2010 East Asia & Pacific Summer Institutes

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

NSF

Australian Academy of Science

Australian Government
Department of Innovation
Industry, Science and Research

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Contents

Introduction

The Australian Academy of Science was delighted to welcome the seventh group of twenty outstanding graduate students from the United States of America to Australia to participate in the East Asia and Pacific Summer Institutes (EAPSI) Summer Program in Australia for 2010.

The program was developed in collaboration with the US National Science Foundation and aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The program started on 15 June 2010 and lasted for eight weeks.

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

I am pleased to report that participants achieved their immediate research goals; indeed 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 co-operative research, whilst others have gained a broad perspective of the nature of research in Australia. I am pleased that at least one of the group has remained in Australia, and hope to welcome more back in coming years. These graduate students and the young Australians with whom they shared their research will play an important role in advancing co-operative research between Australia and the United States in future years.

I would like to extend my thanks to the Australian Department of Innovation, Industry, Science and Research 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 activity could not be sustained.

The Academy looks forward to continuing this program in 2011 and beyond.

Professor Suzanne Cory AC FAA FRS

President
Australian Academy of Science

Orientation program

Tuesday 15 June

Afternoon:	Arrival at Canberra Airport
	Administrative details at Ian Potter House
Evening:	Dinner at Shogun Japanese Restaurant

Wednesday 16 June

Morning	Official Opening, Shine Dome, Australian Academy of Science, Canberra
Morning	Welcome Address
	Dr Sue Meek, *Chief Executive, Australian Academy of Science*
	Lecture: *Australian mammals*
	Professor Jenny Graves FAA, *Secretary Education and Public Awareness for the Australian Academy of Science*
	Lecture: *Postgraduate science opportunities in Australia* Dr Martin Callinan, *Manager Science Policy at the Australian Academy of Science*
	Lecture: *Fulbright Scholarships* Dr Joe Hlubucek, *Executive Director, Australian-American Fulbright Commission*
	Afternoon Lunch at the Shine Dome
	Attend Question Time at the House of Representatives, New Parliament House
	Tour of New Parliament House
	Tour of the Australian National War Memorial
Evening	Cocktail reception dinner, University House

Thursday 17 June

0830	Depart Canberra for host cities

Research reports

Participant
Scott Baalrud
University of Wisconsin-Madison

Australian research advisor
Associate Professor Christine Charles,
Australian National University

Title of research proposal:

Current-free double layers for spacecraft propulsion

1. Research description:

This research supports an ongoing project in the Space Plasma, Power and Propulsion (SP3) group at the Australian National University (ANU) where a new type of electrostatic ion thruster, called the Helicon Double Layer Thruster (HDLT), is being developed. Electrostatic ion thrusters are a highly fuel efficient means to propel a spacecraft, with the limitation that the maximum thrust they can provide is significantly less than that of a chemical-based rocket. Such thrusters are ideally suited for long-term unmanned missions and satellite station keeping.

Several types of electrostatic ion thrusters exist, which have flown reliably in missions dating to the 1960s. The two most popular designs are the gridded ion thruster and the Hall thruster. In both of these designs, thrust is generated from positively charged ions that are expelled at high velocity. However, expelling only positively charged ions would cause the spacecraft to become negatively charged which, in turn, would cause the ions to be attracted back to the spacecraft, eliminating any thrust. For this reason, equal numbers of electrons and ions must be emitted from the spacecraft. In the gridded ion thruster and Hall thruster designs, these electrons are emitted from a separate electron source. Unfortunately, this electron source is typically the life-limiting component in these designs.

The HDLT concept seeks to overcome the limitations imposed by electron sources because it is designed to not need one. This is accomplished because the ion acceleration mechanism in an HDLT is a current-free double layer. A double layer is a type of electric field that can form in plasma and is used in the HDLT to energise ions that ultimately generate thrust. Because the double layer in HDLT is current-free, an equal number of electrons and ions exit the thruster, eliminating the need for an external electron source.

2. Research activities:

We studied the basic properties of current-free double layers using analytic theoretical models and numerical simulations. Of particular interest to the HDLT application is to determine what range of plasma parameters (eg, density, temperature, flows, etc) can support a current-free double layer and what determines the speed of ions exiting the double layer. The few analytic models of current-free double layers that have been published make very different assumptions about what the velocity distribution of electrons is throughout the plasma in a thruster or experiment. As a result, each theoretical model makes significantly different predictions for what parameters are required for double layer formation and what the resultant ion beam properties are. We used numerical simulations to gain insight into what electron distribution should be expected and then used these results to develop a new analytic model.

The numerical technique we used was Particle in Cell (PIC). PIC has the ability to resolve the distribution of ions and electrons in the plasma. We found that the code gave a significantly different result for what the electron distribution is in the plasma than was assumed in any of the previous analytic models. For example, one model assumes that there is a beam of electrons in the plasma source region that was found to be absent in the simulations. Without this beam, the previous analytic theory predicts that the double layer should vanish. However, the simulation results show that the double layer can exist without the beam. This result significantly affects the HDLT because such a beam would not be expected for a thruster operating in space.

3. Perspective of research after this program:

The EAPSI program has allowed me to expand my research interests into the fields of current-free double layers and electrostatic ion thrusters. I'm also grateful to have learned so much about numerical simulations of plasmas, which was not an area in which I had much experience prior to this program. This knowledge will be useful throughout my career. I will continue to collaborate with the SP3 group while we finish this project. We have also discussed possible future collaborations to extend our current work as well as to study some fundamental questions related to PIC simulations that arose during this project. We intend to present our results at the American Physical Society Division of Plasma Physics meeting in November 2010 and to submit them for publication in a plasma physics journal around the same time.

4. Australian advisor's remarks:

On behalf of the Space Plasma, Power and Propulsion Laboratory at ANU, I would like to thank Scott and the EAPSI program for their support which lead to a very successful outcome for all parties: significant research results were obtained which Scott has accurately described above. Scott played a key role and established the basis of a new scientific collaboration between the US and Australia. Scott worked really effectively on a topic somewhat new to him and integrated really well within our group. We are very pleased that he enjoyed his successful visit to ANU and that he had the initiative to choose our group and research topic. We were also very pleased with the administrative and financial support of the EAPSI program.

Participant

Susanne D'Addio

Princeton University

Australian research advisor
Dr Hak-Kim Chan,
University of Sydney

Title of research proposal:

Enhanced delivery of anti-tubercular nanoscale drug cocktails through aerosol formulation

1. Research description:

Tuberculosis (TB) is an intracellular disease, caused by Mycobacterium tuberculosis which infects host macrophages. The World Heath Organisation reported in 2009 that there were 9.27 million incident cases and 1.3 million deaths in 2007. One of the largest contributors to failed treatment is patient non-compliance which results from the intense therapy that involves frequent injections over a six-month period. As a result of non-compliance, Multiple Drug Resistant (MDR) strains have developed, further increasing the difficulty of eradicating the disease. In 2007, half a million cases of MDR-TB were reported. New treatment regiments have been sought in order to promote patient compliance, requiring fewer does and incorporating the use of multiple drugs to suppress mutations of the disease. Nanoparticle drug delivery systems present an attractive new route for formulating engineered particles to improve the delivery of anti-tubercular drugs via incorporation of multiple drugs at high loadings into particles for directed uptake into affected cells. In this work, we aim to develop a matrix carrier for the nanoparticles with appropriate aerodynamic properties for aerosol delivery of dry powders to the lung, which is advantageous due to the effective targeting of the lungs, high surface area for drug transfer and convenient delivery route.

2. Research activities:

Previously, biodegradable nanoparticles which encapsulate multiple anti-tubercular drugs have been formulated at Princeton University and their in vitro activity in TB-infected macrophage cultures has been tested. It is known that particles with aerodynamic diameters of 1 - 3 um show favourable deep lung deposition, this size being dependent on both particle density and the geometric diameter. Both mannitol and leucine were evaluated as matrix materials at various target densities and fixed sizes. The particles were formed using a Spray Freeze Drying technique and were characterised using laser light scattering, scanning electron microscopy, differential scanning calorimetry, X-ray diffraction and impaction. Using a Next Generation Impactor (NGI), the relationship between density of the particles and aerodynamic diameter was explored. For mannitol particles, the fine particle fraction (the dose delivered to the lung) was tailored between 18% and 60% through control over one process parameter. Nanoparticles were loaded into the microparticles up to 50% (w/w) and were redispersed to <200 nm, determined by dynamic light scattering.

3. Perspective of research after this program:

Upon completion of this program, it is clear to me how essential collaborations on the global scale are to developing novel technologies for improved healthcare. One nation's problems become the problems of the world due to increased global travel and migration. The growing collaboration between Princeton and the University of Sydney exemplifies how efficient research can become when complementary expertise is integrated to focus on a common goal. Due to laboratory renovations which began prior to my arrival and continued after my departure, a well-defined set of research goals was determined prior to my arrival, which helped the research progress, with the aid of Philip Kwok, a post-doc in the Advanced Drug Delivery Group. Meetings and input from Dr Chan were insightful and gave me an in-depth perspective of problems that researchers in the pharmaceutical industry try to overcome while also providing guidance for relevant follow up experiments to develop useful results. Overall, my experience was a very positive one.

