Australian Academy of Science

Summer program in Australia for US graduate students in science and engineering

2007

East Asia and Pacific Summer Institutes for US Graduate Students

NSF

Australian Government

Department of Education, Science and Training

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Preface

The Australian Academy of Science had the pleasure in welcoming a group of twenty outstanding students from the United States of America who participated in the fourth *Summer Program in Australia for US graduate students in science and engineering*.

The program, developed in collaboration with the US National Science Foundation, allows students to experience Australian science and engineering in research laboratories. Students also establish personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The 2007 program started on 13 June and lasted for eight weeks.

The Academy acknowledges the importance of research collaboration that goes beyond national borders and academic disciplines. It places great importance in strengthening exchanges that are both competitive and cooperative among talented young researchers.

The participants of the 2007 program achieved their immediate research goals, and from their reports I note that they have accomplished much more. Some students have initiated strong collaborative links that will provide the foundation for lifetime cooperative research. Others have gained a broad perspective of the nature of research in Australia, while others have been enriched by understanding another culture. I know that these graduate students and the young Australians with whom they shared their research will play an important role in advancing cooperative research between Australia and the United States in future years.

I would like to extend my thanks to the Australian Department of Education, Science and Training for their continued support in funding this Program, and of course to our colleagues at the National Science Foundation. Without their kind assistance and cooperation, this important program could not be sustained.

The Academy looks forward to welcoming a new group of students in 2008.

Professor Kurt Lambeck FAA, FRS
President
Australian Academy of Science

Contents

Orientation program

Wednesday 13th June

10.10 Participants arrive in Canberra

10.30 Check–in to Liversidge Apartments

13.00 BBQ lunch at Ian Potter House (Australian Academy of Science)

14.00 Administrative details for NSF Summer Program and living allowances for participants

15.00 Site seeing tour of Canberra to view main public buildings and monuments

18.00 Dinner at University House Cellar Bar Café.

Thursday 14th June

8.00 Breakfast in Liversidge Apartments

8.45 Arrive at the Shine Dome, Australian Academy of Science

9.00 Welcome to the 2007 Summer Program orientation session

Professor Sue Serjeantson, Executive Secretary, Australian Academy of Science

9.05 Official opening of the 2007 Summer Program orientation session

Professor Jenny Graves, FAA, Australian Academy of Science Foreign Secretary

Professor Graves is internationally renowned for her work in mammalian genetics and comparative genomics on Australian marsupials and monotremes. She has made extensive ground-breaking discoveries relating to the cell cycle, control of DNA replication, evolution of the mammalian genome and the function and evolution of sex chromosomes. She is a Research Director at the Australian Research Council Centre for Kangaroo Genomics.

9.15 Lecture – *Australian mammals: Exceeding strange and highly worth observing.*

Dr Hugh Tyndale-Biscoe, FAA

For more than 40 years Dr Tyndale-Biscoe has been employed in marsupial research; from brushtail possums in New Zealand, to quokkas in Western Australia, and from tammar wallabies in New South Wales to opossums in South America.

10.00 Morning tea

10.25 Lecture – *Post-doctoral research opportunities in Australia.*

Dr Joe Hlubucek, Research Project Officer, Australian Academy of Science

11.05 Group photo

11.30 Tour CSIRO Discovery Centre with Ms Christine Cansfield-Smith, Director CSIRO Discovery Centre

12.30 Lunch at CSIRO Discovery Centre Café

14.00 Attend question time at the House of Representatives and tour of Parliament House

15.35 Tour of main public buildings and monuments along Lake Burley Griffin and Mount Ainslie

19.00 Dinner at Zen Yai Restaurant, Civic

Friday 15th June

8.00 Breakfast in Liversidge Apartments

9.00 Arrive at the Shine Dome

9.15 Site visit of research schools, Australian National University

12.30 Picnic lunch at Australian National Botanic Gardens

13.30 Tour of Australian National Botanic Gardens

15.00 Tour of The National Museum of Australia – *First Australian tour*

17.00 Free time

Research reports

Name: Theresa Andrejack

University: Drexel University, Philadelphia

Research advisor(s): Professor Abdelmalek Bouazza

Host institution(s): Department of Civil Engineering, Monash University

Research subject

Geosynthetic-reinforced stone columns

Research description

Land scarcity brought about by urbanisation and suburban sprawl has created a need for construction projects to be located on weak ground that was not previously developed or is in the process of being reclaimed. As a result, government agencies, developers, and designers are more frequently confronted with sites that have undesirable subsurface conditions. The use of geosynthetics – synthetic materials to reinforce soil – has become an increasingly popular practice in order to mitigate poor site conditions. One such use of geosynthetics in this type of application is geosynthetic-encased stone columns.

Stone columns are most often used in soft clay soils to: 1) expedite consolidation of clay, 2) reduce detrimental ground settlement, and 3) increase the bearing capacity of the site. Because the modulus of the stone columns is much higher than that of the surrounding soil, the stone columns carry the majority of the vertical stress. The shear stress of the soil surrounding the column close to the ground surface is usually very low, and thus, there is no mechanism available to resist the bulging of the stone column when a load is applied. The bearing capacity of the improved site is governed by the degree of lateral deformations that occur during loading.

The geosynthetics industry has responded to this need by developing casing that is installed surrounding the stone column. The types of geosynthetics that fulfill this function are either geotextile 'socks' or geogrid tubes that enclose the stone or granular material of the column. By installing the geosynthetic in conjunction with the stone column, there exists a method to prevent the lateral bulging of column during loading, thereby maximizing the bearing capacity of the improved ground. However, the stress distribution within the geosynthetic casing is still poorly understood and has been proven to be dependent on several variables: the stiffness of the geosynthetic casing; the depth of encasement; the diameter of the stone column and; the strength of the surrounding soil. Naturally, it is essential to understand the components of the encase-column system for design purposes so that the system will continue to be effective throughout its design life. My research involves the computer modelling of these systems, on the elemental, small-scale, and full-scale levels in order to investigate the interaction of these materials and the maximum loads that will be experienced by the encasement material.

Research activities

The majority of my time at Monash University was spent designing finite element models using the program PLAXIS. These models can be classified into three groups and progressed as follows: 1) material characterisation laboratory tests, 2) small-scale unit cells, and 3) a full-scale geogrid-encased stone column system.

The first stage in finite element modelling was developing accurate material models according to characterisation laboratory tests. I was able to supply limited tensile data for the small-scale mesh material from tests I completed at my home university in the US prior to arriving in Australia. The other characterisation tests for the materials were done by me or a collaborating graduate student at Monash. It is essential to have accurate material models of the individual components before creating a finite element model where two or more materials form a system.

Once the characterisation tests were accurately modelled, I was able to utilise them when modelling the small-scale unit cell tests. A finite element model that correctly predicts the behavior of a small-scale unit cell test provides a basis for a parametric study to examine the effect of the encasement of the stone column, the stiffness of the encasement, the diameter of the stone column, the depth of encasement, and the strength of the surrounding soil. I was also involved with modelling a site where full-scale geogrid-encased stone columns will hopefully be installed. I ran into several challenging issues with this model, including how to accurately model a three-dimensional site in a 2D program where only plane strain and axisymmetric models can be created. Unfortunately, the Summer program ended before the issues with this model could be addressed.

Perspective of research after this program

The Summer program exposed me to a new research environment and allowed me to interact and create ties with leading researchers in the field of geosynthetics. I gained a great deal of technical knowledge and expertise as a result of this collaboration, and I will be able to apply my new skills to future research endeavours. Looking beyond the technical aspects of my experience, I gained a global perspective of research and of life – indeed, I think it is impossible not to achieve such a perspective while experiencing a different country, culture, people, scientific laboratory, university and engineering practice. I have no doubt that my expanded technical skills, new professional relationships and global awareness will be invaluable to me in the future.

Name: Emilie Bess

University: University of Illinois, Urbana–Champaign

Research advisor(s): Dr Stephen Cameron

Host institution(s): CSIRO Entomology, Canberra

Research subject

Mitochondrial genomics of bark lice (*Psocoptera*)

Research description

The arrangement of genes in the mitochondrial (mt) genome of insects can be used to evaluate relationships among species. The goal of this project is to compare the arrangement of genes in a large region of the mt genomes of a variety of bark lice (*Psocoptera*) species. These comparisons will provide information on how closely related island species, such as those from Hawaii, are to mainland species and may offer insight into the processes driving speciation in island systems. The mt DNA sequence data will also allow us to track the history of mutation events within the mt genomes of these insects. Because *Psocoptera* have higher rates of mt gene rearrangement than most insect lineages, bark lice are ideal model for investigating basic questions of the rates and patterns of mutation in mt DNA.

Research activities

Our goal for the eight-week program was to sequence a 3000 base pair region of the mt genomes of twelve species of bark lice. This process included three rounds of DNA sequencing and primer design. Some technical glitches in the lab prevented us from completing all three rounds of the lab work, so I will complete it in my home lab at the University of Illinois. Preliminary results are very promising and we plan to submit the results of this study for publication in early 2008.

In addition to this molecular research, I worked to construct an Internet-based interactive key to the *Psocoptera* families of Australia. Using Lucid software, which was developed by CSIRO and the University of Queensland, this key will be fully illustrated and available online within the coming year. The most challenging aspect of this project was the compilation of a character data matrix for Australian bark lice. I worked closely with Dr Courtenay Smithers at the Australian Museum in Sydney on this part of the project, and we succeeded in producing the most complete data set on *Psocoptera* families ever compiled. This was a great learning experience for me. There is nothing like spending hours at a microscope with an old master.

