Winkworth, R.C., Wagstaff, S.J., Glenny, D., and Lockart, P.J. (2002). Plant dispersal N.E.W.S from New Zealand. *Trends in Ecology and Evolution*.

ADDITIONAL FUNDING SECURED IN YEAR ONE

Total additional funds secured in 2002/3: **$2,115,409**

Clark, A. PhD student support from Crop and Food. $3,400.

Delsuc, F. Grant from the Lavoisier Programme, France. 16,400 Euro for one year.

Hare, K. American Society of Icthyologists and Herpetologists Travel Award. US$2,000 for travel to Annual Meeting of Ichthyologists and Herpetologists, Manaus, Brazil.

Hare, K. New Zealand Federation of Graduate Women Fellowship Trust Board Fellowship. New Zealand $10,000 Research Fellowship.

Harrison, A. Travel funds from the Maurice and Phyllis Paykel Trust. $1,500.

Hoare, J. FoRST Top Doctoral Achiever Scholarship. For 3 years: $25,000 pa, $3,000 pa conference allowance and university fees.

Hoare. J. Helen Stewart Royle Scholarship. $2,000.

Hoare, J. Shirtcliffe Fellowship. $2,500 renewable annually for up to three years.

Hoare, J. SSAR Student Travel Award $US400 to attend the Annual Meeting of Ichthyologists and Herpetologists, Manaus, Brazil, June 2003.

Holland, B. New Zealand Science and Technology Post-Doctoral Fellowship. $220,500 over three years.

Knapp, M. DAAD Doctoral Scholarship. 12,300 Euro per year for three years.

Lockhart, P. Ancient Plant Phylogenies: the problem of proteome diversity. Marsden Fund $400,000 over three years.

Matheson, J. Massey University Doctoral Scholarship. $25,000 per year for 3 years.

Nelson, N. Post-doctoral Fellowship. US$225 000 (3 years) San Diego Zoo Millennium Post-doctoral Fellowship.

Nelson, N., S. Keall, and C. Daugherty. Biological Sciences (VUW) Strategic Fund grant, for development of workspace on Stephens Island. $20,000.

Penny, D. Is Macroevolution sufficient for macroevolution? Marsden Fund $585,000 over three years.

Perrie, L. Collaborative project with Te Papa. Approx $40,000 for one year.

Riden, H. FoRST Top Doctoral Achiever Scholarship. For 3 years: $25,000 pa, $3,000 pa conference allowance and university fees.

Santure, A. FRST Enterprise Scholarship. $25,000 pa for 2 years.

Spencer, H. Postdoctoral fellowship from the University of Otago. $85,709 for one year.

Steel, M. NZIMA Phylogenetics Support programme. $171,000 for one year.

OVERSEAS VISITORS

The following scientists visited the Centre during Year One:

Professor Des Cooper
Macquarie University
Australia

Dr Sverker Edvardsson
Mid-Sweden University
Sweden

Dr Michael Thompson
University of Sydney
Australia

Dr Kathe Huber
Swedish National Agricultural University
Sweden

Professor Jonathan Losos
Washington University
USA

Dr Vince Moulton
University of Uppsala
Sweden

Dr Brooke Milligan
New Mexico State University
USA

Professor Axel Meyer
University of Konstanz
Germany

Professor Andreas Dress
University of Bielefeld
Germany

Professor Alan Cooper
Oxford University
United Kingdom

Professor Tom Parsons
US Armed Forces Molecular Id Lab
USA

Professor Peter Waddell
University of North Carolina
USA

Dr Bill Martin
University of Dueseldorf
Germany

Dr Dietmar Cieslik
University of Griefswald
Germany

BUDGET 2002/3

Salaries:		
Directors & Principal Investigators	220,000	2.2
Associate Investigators	41,332	0.58
Postdoctoral Fellows	384,000	8.0
Research/ Technical Assistants	84,000	2.4
Others	52,500	1.0
Total Salaries (a)	781,832	14.18
Other Costs:		
Indirect Costs: Overheads	781,832	
Direct Costs: Project Costs	222,800	
Travel	103,000	
Postgrad Student Stipends	360,000	18.0
Equipment depreciation	320,242	
Rental – equipment	0	
Subcontractors	0	0.0
Extraordinary expenditure	39,180	
Total Other Costs (b)	1,827,054	18.0
Total Expenditure	2,608,886	32.2

RSNZ funded $ 1,982,222

RSNZ funded cost per EFT (excluding postgraduate students) $139,790

Overhead cost paid to Host/Partner Institutions 85%

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