4. Australian advisor's remarks:

In a short stay of just two months, Susanne has made exceptional achievements and contributed to building a basis for collaborative research between Princeton University and the University of Sydney, which will form part of her PhD thesis at Princeton. Her project was on making nanoparticles suitable for inhalation to the lungs for treatment of tuberculosis. She managed to prepare porous particles with nanostructures and density to control their aerodynamic diameter. These findings are novel and exciting. She further characterised the particle properties such as the size, morphology, crystallinity and powder dispersion behaviour as an aerosol. As her stay was relatively short, what she has done is well beyond my expectation. On the social side, Susanne has enjoyed Sydney so much that she has planned to return in the future (and we're all waiting for her!).

Participant

Wanda Eugene

Auburn University

Australian research advisor
Associate Professor Andy Dong,
University of Sydney

Title of research proposal:

Culture-Based Education Technology for Indigenous Australians (CETIA) project

1. Research description:

In this project, we set out to develop a localisation and culture design toolkit. The toolkit would enable technology deployments, localisation efforts and designers engaged in application development to better capture what is culturally of value in the technology to indigenous Australians. Using the Cultural Relevance Design Framework (see Eugene et. al 2009), the toolkit will serve as a guide for designers engaging in culturally relevant technology design and to guide the integration of technology such as the XO laptops into Aboriginal communities. In addition to the toolkit, we will also lay the foundation for a design pattern language. The goal of the toolkit and the design pattern language is to bridge the gap between ethnographic field knowledge and data of the Aboriginal culture knowledge traditions, and the traditional design process. Using XO laptops provided by OLPC Australia, I worked closely with community elders to first determine what is of value to the respective community, and then assist them as they discovered ways the new technology can be used to reinforce that community's cultural agenda, ways of knowing and values.

2. Research activities:

The research activities entailed a brief ethnographic study of two Aboriginal communities and working with design experts to forge a design toolkit. These activities were realised in four steps.

Step 1. Evaluate the expressed need, desire or interest of the community regarding the technology. We must first understand what values they hope it will bring and what added benefits they expect to gain by having access to the technology. What are their fears, concerns, goals, etc.? Identify at least one current system in place in these communities that can serve as a model of what they desire to see in the new technology. Example: the message stick.

Deliverable: Community goals, interests and expectation

Encourages the community to be vested and allows for sustainable technologies.

Step 2. What can we offer in respect to their expectation? What value can we offer to help meet their expectation? What do we currently have that resembles what they desire? What modifications would our current tools/activities, if any, require for localisation?

Deliverable: End goals and objectives

Provides core team clear objectives of what efforts are essential in a deployment.

Step 3. Culture inquiry: Using the Cultural Relevance Design Framework we will explore cultural practices, ontology, representation and tasks within Aboriginal knowledge traditions.

Deliverable: cultural conventions, constraints and affordances

Culture Inquiry will serve as the bases for framing tasks, representations and ontologies to appropriate within the technology.

Step 4. Refining: Review and refine this process such that the toolkit can be generalised.

Step 5: Finalise the toolkit that can guide a designer through culturally relevant designs for indigenous Australians. Reflect upon process and present findings to OLPC Australia.

Deliverable: Toolkit

3. Perspective of research after this program:

The program gave me a broader scope to contextualise my research and helped me realise that, in Western societies, when we talk about culture with respect to technology, there are several givens that we have taken for granted, including a belief that involving stakeholders in the design of technologies is sufficient to take into account their needs, broadly construed. We have not adequately accounted for what capabilities matter in order for them to make use of technologies in a way that they would value. We - specifically designers - lack support to deal with the recurring issue of culturally-sensitive design, short of broad aphorisms and methodologies such as participatory design. We would need to better account for them if we are to design culturally appropriate technologies that are instrumental to Indigenous Australians in developing new cultural artefacts based on the introduced technologies. This perspective has led me to consider producing a design pattern language for culturally-sensitive design as part of the outcome of my PhD research.

4. Australian advisor's remarks:

My research group has been investigating the nature of design competence. One of the areas of research is the socio-political scaffolding that provides societies with the capabilities needed to engage in the practice of design. We have been applying the theory of the capability approach to address this specific matter. Wanda's visit has been instrumental in advancing our research work in this area, particularly in strengthening our engagement with Aboriginal communities. We had previously developed a set of six dimensions of capabilities and a set of indicators within these dimensions to assess policy, law and social practices that matter when it comes to providing communities with the capability to design. Wanda's visit has advanced this research program, by identifying measures that are more relevant to Indigenous communities. Specifically, she has been investigating how the dimensions of knowledge, agency, and culture interact to provide a 'capability to design' such that the introduction of new technologies into Indigenous Australia communities is instrumental to their ability to produce a world that they value.

Through an analysis of these three dimensions using a participatory action oriented research methodology, she has derived new understandings of the bi-directional nature of the dimensions of agency and culture and the instrumentality of technology in bridging these. For example, she learned through interviews with Aboriginal elders and community members that in urban Indigenous communities there is less of a sense of understanding about Aboriginal culture, but there is strong agency, that is, a strong opportunity structure for Aboriginals in urban communities to access and produce culture. As such, technology can play a cultural role by bringing in the culture to the community, such as by providing ways for communities to communicate their cultural history. In contrast, in remote Aboriginal communities, there is a much stronger sense of culture, but generally lower agency than in urban Aboriginal communities. In those communities, technology plays an agency role, such as by providing a means for communities to produce cultural artefacts.

We are continuing to explore the inter-relation between these dimensions to produce a culturally-sensitive design pattern language. Furthermore, the articulation of these dimensions and objective measures to assess them are playing a role in formulating policy recommendations for OLPC Australia in their roll-out of laptops across Australia and in influencing Commonwealth policy in the provision of technology to Indigenous communities.

Participant

Brian Gray

University of California, Riverside

Australian research advisor
Dr Leigh Simmons,
University of Western Australia

Title of research proposal:

Perception of sperm competition risk and male investment in reproduction: Can acoustic signals alter the perceived risk of sperm competition in Pacific field crickets?

1. Research description:

My research focuses on measuring the role of social cues - in this case, acoustic signals - in perceiving the risk of sperm competition. Sperm competition (SC) refers to situations in which the sperm from two or more males competes to fertilise the ova of a female. SC game theory maintains that males should invest more in their ejaculates (thereby increasing the competitiveness of the sperm contained within) as the risk of SC increases. SC has been measured in a variety of organisms from multiple taxa, including in humans; in general, male investment conforms to SC game theory, although in many (though not all) cases, risk has been altered by manipulating the actual physical presence of rival males. In solitary organisms, or those that mate in isolation, physical interactions may not be an appropriate method for ascertaining the risk of sperm competition. However, social cues may play an important role. In Pacific field crickets, acoustic signals may act as such cues; a male may be able to gauge the risk of SC via the songs of other males - a lot of song means a lot of rivals and a high risk of sperm competition, whereas little song should translate to few rivals and a low risk of sperm competition. By altering an individual's acoustic experience, one may alter the perception of SC risk.

This parallels a natural system of Pacific field crickets in the Hawaiian Islands. On two islands, the crickets co-occur with an acoustically orienting parasitoid fly. The hard selective pressure exerted by the fly has led to the emergence of a novel male morph lacking the necessary wing structures to produce sound. On one island, >90% of males are of the novel morph; as such, the acoustic landscape of the island has been dramatically altered. These islands are devoid of cricket song, despite the continued presence of the crickets. This is expected to alter the perception of sperm competition risk.

2. Research activities:

For the EAPSI project, we reared crickets in one of two acoustic environments: silent or song. Silent environments are easily established and maintained by removing a small wing structure necessary for sound production, and males in song environments are treated identically. 14 to 16 days post-eclosion, sperm viability was measured via fluorescence microscopy using published protocols. All viability assays were performed blind to the experimental treatments.

We also measured reproductive success by obtaining paternity values. Paternity in field crickets can be determined utilising specific morphological markers. Relative reproductive success is measured by comparing the paternity values for males in each of the acoustic treatments.

Finally, we performed dissections to obtain the masses of various reproductive tissues of the males in each acoustic environment, which prior work suggests is influenced by the perceived SC risk. However, the previous studies used aggregate measures of reproductive tissue mass; we refined the study by obtaining masses for each type of reproductive tissue.

3. Perspective of research after this program:

My research is much improved thanks to Dr Simmons, who provided valuable feedback and guidance during the course of the program. I now have a clearer idea of how to structure my thesis, and I am developing projects that build on the research performed in his laboratory.