Perspective of research after this program

Dr Cameron and I spent a great deal of time discussing the technical aspects of our research on comparative mt genomics. These conversations were exceptionally valuable to me, improving my understanding of this specific topic and of larger questions in my thesis research. While we did not accomplish as much lab work as we had hoped, my time was very well spent. I am currently working to complete the data collection for this project at UIUC and I look forward to continuing to collaborate with Dr Cameron and his colleagues at CSIRO. I was happy to have a chance to work with the staff of CSIRO and the Australian Museum on a second project, an interactive identification key to Australian *Psocoptera*. I am pleased that this project will make a meaningful contribution to knowledge of Australian insects.

Advisor's remarks

I was extremely happy to have Ms Bess work in my lab as part of the Summer program exchange. Emilie was the first visitor to the lab that I have had since starting here in January so it was a large learning curve for both me as a supervisor and her as a visitor. Due to teething problems with lab equipment we did not achieve all that we had hoped but did manage to work through the most technically demanding component of her project (amplification of large fragments of DNA in a manner useful for sequencing) and I am confident that she will be able to complete this work in her home institution. In the face of these technical hurdles, Emilie adapted well and threw herself into an alternative course of work: preparing an electronic identification key for Australian *Psocoptera* (bark lice). This project involved her mastering new software to organise this data and complemented ongoing work within ANIC to prepare electronic keys for the Australian insect fauna. She also took this opportunity to work with specialists at another major Australian collection which has lead to her being invited back for further work with the Australian Museum in 2008. On a personal note Emilie was a joy to have around: hard working, cheerful and inquisitive, and her insights have resulted in several new directions in my own work.

Name:	Robert Cramer
University:	University of Alabama, Tuscaloosa
Research advisor(s):	Dr Jack White
Host institution(s):	School of Psychology, University of South Australia

Research subject

Personality functioning in criminal defendants and civil litigants

Research description

We are examining the Five-Factor Model of Personality (FFM) as it relates to maladaptive personality functioning in criminal defendants and civil litigants. The FFM consists of five broad domains: neuroticism, extraversion, openness, agreeableness and conscientiousness. From a theoretical perspective, these domains underlie expression of personality characteristics and other behaviours. We are particularly interested in the validity of the FFM as it relates to pertinent criminal characteristics, namely anti-social features, borderline traits and substance use. Multivariate regression will be employed to assess these relations upon completion of assembling the archival dataset.

Research activities

I composed a comprehensive literature review, archived most of six years worth of forensic data and assisted in assessment of criminal defendants. All of these activities were supervised by Dr Jack White. Additionally, I assisted with conference preparation and literature review at the university under the direction of Dr Andy Day.

Perspective of research after this program

Simply put, the research community is much larger than I thought. Potential international collaboration has altered my post-graduate options. Although I still aim to pursue an academic career, I remain open to overseas locations such as Australia. I have also gained an appreciation for the practical implications of research, such as validating the use of a new instrument in forensic practice.

Advisor's remarks

Very positive research project with Rob being the ideal researcher. He balanced having a rich and rewarding time with the hard slog of data collection and analysis.

Name: Gregory Crosswhite

University: University of Washington

Research advisor(s): Dr Andrew Doherty

Host institution(s): Department of Physics,
University of Queensland, St. Lucia

Research subject

Applying variational techniques to find translationally invariant matrix product representations of ground states for infinite one-dimensional quantum spin systems

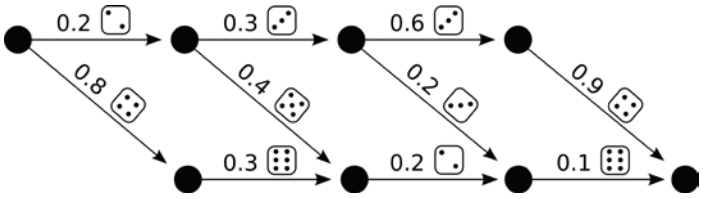
Research description

The laws of quantum mechanics give rise to a strange behaviour called *entanglement*, in which two or more particles can each seem to know what the others are doing, no matter how far away they are from each other. Imagine for a moment that you and some of your friends had entangled dice. Then no matter where you are, when you roll your die, you will know that all of your friends will get the same result when they roll their own die. This will be true even if, say, one of your friends was on Mars and decided to roll their die at the same time as yours. This is not because the dice are fixed; each time you roll, you get a different and unpredictable result, but that result will always be the same as that obtained by your friends. This effect appears as if it were communication faster than the speed of light, and so Einstein dubbed it 'spooky action at a distance.'

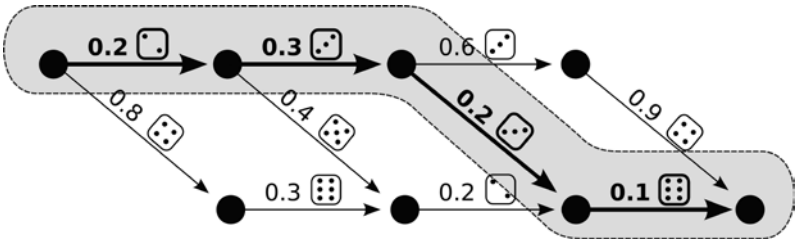
Even though entanglement may be spooky, it turns out to be very useful. Although you cannot use it for actual faster-than-light communication, it turns out that if you build a computer that can tap into it – a *quantum* computer – then you get the power to solve problems efficiently that are intractable for classical computers. Furthermore, it turns out that entanglement is responsible for many exotic behaviours we see in materials, such as superconductivity and superfluidity, that we can and do make use of.

Unfortunately, the presence of entanglement in a system makes it very difficult for it to be simulated. To see why, contrast quantum dice with normal dice. If you had a handful of normal dice, then all you would need to know the probability of each outcome of all dice is just the probability distribution of each individual die separately. However, for quantum dice, due to the presence of entanglement, you cannot do this because the probability distribution of each die can depend on the outcome of rolling the others; instead, you have to determine the probability of each and every one of the outcomes possible for all the dice – 6^N outcomes for N dice! This makes it intractable to completely understand the behaviour of even 100 quantum dice.

Fortunately, although in general quantum systems need an exponential amount of information to be simulated properly, in practice many systems of interest can be adequately simulated with much less information. The trick is to restrict yourself to a subset of all possible distributions that gives you enough flexibility to adequately duplicate the behaviours of the system while still being small enough to be tractable. One such subset which was introduced in the mid-90's is called *matrix* product states. These can be visualised as diagrams which look like the following:



Each possible 'walk' through the diagram gives a possible roll of 4 dice, and the probability of obtaining that combination is given by the product of the weights along the path. So for example, the probability of rolling 2, 3, 3, 6 is 0.2 x 0.3 x 0.2 x 0.1 = 0.0012, as illustrated in this diagram:



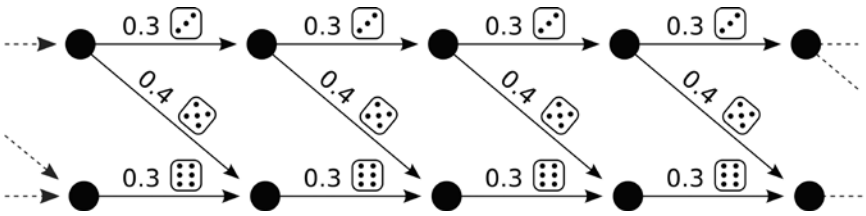
There has been a lot of interest in matrix product states because they seem to offer a good compromise between size and expressive power; the amount of information needed to represent them only grows linearly with the size of the system being modelled, and yet they are able to adequately capture the entanglement present in many systems in which we are interested. However, since they are relatively new, we are still investigating exactly how effective they can be, and there are many situations in which we are still figuring out the best way in which to apply them. This is the basis of my doctoral program research.

Research activities

'If we knew what it was we were doing, it would not be called research, would it?'

- Albert Einstein

During the summer, I designed an algorithm to find translationally invariant matrix product state representations for ground states of infinite one-dimensional systems; an example of what such a representation looks like is as follows:



The links (which correspond to the weights of possible outcomes at a site) are repeated ad infinitum; thus, to represent this infinite system we only need the set of links at one site.

There are many reasons why we are interested in finding ground (ie lowest energy) states, but one of the major ones is simply that they are the easiest states to find. To find higher energy states one has to solve an eigenvalue problem, which is difficult; by contrast, to find the ground state one only has to solve an *optimisation* problem, which is much easier. The premise of algorithms based on the optimisation approach is that we find the lowest energy state that can be expressed in matrix product form, and then hope that this is not too far from the true ground state of the system.

Although there is already an algorithm that finds ground states for translationally invariant one-dimensional systems, it uses a technique called imaginary time evolution, and we were interested in whether we could use a direct variational approach instead. The idea behind the direct variational approach is that you fix all of the weights except those at one site, and then find the set of weights at that site which minimises the energy of the system. In a sense, though, this goes against the spirit of a translationally invariant state – if one only changes the weights at one site, then one has broken the translation invariance. Our original idea for how to solve this was to update *all* the sites at once with the new weights at the minimised. However, this idea has a fundamental problem: given that the updated weights were selected at that site assuming the old weights were at every other site, it is not necessarily the case that putting the updated weights everywhere will result in a lower energy state than what one had started with. We had ideas for many tricks that might make this approach work anyway, but after a couple of weeks it was obvious that this was not going to work.

Instead, we turned to an alternative approach. We started with a finite system, and then gradually introduced new sites to the middle of the system. The idea is that after a period of time, the new sites would start to feel like they were in an effectively infinite system, since they would be surrounded by many sites to the left and right. After a period of time, hopefully, each new site introduced would start to appear like the last one, at which point we would declare that we have found the translationally invariant representation.

There were many technical issues that we had to resolve to get this to work. One particular problem which thwarted me for a long time was that in one step of the algorithm an arbitrary complex phase was getting introduced into many of the weights; this prevented the algorithm from converging. I spent many days coming up with kludges to work around this, but eventually my host figured out a very simple, elegant solution that caused all of the phases to be completely cancelled.

Eventually, all of the issues were resolved and the algorithm worked just as we hoped it would. At that point, we started looking at ways to make the code implementing the algorithm run faster. The group offered me a great deal of advice that allowed me to improve my running time by an order of magnitude – runs which had taken two hours were reduced to *two* minutes. We had shown at this point that not only could the variational method be made to work, but it was competitive with the previous approach.

Perspective of research after this program

My ultimate goal in my research is to learn how to model systems with more than one dimension. Before this program, I had been looking into applying known techniques for modelling some finite sized systems. Now, however, I have been given ideas for a more exciting project: developing a new technique for modelling translationally invariant two-dimensional systems, based on ideas from the one-dimensional code.

We spent the last couple of weeks of the summer discussing how we could extend the approach we had used for one dimension into two dimensions. For various reasons, it is much more difficult to insert a new site into the center of the system when working in two dimensions; but thanks to the experience of the group in working with two-dimensional systems, we were able to figure out a way to do it. Moreover, they taught me a number of tricks they had learned which I will need to get my code working, as well as to make it efficient.

So, in short, this program has given me exposure to new ideas that have lead my research into a new and exciting direction.

Name:	Steven Dow
University:	Georgia Institute of Technology, Atlanta
Research advisor(s):	Dr Bruce Thomas
Host institution(s):	School of Computer and Information Science, University of South Australia, Mawson Lakes Campus

Research subject

Simulating complex computing applications using human hidden wizards

Research description

My primary research project involved classifying a broad range of sensor and display into a taxonomy of 'mixed reality' technologies with the goal that other researchers can understand possibilities for mixing physical and virtual environments. Also, drawing from my background in psychology I consulted with other PhD students in the lab to advise their human–subject experiments.

Research activities

The primary activity was an extensive literature search on existing configurations of sensors and displays in human–computer interaction, as well as related taxonomies. I led brainstorming sessions with the host advisor and other students and produced initial sketches for a visualisation of our findings. I led a half-day workshop on some prior work, sharing my expertise on designing 'augmented reality' applications in a multimedia tool called Director.

Perspective of research after this program

I learned that all research labs operate differently, a perspective solidified after visiting two other labs in Australia and New Zealand. I really liked the work environment in Dr Thomas' lab and it helped me think about how I will work with students and balance my life as a professor one day.

Advisor's remarks

Steven Dow's stay was quite productive for gaining a mutual understanding of each other's work. Steven worked closely with a number of research students on experimental methods for human–computer interaction. His novel thoughts on wizard-of-oz techniques helped us better understand new ways of evaluating our work. Steven presented some workshops on Georgia Tech's DART software. Overall it was a very positive experience for everyone.

Name: Wesley (William) Dowd

University: University of California, Davis

Research advisor(s): Dr Gillian Renshaw

Host institution(s): School of Physiotherapy,
Griffith University,
Gold Coast Campus

Research subject

Proteomic analysis of mechanisms of hypoxia and anoxia tolerance in epaulette sharks

Research description

Few vertebrates can survive low oxygen (hypoxia) or the complete lack of oxygen (anoxia) for any extended period of time. The epaulette shark (*Hemiscyllium ocellatum*) survives periodic hypoxic and anoxic episodes of a few hours at 25–30ºC on shallow reef platforms of the Great Barrier Reef with no long-term detriments. These episodes occur during nocturnal low tides when net ecosystem respiration exceeds oxygen production. Interestingly, the reef and lunar tidal cycle at Heron Island interact to create a natural hypoxic pre-exposure, or preconditioning, environment in which epaulette sharks experience progressively longer and more severe hypoxic episodes over several days. Hypoxic preconditioning lowers total metabolic rate and the critical oxygen tension as well as oxidative enzyme activity in motor regions of the brainstem, but its effects on the cellular stress response and energy metabolism within different tissues are unknown.

Notably, epaulette sharks do not utilise many of the previously described mechanisms for tolerating low oxygen, yet they are still able to tolerate repeated hypoxia and at least several hours of anoxia at tropical temperatures. Dr Renshaw previously demonstrated several mechanisms promoting brain energy conservation in this species. Her work has also suggested that epaulette shark neurons are able to quantify the severity of abiotic stress (they discriminate between hypoxia and anoxia) and to adjust their stress response accordingly, but the molecular mechanisms underlying this 'threshold' remain elusive.

I came to Australia to extend this research to other tissues throughout the animal, with the goal of examining: 1) the specificity/generality of stress response mechanisms across tissues, 2) molecular signalling networks involved in the above 'threshold' quantification of oxidative stress, and 3) possible tradeoffs among tissues during exposure to low oxygen, such as conserving brain function at the expense of liver or kidney function during low oxygen challenge.

Research activities

We conducted two sets of experiments on epaulette sharks at Heron Island Research Station during the Summer program, to test the following hypotheses: 1) Hypoxic preconditioning regimens prime the molecular response to subsequent oxygen challenge by upregulating constitutive expression of compensatory mechanisms involved in low oxygen tolerance; 2) Anoxia elicits both unique and

more pronounced molecular responses within cells of epaulette sharks in comparison with hypoxia.

1. Epaulette sharks were sampled 24 hours after one standardised hypoxic episode (two hours at 5–6% of air saturation), two hours after a second hypoxic episode, and 24 hours after a second hypoxic episode. This experiment examined both the response to hypoxia and the results of hypoxic preconditioning.

2. Epaulette sharks were sampled two hours after one standardised anoxic episode (0.2% air saturation until loss of righting reflex), then at 24 hours under normoxia, and after a second two hour anoxic episode at 26 hours. This experiment evaluated the effects of anoxia and changes due to multiple anoxic exposures. Comparison of the two experiments will reveal differences between anoxia and hypoxia.

Standardised hypoxic and anoxic exposures were performed in airtight acrylic chambers by bubbling seawater with nitrogen gas. Control sharks under normoxia were compared with the treatment animals at each time point. At the appropriate times, tissues were quickly sampled in duplicate, immediately snap-frozen in liquid nitrogen, and shipped to UC Davis on dry ice for analysis.

I will use a proteomics approach (two-dimensional gel electrophoresis combined with mass spectrometry) because it provides a simultaneous means to assess changes in a wide array of proteins and cellular pathways in response to hypoxia. I will analyse cerebellum, gill, kidney, and rectal gland tissues at each time point. Hypometabolism occurs in the epaulette shark brain in response to hypoxia. The gills are the site of oxygen uptake and the interface between hypoxic–anoxic environments and the shark, such that responses to low oxygen may be most extreme in this tissue. In addition, the gills' significant functional role in acid–base balance may be particularly important during anaerobic metabolism, when epaulette sharks produce large quantities of lactate and blood pH is expected to decrease. The rectal gland is a highly aerobic tissue with a critical role in osmoregulation (secretion of NaCl), but it may also have significant anaerobic capacity. I will identify key proteins (pathway 'nodes') involved in the hypoxia–anoxia response within each of these tissues to look for common, tissue-specific, and treatment-specific mechanisms. I will assess changes in circulating energy sources (glucose and ketone bodies) and metabolic byproducts (lactate) in the blood. Plasma samples will also be analyzed (pH; concentrations of Na^+, Cl^-, and urea) to detect breakdowns, or selective down regulation, of acid–base or osmoregulatory processes in response to hypoxia–anoxia.

The bulk of the results of this project await further laboratory work in the US. Interestingly, this trip revealed a possible reverse temperature effect on the ability of epaulette sharks to tolerate anoxia. Previous research has been conducted during summer at Heron Island. This winter trip revealed that sharks lasted shorter periods until the loss of righting reflex at cooler temperatures, a phenomenon which awaits further investigation.

In addition to the research described above, we also collected tissue samples for several of Dr Renshaw's ongoing projects. One examines gene expression profiles in the epaulette shark heart following hypoxia and anoxia. The two Griffith University undergraduate students who accompanied us to Heron Island (Mr Adrian Castelli and Ms Dea Olivier) and assisted with the experiments will also be conducting third year projects using real-time PCR to examine expression of specific epaulette shark genes following exposure to low oxygen stress. We also collected

samples for analysis of brain energy charge following low oxygen exposure, as well as tissue samples for a proposed population genetic survey of the Heron Island reef epaulette shark population.

Perspective of research after this program

The Summer program experience was invaluable to me from both a personal and professional perspective. I completed two experiments that I anticipate will be included as two or more chapters of my dissertation and constitute two or more published research articles. This work on epaulette sharks will provide a valuable comparison to other forms of stress that I am examining for my PhD work. I learned a great deal about the study system from Dr Renshaw, particularly neuronal mechanisms of low oxygen tolerance. I had the incredible opportunity to work at the beautiful (despite the recent catastrophic fire) Heron Island Research Station on the Great Barrier Reef for a month, where I was totally immersed in this unique environment. I also gained a valuable inside look into the workings of the Australian education and funding systems and their idiosyncrasies. The approach of Australian researchers to science and life was also extremely balanced and refreshing. I look forward to furthering this collaboration and developing new ties with Australian researchers.