4. Australian advisor's remarks:

Working with Brian was a delight. He is a mature and dedicated young scientist, who made the absolute most of his opportunities at UWA. We conducted an interesting and novel experiment, which I believe will result in a publication in a top international journal, and represent an important chapter in his PhD thesis. He was also receptive to the possibilities of applying for postdoctoral funding to return to UWA at the end of his PhD. Moreover, his work has laid the seed for future research collaborations with his advisor in the US, who will be visiting UWA later this year for her sabbatical. The EAPSI program offers outstanding opportunities for young researchers to become involved in international research collaborations and I hope the program goes from strength to strength.

Participant

Amanda Grill

South Dakota School of Mines and Technology

Australian research advisors
Dr Victoria Haritos,
Dr Andrew Warden
and Greg Dojchiniov,
CSIRO Entomology

Title of research proposal:

Stability and activity of enzyme-functionalised surfaces for biological degradation of biomass

1. Research description:

Lignin degradation and removal is an obstacle in the development of biofuels made from non-food crops. Lignin constitutes as much as 60% of this biomass, cannot be readily converted by microbes to biofuels and is quite recalcitrant due to its irregular, poly-aromatic structure. Current industrial use of the biomass requires harsh chemical processing to remove the lignin and isolate the cellulose. These caustic conditions are frequently problematic for downstream micro-organisms and require additional treatment of the process stream before fermentation. For these reasons, recent work has focused on more benign technologies for lignin degradation, namely by enzymes. Enzyme functionalised surfaces have been suggested for reactors and packing materials to decrease the amount of enzyme required, and to enhance the enzyme stability and reactive lifetime in the bioreactor. For my EAPSI project I studied the immobilisation of lignin peroxidase, a lignin-degrading enzyme, on commercial carriers used at CSIRO in the immobilisation of other enzymes.

2. Research activities:

My research began with a study of the solution-phase activity of lignin peroxidase to determine optimal conditions related to pH, buffer type, substrate type and reactant concentrations. This was a continuation of what I had been working on at the South Dakota School of Mines and Technology (SDSM&T). Activity was measured spectrophotometrically, and I was able to learn the Bradford technique for determining protein concentration in the samples.

I quickly shifted my focus to immobilisation of lignin peroxidase on Eupergit C250L and Sepabeads HC-HFA and HA, all of which have epoxy functional groups meant to react with the lysine amino acid residues on the protein. These carriers have been used at CSIRO to successfully immobilise carbonic anhydrase, an enzyme used in carbon dioxide capture; I also spent a little time working with this enzyme, learning the techniques to test the thermostability of an immobilised enzyme. I was able to test the effects of pH, buffer molarity, temperature and time on the lignin peroxidase system, gaining information I will make use of back at SDSM&T when exploring other options for immobilisation.

In addition to my project, I assisted with another project here monitoring the conversion of Australian grasses to glucose by cellulases. I was also fortunate enough to visit the CSIRO facilities in Melbourne at the Parkville and Clayton campuses, participating in a protein expression and purification workshop held there at the same time.

3. Perspective of research after this program:

My experience at CSIRO has been invaluable to my professional development and research work. I was able to gain a lot of insight into working with enzymes, making me more confident in the continuation of my research at home. It was very helpful to see a different perspective on my project. Additionally, I really enjoyed the chance to work in a different research environment, hopefully setting the foundation for future collaboration between CSIRO and my department at SDSM&T.

Participant

Kyle Handley

University of Maryland – College Park

Australian research advisor
Associate Professor Donald MacLaren,
University of Melbourne

Title of research proposal:

Exporting under trade policy uncertainty: Theory and evidence from Australia

1. Research description:

I present a framework for trade policy uncertainty combined with a tractable model of export market entry with sunk costs. When tariffs are uncertain, exporters will delay entry into new markets. Cautionary motives make the extensive margin of aggregate exports less responsive to applied tariff reductions under uncertainty. Policy instruments that reduce or eliminate tariff uncertainty such as PTAs or WTO tariff binding commitments are shown to increase entry independently from applied tariff levels. These factors help explain the substantial ex-post increase in firm and product entry following PTAs. I test the model using a disaggregated and detailed dataset of product level Australian imports for 2002-2006. I use the variation in tariffs and trade agreement implementation across countries, products and time, to construct measures of uncertainty suggested by the model. Trade policy uncertainty is quantitatively important in regression tests at the level of the industry and individual product. The estimates suggest preferential trade agreements reduce the probability of major protectionist policy reversals and the risk of losing preferential market access under unilateral preferential arrangements. These uncertainty reductions increase entry and trade growth in Australian imports.

2. Research activities:

Prior to visiting Australia, I had developed a theoretical model and some preliminary empirical tests using Australian trade data. I am an outsider looking in at Australian trade. The objective of my visit was to gain insights and feedback from economists that work with Australian data and have been studying Australian economic policy for some time.

Various members of the department, in particular Russell Hillberry and Donald MacLaren, graciously listened to my ideas and arranged meetings, lunches and presentations with other faculty members. I was invited to give a talk at the University of Adelaide as well, which doubled my exposure to Australian trade economists. The trip to Adelaide was especially useful because researchers there are using some detailed Australia import data that I was seeking. Once I learned the details of how the Australian Bureau of Statistics released and tabbed data on a consultancy basis, I was able to get in touch with a third party re-seller of the data. The re-seller was former researcher at the Melbourne Institute for Applied Economic and Social Research. After explaining my ideas and data needs, I was able to obtain the data at cost and within my limited EAPSI budget. Combined with my tariff database for Australia, I now have a very detailed and novel dataset covering Australia's trade and trade policies from 2001-2009. I have no doubt that the data will be useful for at least one or two additional projects.

Using the detail available in the new data, I was able to formulate a complementary and alternative empirical test of my model. I presented my new work in a department seminar and received many good comments, questions and ideas for the future. I am continuing to analyse the data now that I have returned to the US. I will go on the junior academic job market this year (2010) with this paper as the centrepiece of my portfolio and a major component of my dissertation.

3. Perspective of research after this program:

As a graduate student, I split my time between classes, research and teaching assistant responsibilities and my own research projects. The fellowship was the first opportunity I have had to concentrate entirely on my own research with financial support for an extended period of time. I am happy to say it was an extremely productive time. I also enjoyed the many discussions with other faculty and graduate students about their research. The experience has increased my desire to obtain a position at a research university. It also reaffirms my conviction that more international trade- and policy-minded economists should take the time to learn from their colleagues on the ground in the countries they study.

4. Australian advisor's remarks:

The small group of trade economists in the Department of Economics was very pleased to have Kyle with us for a two-month visit. We had several fruitful discussions about his research, which makes use of Australian trade and tariff data. He was particularly fortunate in being able to meet Professor Peter Lloyd who has made an in-depth study of the Australian tariff and who understands better than most the nuances of how definitions and policy have changed over the decades.

I am sure that Kyle will now be more confident of his understanding of the Australian trade and tariff data, having had access to experts both here and during his visit to the University of Adelaide.

For both parties, Kyle's visit has been very worthwhile and, as his host, I wish to express my gratitude to the EAPSI program in Australia for making the visit possible.

Participant

Alex Hill

University of Wisconsin at Madison

Australian research advisors
Professor Bryan Gaensler,
University of Sydney

Title of research proposal:

The magnetised multi-phase interstellar medium

1. Research description:

Gas in the interstellar medium is crucial to the evolution of galaxies and is intertwined with the life cycle of the stars. A number of observations and simulations have demonstrated that turbulence creates structure on a wide variety of scales, ranging from unresolvably small to many parsecs. The medium consists of the gas, magnetic fields and relativistic charged particles known as cosmic rays, each component having roughly comparable pressure. Gas, magnetic fields and cosmic rays interact through electromagnetic forces.

The warm ionised medium (WIM) has relatively recently become accepted as a major phase of the gas in the interstellar medium of the Milky Way. I work with the Wisconsin H-Alpha Mapper (WHAM), a specialised telescope designed primarily to detect extremely faint emission from recombining ionised hydrogen in the WIM. From WHAM observations, we have detailed information about the distribution, temperature, ionisation state and other physical conditions in the medium. I brought this experience with me to work with measuring turbulence in the magnetised gas in the WIM, using catalogues of Faraday rotation measures of polarised radio sources due to the propagation of the radio signals through the magnetised WIM. Previously, Gaensler et al (2005, Science) found that these signals are depolarised by very small-scale turbulence in the Large Magellanic Cloud, a nearby small galaxy. Our aim with this project was to detect evidence of similar depolarisation in our own Milky Way.

2. Research activities:

I used existing data from wide-area Faraday rotation surveys, combined with the WHAM survey of emission from the WIM, expecting evidence for depolarisation in directions with relatively bright emission from the WIM. Each of these surveys are large, with roughly 35,000 data points, and the uncertainties in individual observations of Faraday rotation are large enough so that we expected any such correlation to be too small to detect without some novel approach. Indeed, we found that by binning the data spatially there is a clear trend for sightlines with bright emission from the ionised hydrogen to have relatively low polarisation. With interpretation, this appears to be evidence of very small-scale turbulence in the WIM in the Milky Way.