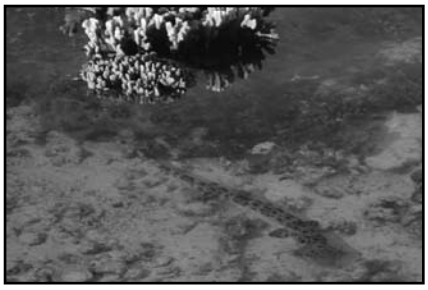
Advisor's remarks

I was delighted to see the level of commitment and enthusiasm from Wes Dowd. He was able to work independently, taking a major role in planning the experiments with attention to accuracy as well as showing a lot of initiative in solving problems encountered in the field. Wes was eager to learn and discuss ideas as well as putting in long hours whenever needed and took responsibility for animal maintenance. In addition, he acted as a mentor for two students who accompanied us on the field trip. I am sure Wes will make a great scientist and I would unreservedly recommend Wes for a science based research position in future.

Despite some difficulties with the facilities available after the fire at the research station we were able to meet our research targets. With a little ingenuity and a lot of help from the staff at the research station, we built a temporary aquarium facility complete with animal holding pool and shade cloth. We were able to control water quality, temperature, salinity and oxygen levels as well as carry out dissections and rapidly freeze the samples in liquid nitrogen. We returned from the field trip with over 500 tissue samples from the animals we collected on permits from the Great Barrier Reefs Marine Parks Authority.

It was a privilege and a pleasure to be involved in the NSF Summer program. It provides a valuable learning opportunity for students and certainly helps to form collaborative international links between laboratories. I anticipate that this new collaboration will continue to develop.

William Dowd in the laborotory



Epaulette shark

Name: Larisa Grawe DeSantis

University: University of Florida, Gainsville

Research advisor(s): Dr Stephen Wroe and Dr Judith Field

Host institution(s): School of Biological, Earth and Environmental Sciences, University of New South Wales, and The Electron Microscope Unit, University of Sydney

Research subject

Effects of climate change on Australian megafauna from the Late Quaternary to the present: Evidence from stable isotopes of herbivorous mammals at Cuddie Springs

Research description

The Australian megafaunal extinction debate is highly contentious, with some researchers attributing the megafaunal extinctions to the arrival of humans and others to climate change. To properly evaluate if and how climate change has affected megafauna we need to first understand if climate change has altered the diets of herbivorous megafauna. By comparing the stable isotope ratios of vertebrate tooth enamel, through time, faunal remains can provide an independent measure of habitat type and help elucidate past climate regimes. Because stable carbon isotopes are incorporated into tooth enamel retaining a dietary isotopic signal that is reflective of plants consumed (ie ^{13}C enriched C_4 plants versus ^{13}C depleted C_3 plants) and ^{13}C to ^{12}C ratios do not decay with time, the ratios of the past can be interpreted similar to those of today. Variation in $\delta^{13}C$ values within individual teeth (ie serial samples, a series of samples taken parallel to the growth axis of the tooth) can also indicate seasonal differences in diet, reflective of changes in vegetation due to seasonal water stress. Additionally, variation in stable oxygen isotopes of mammalian tooth enamel is a function of body water that reflects the response of meteoric water to changes in temperature, precipitation and humidity. Seasonal variations are consequently recorded in tooth enamel with more positive $\delta^{18}O$ values indicating a warmer and/or dryer climate as compared to more negative $\delta^{18}O$ values during cooler and/or wetter winters. Thus, $\delta^{13}C$ and $\delta^{18}O$ values of mammalian tooth enamel can be used to determine diets, quantify dietary variation, and compare seasonal variation through time.

In collaboration with Dr Stephen Wroe and Dr Judith Field, key players in the Australian megafaunal extinction debate, we examined how climate change affects the diets of herbivorous mammalian megafauna using stable isotope techniques. Prior isotopic research on the collagen of marsupials (*Macropus*, *Sthenurus* and *Diprotodon*) has demonstrated that some megafauna shifted their diet with available forage. Our work builds upon these data by providing insight into annual dietary variation, the diets of mammalian communities, and identifying climate changes using oxygen isotopes. By comparing the stable carbon and oxygen isotope values of taxa present throughout the late Quaternary, we can document if dietary shifts in megafauna occurred and in what taxa. We therefore ask the following key questions:

- Has relative seasonality changed from the late Quaternary to the present in southeastern Australia?

- How has climate change affected the diets of mammalian herbivores?

Research activities

In collaboration with my hosts, we examined how Australian megafauna responded to climate change over the last 400,000 years at Cuddie Springs. After identifying the mammalian teeth collected from Cuddie Springs, a fossil site located southwest of Sydney, we designed a study that compares the pre-archaeological mammalian community (400,000 years ago) with a rare archaeological fauna (36,000 years ago). I subsequently sampled the tooth enamel of the herbivorous mammalian taxa from these horizons for stable carbon and oxygen isotope analyses. These data, once prepared and analysed at the University of Florida, will enable us to infer the diets and subsequent climate of the herbivorous mammalian megafauna at Cuddie Springs living 400,000 and 36,000 years ago. Additionally, I serially sampled *Diprotodon* (large 'wombat-like' marsupial) incisors to document climatic variation over the course of a year in both the pre-archaeological and archaeological horizons. These serial samples will enable comparisons of annual climatic variation over the last 400,000 years.

Perspective of research after this program

The Summer program has significantly improved my understanding of mammalian palaeoecology. Being immersed in fossil marsupials, I gained knowledge of their evolutionary relationships, unique morphology, and nutritional ecology. Having a broader perspective on late Pleistocene mammalian megafauna, I am now better equipped to address larger scale questions relating to mammalian responses to climate change. Since my research in Australia concluded, I have begun analysing the data and am currently preparing for the next phase of palaeoecological research I aim to conduct in Australia with newly gained collaborators. I hope that my participation in the Summer program was just the first of many collaborative opportunities with Australian researchers.

Advisor's remarks

Ms DeSantis is clearly an extremely capable and focused young researcher. I have been much impressed by her ability to define research questions and design appropriate methodologies. She shouldered and completed an extraordinary workload in her short stay and there is no doubt in my mind that this effort will be translated into published science. I would be only too happy to assist her in any further work on Australian Pleistocene ecology.

***Diprotodon* incisor, ~36,000 years old, that has been serially sampled for stable carbon and oxygen isotopes.**

Name: Gwyndolen Harburg

University: University of Texas Southwestern Medical Center, Dallas

Research advisor(s): Dr Jane Visvader

Host institution(s): Department of Molecular Genetics of Cancer, Walter and Eliza Hall Institute of Medical Research

Research subject

Involvement of pro-proliferative pathways in mouse mammary stem cell proliferation and self-renewal

Research description

Stem cells have been found in many organs in the body, including mammary glands. Mammary stem cells (MaSCs) are thought to be crucial players in the dynamic remodelling of mammary tissue during pregnancy, lactation and involution. There is also compelling evidence that stem cells are involved in breast cancer. Thus, it is of great importance that there is a better understanding of how MaSCs are regulated. This study targeted signalling pathways known to be important for mammary gland development and, conversely, for breast cancer initiation, to determine how these pro-proliferative pathways affect MaSC proliferation and self-renewal.

Research activities

To explore the impact of pro-proliferative pathways on mammary stem cells, I manipulated the activity of the pathways by either overexpressing key proteins in the pathways or exposing the stem cells to activating ligands. I learned a number of techniques necessary to perform these experiments including: purifying mammary stem cells by flow cytometry, maintaining the cells in *in vitro* cultures, and genetically modifying stem cells by transfections and viral infections. Although I was only able to obtain very preliminary results during the summer fellowship, my findings suggest that pro-proliferative pathways positively affect mammary stem cell proliferation.

Perspective of research after this program

This summer research experience has increased my maturity as a stem cell researcher. I have been fortunate to work with some of the best stem cell researchers in Australia and have gained much by absorbing their knowledge and experience. I learned new techniques that will broaden the scope of my future research plans. The research project I began this summer has opened up new avenues to understand how stem cell proliferation is regulated and may give insight into key aspects of stem cell and cancer biology in the future.

Advisor's remarks

It was a pleasure having Gwyn in the lab as a summer student. She was very keen to learn new techniques in mammary gland biology, participate in lab meetings and read the current literature in this field. Her previous experience in neurobiology enabled her to readily absorb concepts and cellular assays in the breast cancer area, thus making her visit to Australia a very worthwhile experience.

Name: Joshua (Chuck) Harrell

University: University of Colorado Health Sciences Center, Denver

Research advisor(s): Professor Darryl Russell

Host institution(s): Obstetrics and Gynaecology Research Centre for Reproductive Health, University of Adelaide

Research subject

Role of hormones on lymphatic vessel development and breast cancer lymphatic metastasis

Research description

Lymphatic vessels (LV) have long been known to play critical roles in normal physiology and development as well as in the progression of cancers. However, our understanding of the factors that regulate their development and function is limited. Recently proteins that distinguish LVs from blood vessels have been identified. These markers will allow us to begin more in depth studies to understand the factors that regulate their development and function in normal and disease processes. At this point virtually nothing is known about the role of hormones or hormone regulated genes in LV development in hormone dependent organs or cancers. In addition, mapping the development of the lymphatic system in the mammary gland and the ovary has yet to be fully accomplished.

My project was to characterise the mammary glands and ovaries from estrogen receptor knockout mice compared to normal mice to determine if loss of estrogen signalling resulted in diminished lymphatic vessel development. A second goal was to determine if a hormone regulated protease ADAMTS1 was differentially expressed in an experimental model that generated breast tumors compared to their lymph node metastases.