3. Perspective of research after this program:

While in Australia, I travelled to Hobart for the annual meting of the Astronomical Society of Australia and the associated Harley Wood Winter School for astronomy postgraduate students. This opportunity to hear about the ongoing work in Australian astronomy and to meet other astronomers proved extremely valuable. Back in Sydney, the research environment at the Sydney Institute for Astronomy is varied and vibrant, providing an excellent place to work and learn through daily interactions with local researchers. For myself, the fellowship provided me with the time to focus on a new project in a related but distinct area (magnetic field diagnostics) from my work in Wisconsin on the WIM, which worked very well. I was also able to present my Wisconsin thesis work at three institutions in the Sydney area, and look forward to continuing the collaboration with Professor Gaensler and his group.

4. Australian advisor's remarks:

During his visit, Alex worked to combine his own data sets on H-alpha recombination emission from the Milky Way with a new catalogue of Faraday rotation measures covering the same area. For the first time, this allowed a direct comparison of the properties of diffuse ionised hydrogen and interstellar magnetic fields throughout our Galaxy. Alex developed several new ways of visualising these complex data sets and was able to identify some clear correlations between the column density of hydrogen gas and the integrated magnetic field along various sight lines. While there was not sufficient time to fully develop these ideas to their conclusion, Alex and I believe we now have enough material to be developed into a full publication in the coming months.

Overall, Alex proved himself to be a highly motivated student, who is very skilled at data manipulation and has a broad physical understanding. It was a pleasure to host him under the auspices of the EAPSI program and to be given this opportunity to establish this new collaborative project.

Participant

Lily House-Peters

University of Arizona

Title of research proposal:

Examining barriers to realising water-sensitive urban design: The challenge of institutionalising alternative water technologies in spite of long-term drought and conservation education

Australian research advisors
Professor Rebekah Brown
and Professor Nigel Tapper,
Monash University

1. Research description:

The dual challenges of future climate change and population growth coupled with projections of decreased water supply are accelerating the need to develop a comprehensive understanding of how to design water sensitive cities. Water sensitive urban design aims to increase the resiliency of cities to future climate and water supply uncertainties by ensuring the sustainable management of urban water resources. However, there is not yet a real-world example of a water sensitive city, as there exist many barriers to overcoming dominant cultural perspectives, institutional inertia and historically embedded urban water values.

Australia is experiencing water supply impacts due to recent climate change caused by natural variability and human activity. The overall vulnerability of Australia's cities to climate change remains unknown, however the Intergovernmental Panel on Climate Change warns that 'in the context of projected climate change, water supply is one of the most vulnerable sectors in Australia'. Furthermore, steady population growth and rapid urbanisation is increasingly shifting the highest levels of water demand historically found in agriculture and industry to urban residential consumption. Over the last twenty years, domestic water usage in Australia has increased by twenty percent. Although Australia is the driest inhabited continent it has one of the highest per capita water consumption rates in the industrialised world and previous research has shown that half of all water consumed in urban areas in Australia is used externally with lawns consuming up to ninety percent of all water applied to the garden. In spite of prolonged drought, national media campaigns, rising water prices and mandatory water restrictions, according the Australian Bureau of Statistics only 47 percent of Australian households reported practicing water conservation at home.

My research aims to provide insights into the factors that are driving and inhibiting the uptake of water sensitive urban design features and alternative water supply and wastewater technologies on private, homeowner property. This research employs the theoretical framework of transition management to elucidate how practices become institutionalised, how sustainable regimes become established over time and how non-sustainable incumbent regimes can be replaced with alternatives.

My research seeks to answer the following questions:

1. What are the key normative, regulative and cognitive barriers that inhibit and/or delay the implementation (and ultimately, the institutionalisation) of water sensitive urban design on private property?
2. How is social capital, in terms of water sensitive urban design, being built and alternatively, how is it being dismantled?
3. What are the significant mechanisms for realising a transition toward the institutionalisation of alternative technology?

2. Research activities:

My research complements the research agenda of the National Urban Water Governance Program (NUWGP) at Monash University in Melbourne which facilitates progress toward achieving a 'Water Sensitive City', a long-term goal of Australia's National Water Initiative. Two of the central research questions of the NUWGP are 'What institutional factors are most important for enabling change towards a Water Sensitive City?' and 'How can current reform processes be effectively informed and adapted to advance a Water Sensitive City?' My research complements the focus of the NUWGP research initiative through analysis of the patterns and processes responsible for both enabling and deterring the transition towards the institutionalisation of alternative water supply and wastewater infrastructure and technologies on private household property.

The majority of my time in Melbourne was spent establishing contacts in the government, industry and non-profit sector, conducting 18 semi-structured interviews, which lasted between 30 minutes and two hours, and analysing the data gathered through these interviews and extensive government document content analysis. Through exposure to Dr Brown and her research team, I was able to refine my initial research questions and my interview instrument to maximise the likelihood that my research would provide salient and policy relevant outcomes. Working with Dr Brown's research team also increased my access to a wide-range of industry professionals, academics and members of government who work in the realm of urban water management and policy formulation. The people with whom I was granted interviews included Melbourne Water officials, local council officials and engineers, State of Victoria Department of Sustainability and Environment officials and professional landscapers and plumbers. I also participated in weekly research group meetings which enhanced my interaction and social and academic exchange with Australian researchers as well as visiting scholars from around the world. Analysis of my collected data through the theoretical lenses of hydro-social contract theory and transition management theory led to interesting and unique findings regarding significant drivers and barriers to the institutionalisation of alternative water supply systems, such as rainwater and stormwater harvesting and wastewater systems, such as grey-water treatment, on privately owned land within the City of Melbourne. During the final week of my tenure in Australia I was invited to give a seminar talk to Dr Brown's research group consisting of nearly twenty individuals with expertise in the field of Australian water management. I found the experience of presenting my research design and preliminary findings to this group to be especially useful as I was able to receive praise and critique in a friendly, yet professional, setting.

3. Perspective of research after this program:

This opportunity to engage in research in Australia is extremely valuable and has strongly reinforced my perspective that international research collaboration is extremely important to developing worldly, well-informed graduate students. As a participant, I benefited immensely from the experience of cooperatively designing research, collecting data and sharing results with my Australian colleagues. Through this collaboration and the opportunity to work with Dr Brown's interdisciplinary research team, I was able to improve my social science data collection and analysis methods, including questionnaire development and semi-structured interview procedures. I was also introduced to new theories, namely transition management theory, and had the ability to interact on a daily basis with other social scientists utilising similar theoretical frameworks and research methods to critically analyse the current and future challenges to urban water supply and wastewater infrastructure in Australia. I expect that the knowledge and research experience that I gained during this program will make an important contribution to my dissertation research.

4. Australian advisor's remarks:

It was a pleasure to host Lily. She is clearly a highly competent and organised researcher that essentially required limited active supervision. Her project was ambitious and few would be able to complete such a project within such a limited timeframe. She designed her research questions well and demonstrated good independent thought, engaged with the local urban water sector with professionalism and received a high response rate to her approach for interview. Her analysis and presentation of her findings were well received by the social researchers in my team and I am sure set her up well for her future doctoral endeavours. I wish Lily all the best and would be happy to host Lily again in the future.

Participant

Cory Krediet

University of Florida

Australian research advisor
Dr David Bourne,
Australian Institute of
Marine Science (AIMS)

Title of research proposal:

Use of stable fluorescent-tagged Vibrio coralliilyticus strains to investigate bacterial-coral host interactions and coral disease infection processes

1. Research description:

Vibrio coralliilyticus P1 is a coral pathogenic bacterium that causes White Syndrome in Indo-Pacific corals. This bacterium actively inhibits photosynthesis performed by the symbiotic intercellular algae associated with the coral host and also degrades the coral tissue. There is limited knowledge about how the pathogen is able to colonise coral and initiate infection. Exactly where the pathogen is located at different stages of the infection also remains unclear. Green fluorescent protein (GFP) is a stable protein that can be use to fluorescently tag bacterial cells. These tagged cells will then fluoresce under blue light. The primary objective of my study was to construct strains of Vibrio coralliilyticus tagged with GFP. With the strains constructed I have verified the constructs and tested the validity of the system to make sure that the tagging process did not alter the physiology or virulence behaviours of the pathogen.

With this GFP-tag system in place with this coral pathogen, the final objective can be approached. This will involve inoculating the GFP-tagged strain of Vibrio coralliilyticus P1 onto juvenile and adult corals in aquaria and to visually trace where the pathogen is able to translocate during the coral infection.

2. Research activities:

The main component of my research at the Australian Institute of Marine Science (AIMS) involved bacterial tri-parental mating to construct the tagged strains of Vibrio coralliilyticus. Once the strains were constructed, I used a variety of physiological assays to verify that the tagged constructs still exhibited the same properties as the un-tagged parental strain. Some of these assays included micro-growth assays, growth on casein hydrolysis plates, protease activity assays using asocasein, sooxanthellae inhibition assay and protein profiling using SDS-PAGE.

3. Perspective of research after this program:

This was a very short term for this project. We were not able to achieve all aspects of the proposal but I have set up a strong international collaboration between these two labs and I am confident that collaborative research will continue on this and future projects.