Research activities

By immunohistochemical analysis we aimed to determine if loss of estrogen receptor alpha or beta contributed to a loss of lymphatic vessel development in mammary glands, ovaries or uteri. With this approach it was evident that there was no obvious difference in uterus lymphatic vessel development in mice that do not have functional estrogen receptors. Part of our ongoing collaboration is to quantitatively assess this in mammary glands and ovaries through reverse transcriptase polymerase chain reactions and western blotting. During my research it became apparent that we needed to develop a new method of detecting lymphatic vessels in whole mammary gland. Since immunohistochemistry uses only 5 micron-thick tissues sections, it is hard to assess lymphatic density in a tissues that may be 500 microns thick. Therefore we adapted our current protocol and attempted to do whole mammary gland lymphatic vessel staining. Using the mouse ear as a reference (Figure 1) for what lymphatics look like in a whole tissue, we were able to detect lymphatics in immature mammary glands using this approach (Figure 2, 'LV'). We conclude that there are few lymphatic vessels in the mouse mammary gland in an immature mouse. As

the mammary gland develops it become more fatty and some further adapting of our protocol will be necessary to determine if lymphatic vessel development parallels the epithelial ductal development that occurs at puberty.

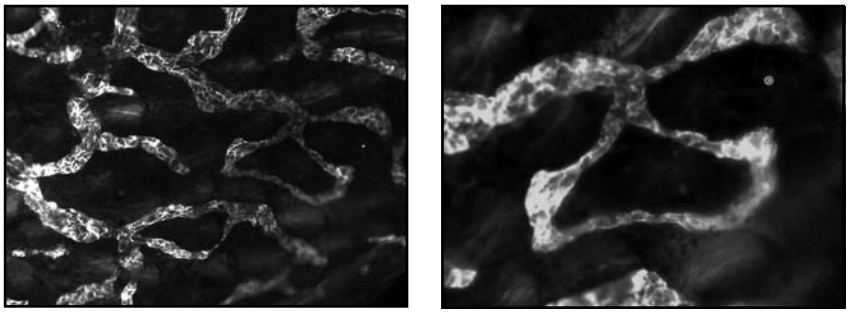


Figure 1. Lymphatic vessel whole mount from mouse ear. Left 20x, right 40x.

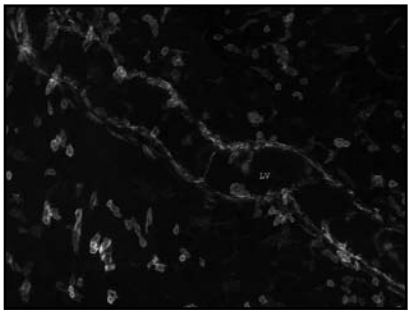


Figure 2. Mouse mammary gland lymphatic vessel.

Some interesting observations were made during our optimisation of the whole mount lymphatic vessel staining. We found that the 'lymphatic specific antibody' we used not only detected the lymphatic endothelial cells that line and compose a lymphatic vessel, but also that the LYVE antibody also binds to other 'non-lymphatic vessel' cells that were scattered throughout the mammary gland (Figure 2). Further analysis will be needed to determine which cell type this is. We hypothesise these are macrophages, and future dual immunohistochemical approaches will determine if this is the case.

For the second half of my project I determined if a protease that is implicated in aggressive cancer cell behaviour was expressed in my mouse model of breast cancer metastasis to lymph nodes. Through immunohistochemical analysis I found that ADAMTS1 was expressed in low levels in primary breast tumors, and these levels were unchanged in the matched LN metastases. We conclude that in this experimental model of breast cancer progression that ADAMTS1 is not likely to play a role in cancer spread. Future studies are aimed at investigating this protease in different models and in clinical cases of breast cancer.

Perspective of research after this program

My research experience in Australia was fantastic. Not only was I able to conduct experiments in a new lab setting, but I was also able to tour numerous laboratories in Adelaide as well as in Melbourne. From this experience I realise that conducting international research collaborations with researchers in Australia is possible and mutually beneficial, allowing for better science to be conducted in both countries. I look forward to continuing my collaboration with my host lab

in Australia, as well as initiating new collaborations in the future. Things are looking good for Australian research in the future.

Advisor's remarks

Chuck's brief tenure in my laboratory was extremely beneficial for myself and my lab team. His unique experience in the study of lymphatic metastasis and microarray gene expression analysis is directly applicable to new projects in which our laboratory is embarking and Chuck was able to give insightful advice on our research.

Chuck worked vigorously on a research project of his own conception in my lab seeking to confirm a role for estrogen in lymphatic development and metastasis of breast cancers to lymph nodes that is implicated both through his and our previous research. Some preliminary data and key methods were established, and this project was limited only by a lack of time and the difficulties of transporting unique biological samples between USA and Australia. This research collaboration will continue and is expected to yield at least one manuscript as well as ongoing collaborative exchange between our two laboratories.

It was a pleasure on a personal level to have Chuck in our laboratory. He was a model lab citizen and contributed to all aspects of the lab's functions. Chuck also immersed himself in the cultural opportunities afforded him through this visit to Australia and will take with him a healthy knowledge of South Australian wine and footy culture.

Name: Nikolas Hrabe

University: University of Washington, Seattle

Research advisor(s): Professor Mark Hoffman

Host institution(s): School of Material Science and Engineering, University of New South Wales

Research subject

X-ray computed tomography characterisation of porous titanium for biomedical applications

Research description

Solid titanium is currently used for orthopaedic joint replacement components such as hip stems but is limited by an elastic modulus (stiffness) much higher than bone. It is thought this stiffness mismatch, termed stress shielding, limits the useful lifetime of the implant. Porous titanium will have a lower elastic modulus (stiffness) than solid titanium, and possibly make a more mechanically compatible implant material. To achieve this, it is necessary to understand the fundamental relationship between the amount, size, and shape of porosity and the resultant mechanical properties. X-ray computed tomography (CT) is a non-destructive characterisation method that provides information on the pore structure of the porous titanium of this thesis work.

Research activities

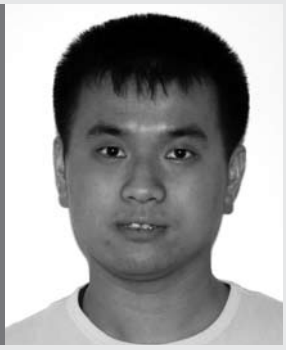
Porous titanium samples were analysed via x-ray CT using the shared facilities at the electron microscope unit (EMU) at UNSW. My host, German collaborators, and the technical staff of the EMU assisted in forming the analysis procedure and interpretation of results.

Perspective of research after this program

Mechanical characterisation of this material will be undertaken, upon return to the US, to determine structure-property relationships. Biological characterisation is also planned.

Advisor's remarks

The research undertaken by the visitor has been well executed and resulted in clear beneficial outcomes. He has also contributed very positively to my group here at UNSW, both in terms of providing new perspectives to ongoing research projects but also enhanced knowledge regarding 3D analysis of porous metallic structures. The program has been mutually beneficial.



Name: Ying Hu

University: Rice University, Houston

Research advisor(s): Professor Halina Rubinsztein-Dunlop and Dr Timo Nieminen

Host institution(s): Centre for Biophotonics and Laser Science, University of Queensland

Research subject

Development of a depth sensitive reflectance spectroscopy using nanoshells as contrast agents

Research description

This research subject is formulated from my initial proposal. We studied the light scattering from single spheres based on Mie's theory. We then extended our calculations to concentric layered spheres.

Research activities

The main research activities include the learning from Dr Nieminen and literature about Mie's theory, extensive programming and debugging in MATLAB. I also participated in the laser group meeting and the Rubensztein-Dunlop group meeting and gave presentations about research projects in my lab at Rice and my accomplishment at UQ.

Perspective of research after this program

I would like to apply the code I developed at UQ to calculate the light absorption/scattering, and angular radiation intensity of nanoshells – the gold-coated silicon spheres hundreds of nanometres in diameter. The next step would be to imbed the nanoshells into human tissue for laser spectroscopy fiber design. I will also conclude the paper Dr Nieminen and I are drafting about studying how coating improves the trapping force on small particles under the optical tweezer.

Advisor's remarks

Ying was productive and hard-working, and mastered the basic elements of a difficult field. This has already allowed him to contribute to his group at Rice, by improved modelling of nanoshells. He has also contributed positively to our research, extending the range of particles we can model optical forces for. A paper based on his results will be ready for submission to *Optics Letters* in September.

Overall, we are pleased to have had Ying as a visitor, and are very happy with what he achieved. His visit has been productive for both his group at Rice and our group.

Ying Hu at the Summer program orientation program at Canberra in June 2007

Group photo with Professor Halina Rubinsztein-Dunlop

Name: Claudia Jones

University: University of California, Berkeley

Research advisor(s): Dr Jochen Brocks

Host institution(s): Research School of Earth Sciences, Australian National University

Research subject

Relating lipids to biomarkers: A study of the timescale and mechanisms of lipid diagenesis

Research description

The purpose of this research was to determine the form of the diagenetic products of lipids and pigments produced by organisms colonising the water–sediment interface of a hypersaline lake. During the course of my research, I did identify some of these compounds, but more importantly, determined the most effective techniques for extraction to obtain the highest concentrations and widest varieties of compounds of interest. The importance of this initial analytical step renders the researcher 'blind' to the absence of lost compounds.

Research activities

Analyses were performed using an Agilent gas chromatography machine coupled to an Autospec mass spectrometer, for high-resolution analysis of compounds of low abundance. Samples were collected at Lake Tyrrell, Victoria over a four day sampling period including filtering of water, collection of microbial mats and coring of sediments. Sediments and mats were preserved in the field under nitrogen gas, stored on dry ice, and brought back to the lab for freeze-drying and/or immediate extraction and preparation for analysis. Sub-samples were stocked for further investigation.

Perspective of research after this program

I believe this program was of great benefit to my research, both in results and in practical and personal experience. I learned an immense amount about the background and techniques of biomarker analysis, and I was able to interact with many different researchers in government and university labs, as well as in the field. This program helped me achieve some of the short-term academic and professional goals I had set for myself, as well as providing me with the opportunity to form longer term collaborations with my host to achieve long-term goals.

Advisor's remarks

Claudia is a highly motivated, energetic, independent and resourceful student. In our new geochemical laboratory for trace biomarker analysis, she learned all relevant analytical techniques exceptionally quickly and, despite a tight time schedule, was able to include a sample return mission to a salt lake in outback Australia and generate results in the laboratory that are in quality and quantity fit for publication. Claudia also introduced several valuable new methodologies to our laboratory, and I can state with confidence that this exchange program was of highest mutual benefit.

Name: Jason Ladner

University: Stanford University, Stanford, California

Research advisor(s): Dr Madeleine van Oppen

Host institution(s): Australian Institute of Marine Science, Townsville

Research subject

Examining the genetic basis of coral morphospecies: A microarray-based approach

Research description

With permeable species boundaries and multi-species synchronised mass spawning events, reef corals represent an animal taxon unparalleled for its potential for interspecific hybridisation. Similarly, available data provide evidence that genetic introgression between coral species is common over evolutionary time scales. Yet in the face of genetic exchange between species, distinct morphologies and ecological specialisations are maintained across large sympatric distributions. Our project utilises the high-throughput nature of microarrays to detect regions of the coral genome that are not introgressing between two highly cross-fertile coral species, *Acropora millepora* and *A. pulchra*. These represent potential genomic regions responsible for the differences we see between the two species.

Research activities

This research project included fieldwork collecting samples at Magnetic Island and lab work extracting DNA, running microsattelite and qPCR analyses, and performing cross-specific microarray hybridisations.

Perspective of research after this program

This research experience has brought to light many of the hidden complexities of my project, and it has helped me to deal with them. The coral research community in Australia is extremely talented, experienced and far-reaching. Working here has provided me access to many of the best minds in coral biology, as well as many genetic tools that would have taken me years to develop myself. This program has provided me with a solid foundation for my dissertation research, and with lots of ideas on how to improve upon it.

Advisor's remarks

It was a pleasure to have Jason in my group at AIMS. Jason clearly is a very bright and independent young researcher. He has a pleasant personality and he fitted well within the AIMS research environment, sharing his knowledge freely while at the same time learning from our experience and expertise. He also took the opportunity to meet other well-known coral researchers who are based in Townsville.

We have only just begun to conduct microarray analyses in house and have purchased a scanner in the last 6 months. The timing of Jason's visit was therefore perfect, and allowed both Jason as well as us to learn quickly. Jason's research project is highly novel and fairly complex, and several unforeseen problems arose during his experiments at AIMS. Jason invariably tackled the problems systematically and always came up with a solution. The results from the work conducted at AIMS will form the basis for much of Jason's PhD, and it was great to see him carry the experiment through to completion in spite of the hurdles he had to face. I was impressed by Jason's commitment to the project.

Jason has indicated he may want to return to AIMS for a second visit during the remainder of his PhD, perhaps to participate in our coral spawning field work or to conduct additional genetic analyses. I would definitely support such a visit. We have also discussed the possibility that I will collect additional samples for his PhD project.

In summary, Jason's visit has been fun and very much a success. This is a wonderful program and I am pleased to see that the Australian Academy of Science supports it.

Name:	Christopher Lew
University:	University of California, Riverside
Research advisor(s):	Dr Huanting Wang
Host institution(s):	Department of Chemical Engineering, Monash University

Research subject

Pure-silica-zeolite LTA nanoparticles for low-dielectric constant films

Research description

One synthesis method of nanocrystalline SOD involves the transformation of pure-silica-zeolite MFI to LTA to SOD through an alkaline liquid-phase reaction. Prematurely stopping the reaction at the LTA phase results in a zeolite framework that is less dense than MFI, thus giving the final material higher porosity. The higher amount of air that is incorporated into the material should lower the dielectric constant (k), which is critical for low-k films in microprocessors.

Research activities

Research activities included the synthesis of pure-silica-zeolite MFI, the transformation of the zeolite crystals to the LTA and SOD phases, and the characterisation of the zeolite phases with x-ray diffraction.

Perspective of research after this program

I was pleasantly surprised by the quality of the research conducted in Australia. However, the slower pace was frustrating at times, and an 8 week program was not enough time to adequately finish a reasonable project.

Advisor's remarks

During his visit, Christopher worked on the project as planned. He made significant progress in the synthesis of zeolite nanocrystals. I was impressed by his hard-work, creativity and dedication. I am pleased that the research collaboration between the two parties has strengthened since Chris' visit.

Name:	Laura Lunsford
University:	North Carolina State University, Raleigh
Research advisor(s):	Professor Tim Turpin and Dr Richard Woolley
Host institution(s):	Centre for Industry and Innovation Studies, University of Western Sydney

Research subject

Linkages and social networks of knowledge producers and innovators: In the case of Australia

Research description

'I think I chose people rather than backgrounds. And they are choosing me as well as I am choosing them.' – Senior Scientist, commenting on mentoring.

This project investigated the linkages and networks associated with innovative scientists in academic and government agencies in Australia. Little is known about the interpersonal networks of these knowledge generators. The project dovetailed with an existing project, S*cientific careers and innovation networks in the Asian region*, conducted by Dr Turpin and his colleagues at the University of Western Sydney's Centre for Industry and Innovation Studies. The specific aims of the project were to:

1. Examine what, if any, types of mentor-like behaviours scientists report receiving during their undergraduate or graduate education.
2. Determine what types of mentor-like support scientists provide to their students or junior colleagues.
3. Investigate how scientists develop their style of mentoring.
4. Isolate the specific behaviours that comprise mentoring support for scientists.
5. Determine the time-frame when mentoring outcomes should be assessed.

Research activities

The purpose of this study was to learn more about the social networks of scientists, how these relationships evolve over time, and how these relationships influence productivity. There is little empirical work on mentoring thus, knowing more about these networks might influence institutional policies on the development of mentoring programs for young scientists. This work also sought to answer questions raised in a previous study on doctoral advisors and their protégés such as how much time should elapse before mentoring effects could be measured, and what specific behaviours comprise mentoring relationships.

A convenience sample of one hundred young and senior scientists, from an ongoing research project, was invited to participate in this study on the mentoring relationships of scientists. Scientists were located in Sydney or Canberra, Australia. Women were over-sampled to ensure their presence in the study (about 30% of the invited participants). Twenty-three interviews were conducted and lasted from 20 to 55 minutes. Two interviews were by phone; the remainder were in person. Female scientists comprised about one third of the sample. About three quaters of the sample worked at a university and the remainder worked at government research centres or agencies. The interviews were semi-structured and focused on being mentored and mentoring others. Notes were taken during the interviews and transcribed immediately afterwards. Participants were assured of the confidential nature of their responses and that they could cease participation at any time.

Perspective of research after this program

I am keenly interested in talent development and how mentoring is used in that context, particularly for scientists. While I had read about these topics before arriving in Australia, I now have a better understanding of how graduate education takes place in Australia specifically and the Asian–Pacific region more generally. Graduate education is delivered differently in Australia and the United States, which provided me opportunities to examine mentoring of scientists in a different context and to question assumptions about graduate training supervision and mentoring generally.

The opportunity to interview senior scientists in Australia was incredibly valuable. These interviews not only advanced my research agenda, but also provided insight into how mentoring relationships exist and develop in other countries and how they have changed over time. These scientists were exceptionally thoughtful and experienced researchers and I am grateful for their time in sharing of their expertise.

The opportunity to conduct this research in another country has deepened my appreciation of the value of international collaboration on research. I had several discussions about mentoring being the link through which resources are passed on from one person to another and that it is an important psychological experience that enables science to proceed.

Advisor's remarks

Hosting Laura as part of the Summer program was a very constructive experience. The program is well organised and administered, creating a minimal burden for host institutions. Laura was very professional in her approach and achieved her data collection goals, despite the challenges of distance and the complicating factor of the mid-year break in Australian universities.

Laura's project was an innovative use of our scientist database and continued the process of developing a reliable panel of professional science researchers and educators who participate in social science research. Feedback from some of those who participated has been very

complimentary about Laura's approach to them and the conduct of the interviews. It appears the program will allow Laura to advance her research in the area of mentoring, and has provided an opportunity for us to learn about the significance of this area in relation to our own interest in research network formation.

In addition, Laura was a very personable addition to the Centre who, when she was not out in the field, engaged with other members of staff. Overall, participation in the program was a beneficial and positive experience that has created the potential for future collaborative activity.

Laura Lunsford at the orientation program at Canberra in June 2007

Professor Tim Turpin, Mrs Robyn Turpin and Laura Lunsford

Name: Carla Ng

University: Northwestern University, Evanston, Illinois

Research advisor(s): Dr Adele Pile and Dr Murray Thomson

Host institution(s): Department of Marine Biology, University of Sydney

Research subject

Anthropogenic impacts of drill spoil deposition on deep-sea benthic communities

Research description

The original objective of the research was to collect data from offshore oil platforms via ROV video and collection of organisms to determine the impacts of deep-sea oil drilling lubricants and drill spoil on deep sea benthic marine life. Drilling in the deep sea requires use of synthetic lubricants, unlike near-shore drilling which can use water-based drilling fluid. The impacts of these synthetic drilling fluids, which are mixed with sediments and dispersed around the site as drill spoil, are still not well understood. We planned to conduct stable isotope analysis to determine trophic positions of organisms present around the drill site, and use bioaccumulation models I had developed during my PhD at Northwestern to probe possible chemical transfer routes in the deep sea.