4. Australian advisor's remarks:

Cory was an exceptional student who worked diligently during his short project and stay at AIMS. Cory worked incredibly independently in his research and achieved a lot of success. This short project will form the basis of further work to be conducted within the laboratory and it is hoped that a continuing collaboration can occur between the laboratories at AIMS and the University of Florida. There is no doubt that Cory will go a long way in his research career. This EAPSI scholarship from the Australian Academy of Science and the National Science Foundation which helped to provide the opportunity for Cory to conduct a short research project in Australia on a novel and interesting topic will aid his training and development as a world class researcher.

Participant

Noah Kuntz

Drexel University

Australian research advisors
Professor Hugh Durrant-Whyte
and James Underwood,
University of Sydney

Title of research proposal:

Evaluation system for segmentation of 3D LIDAR data

1. Research description:

In order for a robot to navigate through or interact with its environment, it must process raw sensor data to form a logical map of its surroundings. One useful sensor for this purpose is 3D LIDAR. These sensors sweep a laser around the environment and collect distance measurements for millions of points around the robot. This 3D point cloud must be processed to extract a useful map of the environment, where the ground and various objects are segmented from one another so navigation or object manipulation can be performed. My research project involved developing a software tool for testing the performance of LIDAR processing and segmentation algorithms. Segmentation is an important step before objects can be classified into general types such as a car, a tree or a person. Segmentation results can also directly be used for navigation, as obstacles and ground planes are identified.

2. Research activities:

A software utility was developed that allowed the testing and visualisation of LIDAR segmentation algorithms. The user can view a 3D rendering of the resulting segmentation for a given algorithm, and change parameters to see how the segmentation results are affected. The utility also allows a user to hand label the segmentation of a data set and can then run a comparison between the results of a segmentation algorithm and the manually selected segmentation. The utility can be used to run a series of tests with different parameters while measuring the accuracy of the segmentation for each set of parameters and each dataset. The data produced by these tests can be analysed to tune algorithms and determine the most effective techniques for segmenting different densities of data and object in different environments.

3. Perspective of research after this program:

This program enhanced my research experience by allowing collaboration with researchers doing cutting-edge work in the field of robotic perception with LIDAR sensors. Through this collaboration I gained some insights into their methods and was able to contribute to their research project. I was also able to experience research with a much larger and more diverse research group, and was able to see several presentations and demos of work in other areas of robotics. I gained a broader perspective into this field that will be valuable in my future work.

4. Australian advisor's remarks:

Noah has made a critical contribution in the development of robust segmentation techniques for the processing of 3D LIDAR (laser) data. He has developed a framework which allows the analysis of various segmentation algorithms combining visual display of the processing results and quantitative metrics for performance evaluation. Such tools are essential in our effort of formulating a quantified analysis of segmentation techniques. Integrated with the work of several other researchers from the Centre for Intelligent Mobile Systems, Noah's systems will lead to a submission at the International Conference of Robotics Automation in September, and subsequently to an extended journal version. Noah's segmentation performance evaluation metric is also the subject of a patent application. The analysis Noah has contributed to belongs to a wider research effort on artificial perception which in the long term will allow robots to navigate autonomously and understand the world around them.

Participant

Christopher Laumer

Harvard University

Australian research advisor

Dr Nick Murphy,
La Trobe University

Title of research proposal:

Taxonomy and phylogeny of Australasian Prorhynchidae (Platyhelminthes: Turbellaria)

1. Research description:

The Prorhynchidae comprise doubtlessly one of the most characteristic and abundant flatworm taxa to be found in aquatic and terrestrial habitats. These mostly pale, microscopic, ribbon-like worms possess adaptations of considerable biological interest, such as their remarkable 'penis-hunting' ability, whereby prey are subdued using organs and venomous secretions of the male reproductive system. Their biogeography is also of fundamental interest – perhaps paradoxically, although prorhynchid diversity is largely known through single- or two-locality endemic species, the family also contains several species with an apparent cosmopolitan distribution, suggesting remarkable powers of dispersal. Nonetheless, because of perceived technical difficulties in their collection and identification, the family is very poorly understood outside continental Europe. In Australia in particular, only one species, the giant (7cm!) Prorhynchus tasmaniensis, has been described and none are known from the mainland.

Research activities:

The EAPSI project I undertook was primarily alpha-taxonomic in nature – I sought to collect as much of the Australian prorhynchid fauna as possible, with the aim of characterising their distinguishing morphological features, and eventually publishing these observations as descriptions of these new species. With the gracious help of colleagues from several institutions, species were collected in diverse habitats in Victoria, South Australia and Tasmania, including eucalypt-sclerophyll forests, cool and warm temperate rainforests, groundwater, temporary waters and remote, artesian-fed desert springs. The diversity of Australian Prorhynchidae encountered was totally beyond expectation, particularly in rainforest habitats – altogether, over 20 new taxa were collected, nearly doubling the diversity of the family. Each species was studied alive in detail, using a combination of illustration and microphotography, before being fixed for later histological analysis. In addition, I obtained tissue samples from each new taxon I encountered, from which DNA sequence data will be generated to estimate the phylogenetic relationships of the Australian species and their affinities to taxa outside the Australasian ecozone.

This phylogenetic context will prove particularly useful in understanding character evolution within this taxon, as well as in identifying clades endemic to the Australian continent. I was also able to collect multiple populations of two cosmopolitan species, which will be used to investigate dispersal ability and the potential for cryptic speciation within these widespread, 'weedy' species. These collections, although preliminary, suggest that Prorhynchidae may represent an important, although largely unrecognised, component of Australian biodiversity. It is hoped that the anticipated description of these new taxa will set the stage for future evolutionary and ecological research on these fascinating animals.

3. Perspective of research after this program

This field work necessitated by this project was orders of magnitude more ambitious and logistically difficult than any I have yet conducted, and was successful only through the great magnanimity of Australian colleagues in several institutions. Through their attention and support, I was able to sample a truly incredible diversity of the habitats South-East Australia has to offer, and learned several important new sampling techniques that will prove useful in my remaining dissertation work – and beyond! It is difficult to overstate the value of international collaboration in biodiversity research.

Participant

Michelle Mo

Yale University

Australian research advisor
Dr Brett Graham,
University of Newcastle

Title of research proposal:

Determining the role of chromogranin B in neuronal calcium signalling

1. Research description:

An organism's ability to live and develop is dependent upon cell-cell communication, a process that underlies many of the most basic of functions to the most complex. Calcium, an essential second messenger, is vital for regulating neuron-to-neuron interaction in the nervous system and for mediating processes ranging from the development of the nervous system to the formation of synaptic connections. Additionally, modifying neuronal intracellular calcium levels can modulate the amount and type of neurotransmitter released to adjacent neurons. Likewise, calcium plays a role in the activation of several key enzymes that are involved in long-term potentiation (LTP) and long-term depression (LTD).

Previous work has established that chromogranin B (CGB), a protein located in the endoplasmic reticulum (ER) and in secretory vesicles, amplifies calcium release via the inositol 1, 4, 5, triphosphate receptor (IP3R). Further studies have also implicated specific regions of CGB that may mediate calcium release from the IP3R. However, the mechanism by which CGB regulates processes such as neuronal development and synaptic formation remains unknown. The aims of this research will therefore test the hypothesis that CGB, at both the cellular and neuronal network level, is crucial for moderating processes such as neuronal development, neurotransmitter release and synapse formation. This project will utilise a combination of electrophysiology, molecular biology and biochemistry techniques in a functional, physiological model to study the methods by which CGB regulates neuronal development and synapse formation.

2. Research activities:

The Graham laboratory studies spinal cord electrophysiology with particular focus on pain processing. Techniques performed include acute slices of the brain and spinal cord. These preparations are then used to make in vitro patch clamp recordings, characterising the excitability and processing capacity of spinal sensory circuits.

During my time in the Graham laboratory, I learned how to prepare acute slices of the spinal cord and conduct in vitro patch clamp recordings on neurons. In addition to learning these techniques I worked on developing and optimising the use of calcium imaging to monitor the spread of excitability in the spinal cord. A variety of dye loading techniques were trialled using two different calcium indicators, Fluo-4 and Rhod-2. I found that pressure application of Fluo-4 at room temperature loaded neurons the best. Following successful loading of neurons in slices, various stimuli were then used to monitor excitation. These stimuli included: electrical stimulation of the dorsal root, puffing of glutamate onto the slice and bath application of various agonists. The age of the mice was also critical in determining health of the slice and stimuli response, as slices cut from older mice led to more difficult dye loading and therefore poorer resolution of calcium signalling. One method to circumvent the issue of dye loading would be to use a viral vector containing a genetically encoded calcium indicator. Therefore, I learned how to perform surgery that would allow me to inject the viral vector into the spinal cord of mice, leading to the expression of genetically encoded calcium indicator in neurons.