Research activities

Unfortunately, I was unable to go offshore during my time in Australia. Although I completed my offshore training within the first few weeks of the program, our research group was not put on the schedule at any of the participating oil platforms in time. It can be difficult to find bed space on a working oil platform. In addition, maintenance and weather issues kept our team from going out until the last week in August, when one spot became available but had to be given to the Honours student in the program so that he could complete his project.

Because our original research objective could not be completed, my host and I set up a series of lab bench experiments that would allow us to study some effects of drilling lubricants on marine organisms, while at the same time giving me some experience and training on new laboratory techniques.

We collected colonies of *Bugula neritina*, a cosmopolitan bryozoan, from Watson's Bay (Sydney), and conducted a series of exposure experiments using a water-based drilling mud that had been collected on a previous offshore trip. *Bugula* are a good candidate for such experiments, as they are easy to maintain in a laboratory setting. In addition, being a cosmopolitan species, it is representative of the type of organisms that might be present in a disturbed environment such as a drilling site, though they are currently restricted to shallow water environments.

Colonies of *Bugula* were placed in drilling mud treatments which consisted of filtered seawater with a sediment layer composed of 0, 25, 50, 75 or 100% drilling mud, and monitored for activity

over a four-day period. At the end of this acute toxicity test, all colonies were placed in the dark for one day and then stimulated to spawn by exposure to sunlight. Spawning success and subsequent development of larval colonies was then monitored. The spawning experiment allowed us to probe possible developmental or second-generation effects of exposure to drilling mud.

We found that the water-based drilling mud had no significant effect on *Bugula neritina* viability, spawning success, or larval growth, and concluded that this particular drilling mud was chemically non-toxic to this bryozoan. We did find, however, that the mud had a physical fouling effect on organisms like skeleton shrimp, which are commonly found living in bryozoan colonies. This leads us to believe that benthic infauna in the deep sea, living in close contact with sediments and therefore with deposited drill spoil, might be negatively affected. Our laboratory-scale *Bugula* experiments laid some of the groundwork for developing methodology to conduct *in situ* experiments at drill sites, where Dr Pile will determine whether these cosmopolitan bryozoans can in fact survive in the deep sea and if so can be used to monitor impacts of different drilling fluids in contained experiments, providing the opportunity to run parallel experiments on the lab bench and in the environment. No two drilling mud formulations are identical and most formulas are proprietary, so finding a single organism robust enough to use in monitoring drill spoil effects at a number of different sites and in the laboratory could be of great benefit.

In addition to these experiments, I worked with Dr Murray Thomson, one of Dr Pile's collaborators, to learn a number of techniques related to measuring stress response in marine organisms. These included immunofluorescence staining of muscle tissue for heat shock proteins (specifically HSP-70) and fluorescence microscopy to determine the intensity and location of stress response (using deep-sea isopods and shrimp taken from a drill site), as well as western blotting, again to measure HSP-70 expression. Western Blots were performed on tissue taken from bryozoans that had been used for the acute drill mud exposure experiments described above. Although we found that the available antibodies did not bind to bryozoan tissue, I found the opportunity to learn this widely used technique very valuable.

Perspective of research after this program

Although I was not able to fully realise my research objectives during my time in Australia, I learned a number of new techniques and was able to expand my experience to include some laboratory works. I found the immunofluorescence techniques I learned very useful for visualizing stress responses at the cellular level, and plan to continue learning about and using these techniques as I move beyond my PhD work. Working in a marine research group gave me some confidence that the skills I have learned during my PhD research can be applied in other systems as well. Finally, I found collaborating with researchers from a different scientific 'system' than my own very intellectually stimulating, and hope to continue such collaborations throughout the rest of my career.

Name: Erika Nyhus

University: University of Colorado, Boulder

Research advisor(s): Dr Simon Dennis, Dr John Dunn and Dr Daniel Navarro

Host institution(s): Department of Psychology, University of Adelaide

Research subject

The role of item and context information in episodic recognition memory

Research description

Episodic recognition refers to the ability to recognise when and where people and objects were experienced. Every day we are faced with situations that require episodic recognition such as recognising a person we have met before. These situations require integration of item information (eg whether you have seen this person before) and context information (eg where you have seen this person before). Therefore, to understand episodic recognition it is essential to consider how and when item and context information contributes to episodic recognition. We investigated the role and time course of item and context information in episodic recognition by measuring people's event related brain potentials (ERPs) during a memory task and linking the data to formal models of episodic recognition.

Research activities

A previous study showed a unique contribution of item and context information to episodic recognition. Malmberg, Steyvers, Stephens and Shiffrin (2002) manipulated both the frequency of letters (orthographic frequency) and the frequency of words (normative frequency) presented in an episodic recognition experiment. The subjects studied common words of relatively high normative frequency and uncommon words of relatively low normative frequency. Half of the high normative frequency words and low normative frequency words contained common high frequency letters and the other half of the high normative frequency words and low normative frequency words contained uncommon low frequency letters. The subjects were later tested on their memory for these words. The results showed that subjects were better at recognising words of low than high normative frequency and better at recognizing words with low than high orthographic frequency. Assuming that orthographic frequency represents item information and normative frequency represents context information, these results suggest that both item and context make a unique contribution to episodic recognition.

Malmberg et al's (2002) paradigm was only tested through behavioral measures. Determining the neural correlates underlying orthographic and normative frequency in episodic recognition would provide insight into the role and time course of item and context information in episodic recognition.

Under the guidance of Dr Dennis I designed and conducted a study to test Malmberg et al's (2002) paradigm using ERPs. Following Malmberg et al (2002), subjects were presented with words in high and low normative and orthographic frequency. Then ERPs were recorded during an episodic recognition test.

After gathering the ERP data, Dr Dennis introduced me to formal computational models of episodic recognition. This entailed reading and discussing papers that have shaped the field of memory research in cognitive psychology. After learning about various models, Dr Dennis showed me how he uses these models to inform the results of his own studies.

For the remainder of the summer institute I focussed on analysing the results of the study we conducted. Preliminary behavioral results showed that subjects were better at recognising words of low than high normative frequency and better at recognising words with low than high orthographic frequency. Although these results replicated Malmberg et al (2002), suggesting that both item and context make a unique contribution to episodic recognition, it is possible that the results were confounded. Therefore, with the help of Dr Dennis and Dr Dunn, I performed additional analyses to look at the influence of a number of linguistic factors that could have influenced our results. Preliminary ERP results showed a context effect; between 500 to 800 ms ERP memory effects were greater for words with low normative frequency than high normative frequency. Additional analyses are currently being performed to clarify the behavioral and ERP results.

In addition to the work I did with Dr Dennis and Dr Dunn, Dr Navarro helped me do additional analyses for a previously completed research project on semantic and perceptual contributions to episodic recognition.

During the time that I was in Australia I presented my work at the University of Adelaide psychology department's weekly Brain and Cognition Unit seminar series and the Australian Society of Cognitive Science's annual conference. I plan to publish the work I did while in Australia.

Perspective of research after this program

Through the summer institute I learned about how scientific research is conducted in Australia. I was very impressed by the research being conducted at the University of Adelaide. The professors there were doing impressive research and their expertise contributed greatly to my own research. I was able to make personal contact with two lab groups and initiate collaborations with three professors. These collaborations were very rewarding and will lead to publishable scientific research.

In addition, I learned a great deal about the similarities and differences between the American and Australian university system, graduate education and funding opportunities. This experience will aid me in my pursuit for international collaboration throughout my research career.

Advisor's remarks

I would like to commend the program and Erika in particular for what I thought was a very rewarding exchange. Erika worked intelligently and diligently and fit into the laboratory culture very well. The project also opened up a collaboration with Dr Heathcote at the University of Newcastle and has been an important contributing factor in the development of a new perspective on recognition memory. We are continuing to work on the project and while some challenging scientific issues are still to be resolved, I would anticipate publication within the next year. I would think that this has been a prime example of what can be achieved by programs of this kind.

Name: Paul Supawanich

University: University of California, Berkeley

Research advisor(s): Professor Phil Charles

Host institution(s): School of Engineering, University of Queensland

Research subject

Investigation of transportation modes and their effects on land use

Research description

My main research objective was to study the influence that the southeastern busway in Brisbane has had on land values along the transportation corridor. Since its completion in 2001, there has yet to be much information provided about how a busway affects land rents compared to a rail service. I wanted to use past research which utilises both hedonic pricing as well as use of a bid-rent curve and apply it to this project. Additionally, I wanted to take this opportunity to observe current practices in transport planning in Brisbane, as it is a fast growing city that has been noted to have similar growth characteristics to some US cities.

Research activities

The majority of my research was done in meetings and interviews with local officials in state and local government. Chris Hale was able to provide me numerous contacts within Brisbane City Council as well as Queensland Transport. Additionally, I was given information from academics in other local universities who conduct transportation research; notably, The Urban Research Centre at Griffith University, Nathan Campus. Through my meetings, I was able to gain a historical background on the south eastern busway and transport planning in Brisbane. I was also able to gain a broader perspective on local transportation issues moving into the future, something that is difficult to gain through literature alone. In my gathering of data, my contacts were able to provide me a wealth of local literature and reports in relation to my area of study. I also used a great deal of data collected from the Australian Bureau of Statistics.

Perspective of research after this program

Based on my research that I've conducted, I can see that there is quite a bit more that can be done here in south east Queensland. The region continues to grow at a very fast rate and I believe that similar studies in transportation planning and evaluation are crucial in making sound decisions for future transportation projects. Through my conversations, I was under the impression that there is a local shortage of transportation engineers simply because: 1) there is no specific transport-engineering programs in Queensland universities, 2) many engineers are going into the booming mining business, and 3) many transport planners choose to practice in other parts of the world.

Thus, I believe that there is an important place for transportation research here in south east Queensland as well as other parts of Australia. It's a difficult to say how my 'perspective' of this research has changed in general because I believe it may be very different in different localities. I do believe that it reinforces my notion that transportation and the movement of goods and people are a critical component of the growth and success of any city. Brisbane is no different. Yet, Brisbane has a great opportunity in that it is still a relatively small and developing city. If sound and accurate research is done to make informative decisions, Brisbane has the potential to grow into an even better city in the future.

Name: Jason Wither

University: University of California, Santa Barbara

Research advisor(s): Professor Bruce Thomas

Host institution(s): School of Computer and Information Science, University of South Australia

Research subject

Far-field annotation in outdoor augmented reality

Research description

The majority of my time was spent working with a laser range finder device. I worked on integrating this device into a mobile AR system. Primarily this involved becoming familiar with the device and how it works for our desired tasks, and figuring out how to calibrate it. I left Australia with the knowledge to build a prototype in my lab at home. I also worked with Steven Dow on creating a taxonomy of immersion in Augmented Reality. This taxonomy should be particularly useful to see areas of Augmented Reality that are currently under developed, and could use further work.

Research activities

My day-to-day activities in the lab were split between several different topics. Working on the laser range finder was primarily done by me, although I did get a lot of help from other lab members to build a mount to hold both the laser range finder and a camera. I also spent quite a lot of time meeting with various people, talking about our Augmented Reality taxonomy, as well helping other students in the lab to design user studies, something I have had quite a bit of experience in.

Perspective of research after this program

This program gave me a very interesting look at how other labs do research that is very similar to my own. I enjoyed seeing the slightly different focuses of each lab, and think that it will make my own research more interesting since I can take home many of the ideas I saw.

Advisor's remarks

Jason was a great asset for the lab during his time at the University of South Australia Wearable Computer Lab. Not only did he pursue an interesting project with the laser range finder, but he also contributed too many discussions concerning the current research in the lab. A number of the PhD students are currently planning evaluations of their work, and there were many talks about how best to conduct these studies. Jason and his supervisor have conducted a number of Augmented Reality evaluations, and his comments were of great value to the team.

His investigations into the laser range finder sensor opened a number of interesting research directions. This new direction is very helpful to one PhD student in particular, Ben Avery. Jason made use of the fact the Wearable Computer Lab has an electronics workshop in the adaptation of the sensor device.

Overall Jason made a great contribution to the University of South Australia Wearable Computer Lab while he was here. His knowledge and background provided a great source of information and insight to our current work. His personality allowed him to fit in rapidly and become one of the team.

It is my opinion Jason internship was a great success.

Name: Brian Yates

University: University of California, Berkeley

Research advisor(s): Dr Robert Seviour and Dr Elizabeth Seviour

Host institution(s): School of Pharmacy and Applied Science, La Trobe University, Bendigo

Research subject

Microbiological aspects of foaming in anaerobic wastewater digesters

Research description

This research is aimed at the isolation as well as *in situ* identification of putative foam-forming microorganisms in wastewater digesters. This is done keeping in mind the overall effort of linking the causes of foaming not only to the organisms living in the environment, but also to the mathematical models of drainage and foam ripening developed for non-biological systems.

Research activities

Isolation of wastewater samples from numerous plants across Victoria and subsequent analysis by fluorescence *in situ* hybridisation, microautoradiography, *in situ* measurements of microbe hydrophobicity and hydophilicity, as well as routine stains for common microorganisms.

Perspective of research after this program

Research will be carried out as was planned however, these experiments will now be augmented with identification and environmental requirements of microorganisms commonly found in and thought to be the cause of foaming episodes at wastewater plants. In this respect, the mathematical, physical and chemical models of foaming from non-microbial systems will be married to the hypotheses put forth in microbiology to gain a holistic view of foaming in these systems.

Advisor's remarks

Brian Yates spent two months working in my lab becoming familiar with some of the molecular methods now available for identifying bacterial populations of interest in complex microbial communities, and for studying their ecophysiology. He had little or no microbiological background and so this visit allowed him to become more familiar with the literature on foaming and its microbiological basis. I think he is now confident enough with these molecular protocols to use them in his PhD program at Berkeley. We were also able to visit several wastewater treatment plants in Victoria with these digesters, providing Brian with an opportunity to discuss their operation with plant personnel there. In my view his visit should prove very useful for his future planned experimental program. He interacted very well with other PhD students in the department and with staff, and clearly enjoyed the Australian way of life.

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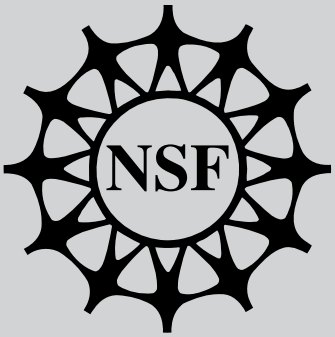

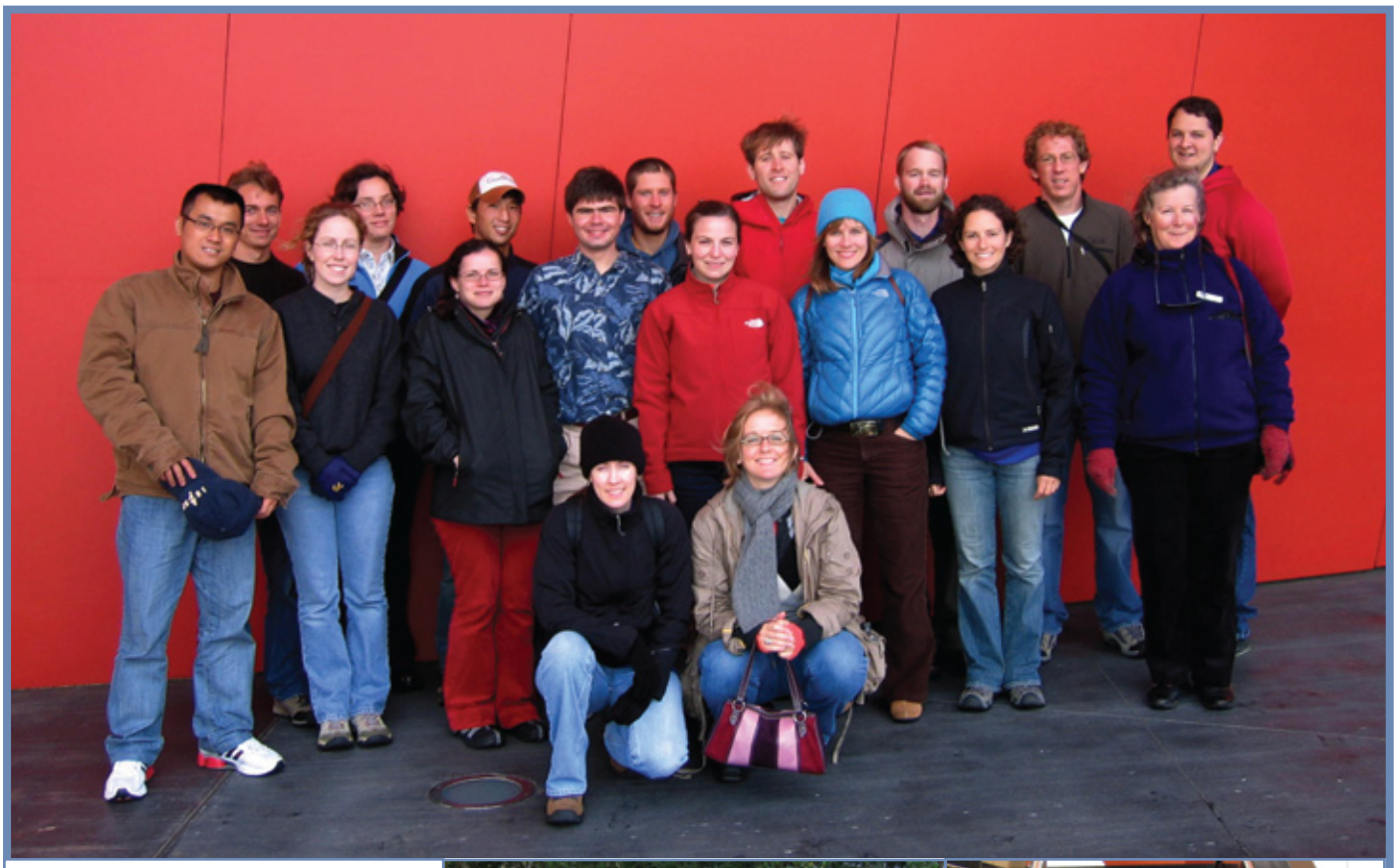

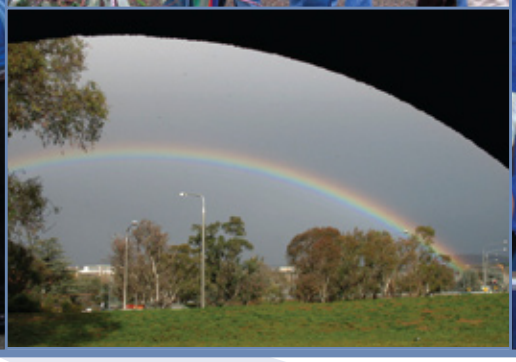

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