Overall, during my time in the Graham lab, I was able to work towards developing and optimising the use of calcium imaging in spinal cord slices as well as learn acute spinal cord preparation and in vitro patch clamp recordings. Possible future experiments in the Graham lab stemming from the results I obtained may include the optimisation of calcium imaging in older mice and the use of the genetically encoded calcium indicator. Additionally, the techniques I learned will allow me to study the role of CGB in neuronal development and synapse formation.

3. Perspective of research after this program:

The brief but rewarding time I spent in Australia was an extraordinary experience. My host was a wonderful mentor and neighbouring labs were extremely collaborative and helpful. I was also able to engage in numerous discussions with my Australian colleagues and as a result have formed potential future international collaborations. Through the EAPSI program I have learned several novel techniques essential for my research and have been able to gain new perspectives on science.

4. Australian advisor's remarks:

Michelle's time in Newcastle was an absolute pleasure for us all. During her visit she made significant headway on a commencing project (calcium imaging in acute spinal slices). It was only through her past experience, contacts and collaborations, and determination that this project got off the ground and has advanced to a point where optimisation is the next step. We hope to continue working collaboratively through this process, with Michelle, and anticipate that both labs (based at the University of Newcastle and Yale) will benefit from this relationship. Finally, Michelle contributed significantly to the general working environment of our lab group as well as the larger neuroscience program in Newcastle. Her willingness to share and exchange ideas, along with her enthusiasm and dedication led to the formation of many friendships that will last far beyond her stay with us.

Participant

Samuel Papendick

South Dakota School of Mines and Technology (SDSM&T)

Australian research advisors
Professor Victor Rudolph,
Professor Sue Golding
and Dr Paul Massarotto,
University of Queensland

Title of research proposal:

Microbial enhanced coalbed methane

1. Research description:

By now it is well accepted that our nation - and world - needs to move beyond the thought of abundant and readily accessible energy. Oil, natural gas and coal have a respective reserve to production ratio of 42, 60 and 121 on a global basis (BP, 2009). To utilise coal, our most abundant resource, we will need to find clean and efficient extraction and combustion methods. Natural gas is a favourable energy source due to its ease of transportation via pipelines and clean burning properties. These two resources are often found coupled beneath the earth where coal can hold seven times the natural gas of similar sized conventional reservoirs (DOE, 2001). Coal bed methane (CBM) is gas associated with coal that has a higher purity of methane and lower levels of CO2 and H2S.

The source of CBM can be either thermogenic or biogenic (Green, 2008). Coal formation begins when plant material is buried as peat and matures into coal. Micro-organisms originally associated with the plants break down carbonaceous material, producing primary biogenic methane. As the coal sinks deeper and is exposed to more extreme temperatures, reduction reactions form thermogenic methane and heavier hydrocarbons. In some cases, deeply buried coal is uplifted to an environment that once again favours microbial activity. Meteoric recharge can deliver new micro-organisms and nutrients into the coal seam that subsequently form secondary biogenic methane. This secondary biogenic methane is of great interest, because it may have formed in recent geologic time, if not still forming today. Biological methane generation is not unique to coal; similar microbial processes lead to natural methane emissions from livestock ruminants, termites, rice paddy fields, natural wetlands and landfills. These biogenic methane sources constitute over 80% of all global methane emissions (Ferry, 1993). Utilisation of this methane would have the duel effect of reducing greenhouse gas emissions and increasing energy reserves.

Typically, high pressure causes physical adsorption of methane to coal. To extract it, water is pumped from the coal seam, resulting in a pressure drop and desorption of methane from the coal. This has become a favourable method for production of natural gas; in 2005, 9.5 billion m3 were produced in this manner from the Powder River Basin in Wyoming (Green, 2008) and 9.5% of the 2007 Australian energy production came from CBM (Commonwealth of Australia, 2007). While this provides an inexpensive and cost-effective means of extracting the coalbed methane, it may also disrupt the natural aquatic environment of the micro-organisms responsible for secondary biogenic gas.

The biologic degradation of coal to methane is a complex mechanism that requires a strict anaerobic environment. A chain of different organisms is required to degrade and pass along molecules, similar to the concept of "division of labour". With coal being a complex structure of aromatic rings, the process begins with hydrolytic bacteria breaking down the coal to soluble organic molecules such as benzoic acids. Fermentative bacteria follow by breaking down these products into simple molecules such as alcohols, acetate, CO2 and H2. The final step is the utilisation of these simple molecules by organisms called methanogens, resulting in the final product of methane (Gilcrease, 2007). To maintain an energetically favourable system, each successive organism is required to consume and maintain low levels of the previous products. This set of organisms is found living symbiotically and is referred to as a consortium.

The main scope of this research is to explore the possibility of stimulating methanogenic consortia present in coal seams to replenish extracted CBM. By creating new methane in these coal seams, the gas becomes a renewable bioresource. The possibilities are immense; just by converting 1/10,000 of the coal reserves in the US lower 48 into methane, 10% of the current (2008) US natural gas reserves will be replenished (Scott, 1999; BP, 2009). The thermal gasification of coal is currently used to produce natural gas in North Dakota facilities, but at the expense of extraction, transportation and processing of the coal. When developing new energy technologies with low CO2 emissions, this process, occurring in situ and at the source, is an attractive alternative.

Our current understanding of methanogenic consortia is derived from sewage treatment or degradation of lignin using strains normally obtained from pond sludge, lake sediments and rumen (Lomas, 1999; Cheesemean, 1972). The information pertaining to the degradation of coal by a native methanogenic consortium is limited. The research I conducted at the South Dakota School of Mines and Technology (SDSM&T) focused on filling the knowledge gap on coal biodegradation. Determining growth-limiting factors for these consortia and finding the means to cost effectively manipulate these coal seams will be the focus of my PhD research. Previous students to my advisor, Dr Patrick Gilcrease, have laid the groundwork and proof of concept for enhancing microbial conversion in the Powder River Basin (PRB) in Wyoming. They have shown that water samples taken from coal seams can produce methane from coal as the sole carbon source. Their studies have also shown that temperature, pH and coal surface area can be manipulated to optimise the production of methane (Green, 2008). A phylogenetic classification was also obtained by 16S rDNA sequencing. The maximum production rate of methane was found in the laboratory to be 16 SCF/ton/day. If these ideal conditions could be extrapolated to the PRB, with known reserves of 50 SCF/ton coal, the entire reserve could be replenished within 10 days.

Dr Gilcrease contacted the University of Queensland and began preliminary research pertaining to the microbially-enhanced coalbed methane. Produced water samples from several wells in the Surat basin of eastern Queensland, Australia, were shipped to our laboratory in South Dakota for screening tests, similar to those done in the PRB. It was found that these water samples contain viable micro-organisms that produce methane from coal as a sole carbon source. The idea that coal can be solubilised into the aqueous phase and made more accessible for the micro-organisms was also explored. By adding chemical surfactants into the system, it was shown that methane production from Australian Walloon coal was enhanced. While at SDSM&T I conducted experiments that screened for certain methangonic species and tested the effect of coal particle size on methane production.

2. Research activities:

Although I originally proposed to collect freshwater samples, screen for potential stimulants and learn special equipment protocol, the proper apparatus was not available. Consequently, my seven weeks at UQ consisted of organising and building a lab capable of culturing coal seam micro-organisms. Shortly after arriving, my group received a grant for projects relating to microbial enhanced coalbed methane, which provided extra resources and the opportunity to stay in Australia for a full year. My new goal was to build a lab with an anaerobic chamber, gassing manifold, gas chromatography and media preparation equipment that could be used over the next year.

The construction of this lab was not a simple task, and required the cooperation of several people. I would have been unable to get all the equipment and organise the construction without the help of Dean Biddle, Paul Jensen, Damian Batstone, John Shu, The ChemEng Workshop, all Lab Managers and various graduate students. Waiting on parts to arrive and people to find meeting time was one of the most challenging aspects of this setup, which made it frustrating at times. To stay busy, my US advisor and I have been reviewing previous results and literature to incorporate into a short publication. Free time has also provided the opportunity to plan future experiments and modify those originally proposed in the EAPSI proposal.

3. Perspective of research after this program:

As I observed in the past, research progress fluctuates. Downtime that results from literature reviews, equipment and computer training or shipment of lab parts is a necessary phase that provides time to reflect on proposals and ideas. Having time to organise thoughts and get properly working equipment will helped execute experiments and obtain the best results. It seems that once I get comfortable with a slower pace, everything comes together and the there is more work than the day allows. As with progress, plans also change. I came to UQ with expectations and a solid plan but unexpected circumstances forced those plans to adapt to the new situation.

4. Australian advisor's remarks:

Sam has spent two months setting up a dedicated laboratory to be used for a much more extended stay than originally anticipated (about a year all up). This will provide a much better foundation for fast progress compared with a shared facility, as proposed for a shorter visit. With this preparatory part of the work now nearly complete, we are anticipating fast progress and highly productive outcomes for his research activities.

Sam has integrated very smoothly and effectively into the research group and has accomplished a great deal in a short time (notwithstanding his frustration at not making even better progress). This is especially true considering the difficulties in finding ones way within a large and cross-disciplinary research activity, the requirement to liaise with a large number of people and negotiate an unfamiliar bureaucracy.

His research forms an important part of a larger project, into which he is already contributing in seminars and discussions. We expect that his early results will form the basis for a new grant application for a novel process for treating coal mine washery wastes.

Participant
Rory Polera
University of North Carolina at Chapel Hill

Australian research advisor
A/Professor Cynthia Joll,
Curtin Water Quality
Research Centre

Title of research proposal:

Fluorescent fingerprinting of dissolved organic matter as a monitoring tool in reclaimed water

1. Research description:

Adverse environmental impacts from climate change, urban sprawl/land use and population growth have been predicted to pose significant challenges to utilities and water resource managers by causing trends that have not been previously experienced; including declining groundwater table depths and recharge rates, changing surface water drainage rates, degrading water quality from concentrated nutrients/contaminants and unpredictable precipitation events leading to major flooding and drought-like situations (Jackson et al 2001, IPCC 2008). Shortages, inconsistencies and uncertainties of available water resources have challenged utilities to find alternative sources, leading to the development of water reclamation systems where treated wastewater is diverted for non-potable applications, including irrigation and industrial use, and where advanced treated wastewater is used for indirect and/or direct potable reuse, including injection into groundwater aquifers and direct flow into drinking water treatment plants (Asano and Levine 1996, EPA 2004, Shannon et al 2008). With the development of such systems, a more comprehensive understanding of source water quality, through more advanced influent water quality characterisation and the fate/transport of particular water quality parameters during treatment, storage and distribution, through more advanced monitoring metrics will be imperative for water utilities to maintain safe water treatment and distribution to their customers.

Henderson et al. (2009), at the UNSW Water Research Centre recently proposed - and as preliminary results from the Cory Research Group in the US suggest - there are significant difference between the fluorescent signatures of dissolved organic matter (DOM – ubiquitous in all water sources) found in wastewater, reclaimed and potable water as a function of dominating organic matter groups (eg, nitrogenous and protein-like material in wastewater vs less concentrated, more broad humic-like material found in natural and treated drinking water systems). These fluorescent differences have aided in the development of potentially a new on-line, real time water quality monitoring system to ensure that utilities are adequately tracking a changing water quality throughout treatment, storage and extensive distribution networks, such that in the case of cross contamination events or a rapidly degrading water quality, the utility will be alerted prior to any potential harmful consumption of poor quality water. Such measures are crucial for ensuring safe water treatment and distribution in order to protect public health and preserve confidence in water utilities worldwide.

2. Research activities:

1. Collected drinking water, wastewater and recycled water samples approximately 1x/biweek from various water treatment facilities and distribution systems throughout the greater Perth and Western Australia region. Site visits allowed for touring facilities and a better understanding of influent water quality, contaminants of concern, standard treatment practice and processes employed.
2. Analysed samples with fluorescence and ultraviolet-visible spectrophotometers, while also determining other chemical water quality parameters like pH, temperature, conductivity, chlorine and total organic carbon concentration. Attempted to characterise dissolved organic matter with size exclusion chromatography and analysed for disinfection by-product formation (potential) as supplemented by other ongoing projects in the research group.
3. Corrected fluorescence data with Matlab coding for instrument specific response (per Cory et al 2010) to characterise dissolved organic matter source components of different water samples and fit to a previously generated parallel factor analysis model for quantative analysis of changing dissolved organic matter throughout treatment process and the distribution system as a function of both time and space (parallel factor analysis models obtained from previous MS work in US).
4. Created independent parallel factor analysis models with samples collected solely in Australia and analysed on the Cary Eclipse Fluorescence Spectrophotometer (as there is argument that different instruments pull out different components due to different sensitivities).
5. Applied and fully set up fluorescence analysis approach and methods at the Curtin Water Quality Research Centre (of which they are fully prepared and equipped to do independently), something the Centre has been quite interested in doing but had previously outsourced to other research groups in Australia.
6. Forged a new working relationship with other fluorescence experts at UNSW for comparing analysis methods and results from water treatment systems in the US and in Australia. Currently, working toward comparing results from common treatment systems (Beenyup Wastewater Treatment Plant) and, more broadly speaking, parallel factor analysis models for various water types.

3. Perspective of research after this program:

Although water reuse has been and is becoming more incorporated into water resource management plans in the US, it is finally becoming nearly imperative for most utilities to sustain water resources for future generations (encompassing major changes from climate change, urban sprawl/land use and population growth); however, continued technical errors (cross contamination, backflows, etc) and scientific uncertainties (fate of distributed recycled water quality) along with quite negative public perceptions have allowed scientists and engineers the chance for newer age and more exciting research projects to ensure safe water augmentation practices through water reuse. Although water reuse in my current town in NC in the US is somewhat incorporated (for irrigation and industrial use), it doesn't seem to have a direct impact on my way of life, whereby in Australia, utilities have been on the forefront of implementing such tactics due to a hostile climate and ever-increasing unpredictable weather patterns (direct groundwater injection of recycled water into drinking water aquifer). Moreover, the water systems particularly in Western Australia are ever more complex due to the nature of the land mass (predominately used for mining) and distribution of population (over great distances - water pipelines move drinking water over 600+ km), somewhat shifting the scope of some aspects to my ongoing research.

Before coming to Australia, I had quite a narrow mindset and view of my proposed MS research project. Sure, water reuse was important to us in the US; however, the technical mistakes and application of these practices has not directly affected my lifestyle, as it is somewhat a function of frequency and differences in water management practice. In the US, we have public utilities that predominately collect, treat and distribute water and wastewater needs for each town (and as a safeguard are interconnected to most nearby utilities in case of major failure or water shortages). In WA, Water Corporation handles nearly all the water needs for the entire state. Each institutional structure and management approach certainly has advantages and disadvantages to the way their systems and resources are managed and operated; however, the problems in WA seem much more in-your-face and real as they have reached a point with water resources that most utilities in the US fear. This has provided a lot of excitement in the necessity of research projects; particularly in water topics and especially along the lines of the scope of my project (characterising dissolved organic matter in changing water quality, from source water to treated distributed water quality). To experience nearly a worse-case scenario hands on, and learn from those leading such projects, has been very challenging and rewarding.

The scope of my research has predominately revolved around water and wastewater/reclaimed water monitoring (detecting differences among water type); however, now, with a more focused drinking water quality research group, I have shifted my scope to applying these fluorescence monitoring metrics within drinking water system pipelines for detecting rapidly changing water quality whether it be from directly recycled wastewater (with high tech treatment processes like membranes and advanced oxidation methods of ultraviolet light and ozonation), or just conventional drinking water treatment of protected watershed sources. Linking water age to water quality is an unknown area whereby fluorescence might be a next-generation approach to linking these differences in water distribution system monitoring.

4. Australian advisor's remarks:

It has been a great pleasure to host Rory's research visit to Australia under the EAPSI program. Rory has contributed to our team in so many ways; in the research arena, he has set up and calibrated our fluorescence spectrometer and taught our researchers how to use the instrument and apply the fluorescence technique to water and wastewater samples so we can incorporate this characterisation tool within our suite of techniques; he has commenced a collaboration between the Curtin Water Quality Research Centre and Rose Cory's team at the University of North Carolina - collaboration which we believe will be a long and fruitful one; he has analysed a number of local water and wastewater samples and this information has contributed to some of our ongoing projects, including ARC Linkage projects; and he has presented a seminar to the group on his Masters research; all in a short period of time. On a more personal note, his conscientious, knowledgeable, thoughtful and keen approach to his research has been a great example to all in our team; with his pleasant and easy-going nature he has been very easy to work with and it has been great for our young researchers to establish friendships with Rory.

We would welcome Rory back to our laboratory at any time, and, indeed, we hope that he might apply for a Fulbright Fellowship to return next year!

Participant

Erin Poth

Johns Hopkins University

Australian research advisor
Professor John Mattick,
University of Queensland

Title of research proposal:

Identification of functionally important domains and biochemical targets of long non-coding RNAs prominently expressed in the developing mouse nervous system

1. Research description:

The sequencing of the human and mouse genomes led to the surprising discovery that the number of protein coding genes found in humans is far less than previously anticipated. Although the genome itself is large in size, it is estimated there are only 20,000 protein coding genes. Additionally, evidence from genome-wide studies have found that most of the genome is actively transcribed resulting in many RNA transcripts being polyadenylated and spliced but do not encode a protein. These non-coding RNAs (ncRNAs) have been found to have many functions including transcriptional regulation, genomic imprinting and recruitment of chromatin modifying proteins. These findings have led to the hypothesis that RNA may not be simply an intermediate between DNA and protein as the traditional dogma suggests, but that they play an active role in many conserved biological processes. We hypothesise that conserved structural motifs found in long ncRNAs are important, if not vital, for their biological function.

2. Research activities:

In this study, we identified several conserved predicted structural motifs in nineteen long ncRNA candidates. Of these motifs, we chose 22 sequences to use as fluorescent probes on a full human proteome chip consisting 17,000 proteins. This high throughput methodology would allow for us to identify putative protein binding partners giving further insight into the function of these long ncRNAs. The 22 sequences were chosen based on three main criteria: 1) previous work (published or unpublished) showing that the ncRNA was developmentally or evolutionary significant 2) interesting in situ expression patterns and 3) high conservation of the sequence of interest across species. During the eight-week EAPSI program, we were able to hybridise all 22 probes to the proteome arrays giving us further insight into the significance and function of these long ncRNA sequences.

3. Perspective of research after this program:

Using bioinformatic techniques in the Mattick Laboratory, we were able to see that long ncRNAs appear to bind a small set of proteins with similar functions and/or properties (ie, metabolic processes, cytoskeleton binding, cytoplasmid localisation etc). We believe that by examining the binding partners of many long ncRNA motifs, we have a better understand of what these molecules are doing in the cell. In addition, our data will allow us to chose sequences with particularly interesting binding partners for follow up experiments.

4. Australian advisor's remarks:

Erin's visit was, from every perspective a resounding success. She applied herself to the project from day one with great energy and intelligence, the progress of which was greatly enhanced by the pre-planning which was done on both sides of the Pacific to ensure that the key reagents were in place for her arrival. Erin undertook all of the planned experiments and achieved all of the objectives we had set out, which will lead, following additional work that we have in train, to a joint publication. Moreover, her visit has very much accelerated and cemented the collaboration between our group and that at John's Hopkins, giving both access to complementary resources and facilities that enabled some very original and exciting work to be done. I will be reciprocating by visiting Erin and her advisor, Dr Seth Blackshaw, in Baltimore later in the year. I thank the Academy and the National Research Foundation very much for supporting this program, and am delighted with the outcome.

Participant

Kristen Rathjen

University of Maryland, College Park

Australian research advisor
Dr Kylie Pitt,
Griffith University

Title of research proposal:

Effects of ocean warming and acidification on population dynamics and statolith formation of early life history stages of cubosoan jellyfish

1. Research description:

Jellyfish abundances are thought to be increasing as a result of anthropogenic activities that have led to increased ocean temperatures, eutrophication and a decline in fisheries. Of particular interest to Australian natives and tourists alike is the carybdeidae family of cubosoan jellyfish found in the tropical waters off Northern Queensland, commonly known as box jellyfish. The sting from several members of this family are responsible for causing 'irukandji' syndrome, which results in such symptoms as nausea, vomiting, respiratory difficulties, unbearable muscle cramping and spasms and occasionally death. Very little is known about the factors promoting cubosoan jellyfish abundance and distribution in tropical waters and information on the early life stages and their response to varying environmental conditions is lacking.

The goal of my EAPSI project was to determine the effects of ocean warming and acidification on asexual reproduction and population dynamics of the polyp stage of the cubosoan jellyfish (Alatina nr mordens). This information will be useful for describing the environmental conditions that promote or hinder asexual reproduction and survival in the early life stages and thus have the potential to affect population dynamics of the adult stage. This data will also provide an aid in predicting how distribution and abundance may be affected under future ocean climate scenarios. With increased water temperatures, tropical cubosoan species will likely find suitable habitats in Southern Queensland, thus posing a danger for swimmers in the area. To compile an accurate risk assessment and timeline for irukandji jellyfish to move into the waters of Southern Queensland it is essential to understand the basic ecology of the irukandjis.

2. Research activities:

I spent my time at Griffith University (Australian Rivers Institute) working under the guidance of Dr Kylie Pitt. During that time, I was able to complete a four-week aquarium-based manipulation experiment using polyps of the cubosoan Alatina nr mordens. During the experiment I monitored the effects of temperature and pH on population dynamics of the polyps daily. I also worked on developing recommended protocols for the rearing and handling of polyps for future experiments.

For the primary experiment, I manipulated pH through the addition of CO2 or O2 to respectively raise and lower pH to maintain treatment levels within the predicted near-future levels of 0.3 to 0.5 below the current ocean pH conditions. Temperature treatments were adjusted to represent winter conditions in the tropical waters off Northern Queensland as well as warmed conditions that are assumed to not typically be experienced by the polyps.

The ecological cue for polyps to metamorphose into juveniles is unknown. In addition to my primary experiment, I also endeavoured to induce metamorphosis of polyps to the juvenile stage under a variety of conditions. These combined experiments are one of only a few studies on the early life stages of cubosoan jellyfish and has provided valuable information on the environmental preferences of the polyps stage and, additionally, enlightenment into the best approaches for handling and rearing early life stages under laboratory conditions.

3. Perspective of research after this program:

The EAPSI program gave me the opportunity to work alongside a wonderful, well-known and respected researcher in the small field of jellyfish ecology. I was able to work with a dangerous species that has high ecologic and economic importance for Australia that I would otherwise not have had access to in the states. It was also a beneficial experience studying an organism where there is very little literature on and attempting to discern some of its basic ecology. I have gained new techniques in working with gelatinous zooplankton and I am leaving with more questions on irukandji jellyfish than what I came with.

4. Australian advisor's remarks:

Kristen's visit was both fun and productive. Kristen undertook a challenging project and although her experimental results were inconclusive, thanks to her diligence and hard work we now know much more about the process of raising irukandji jellyfish. The preliminary work that Kristen undertook has provided a firm foundation for future studies and I am hopeful that it will lead to a joint publication in the near future. It was a pleasure to host such a capable and enthusiastic student and I wish Kristen well in her future scientific endeavours.

Participant

Steven Saville

Clemson University

Australian research advisors
A/Professor Mike House
and Professor Tim St Pierre,
University of Western Australia

Title of research proposal:

NMR investigation of iron oxide nanoparticles for use as MRI contrast enhancement agents

1. Research description:

To use a series of NMR relaxometers to identify the effect of polymer brush length and magnetic particle size of contrast enhancement.

2. Research activities:

Ran hundreds of NMR and SQUID experiments on a series of nanoparticle-polymer complexes.

3. Perspective of research after this program:

This research helped me gain the necessary data needed to continue my PhD and publish several papers.

4. Australian advisor's remarks:

Steven was a valuable member of our research group during his visit to Australia and has made good progress towards understanding the proton relaxation mechanisms of polymer-coated magnetic nanoparticles. His diligent approach throughout his visit ensured he was able to collect a significant amount of data and start the process of interpreting his results. These results will help in the development of new MRI contrast agents. His visit also allowed him to develop new experimental skills on our equipment not available to him in the US. We expect that as a result of his work in Australia we will be able to produce a joint publication. The EAPSI program is a great way to enhance international collaboration as it strengthens direct contacts and also promotes cross-disciplinary research.

Participant

Ian Stephens

University of Illinois

Australian research advisor
Dr Maxim Voronkov,
CSIRO Australia Telescope
National Facility (ATNF)

Title of research proposal:

Using the ATCA and ATNF to probe the evolution of LMC massive star formation

1. Research description:

Collaborate with people at ATNF about data from ATCA. The evolution of massive star formation in the Large Magellanic Cloud is researched.

2. Research activities:

Learning interferometry/data reduction, collaborating with people, visiting the telescope site.

3. Perspective of research after this program:

Positive; I find it very interesting, and it will help lead to thesis.

4. Australian advisor's remarks:

During his stay in ATNF Ian developed a very good understanding of radio interferometry. He proved to be a quick learner and should be able to handle his future observations done with the Australia Telescope Compact Array with minimal guidance. Although delays in the hardware implementation prevented him to execute his own project at the telescope during this visit, he used an opportunity to visit the observatory site and see the instrument in action, including the setup procedure. This experience will definitely help Ian during the course of his PhD project and, in particular, next time he will use ATCA.

Participant

Caroline Titcomb

University of Alabama

Australian research advisor
Professor Jane Goodman-Delahunty,
Australian Graduate School
of Policing and Charles Sturt
University Psychology

Title of research proposal:

Risk of intrafamilial sex offending among biological and non-biological fathers: Does biology matter?

1. Research description:

Specialised court systems and jail diversion programs for criminal cases involving substance abuse, mental illness and familial child sex abuse are becoming increasingly common. Prevalence estimates assert that of the approximate 250,000 convicted sex offenders in the United States, 95% are not incarcerated and 60% receive conditional community supervision. However, the effectiveness and efficiency of these alternatives to traditional legal sanctions is generally unknown. The New South Wales Pre-Trial Diversion of Offenders (Child Sexual Assault) Program likely provides the largest data set of its kind in the world, with over 200 clinical files that have been coded for a variety of risk and outcome variables. My host mentor, Dr Jane Goodman-Delahunty, has gained access to this rare information because she was retained to conduct an independent evaluation of this program in 2009. There have been no scholarly publications using this data, although it potentially provides a wealth of information regarding treatment effectiveness, aetiology of abuse and influences on abuse disclosure, victim self-blame and victim risk of physical and psychological trauma. Exploring these areas could greatly inform not only empirically-based treatment of such offenders and their families, but international public and legal policy regarding such cases.

My specific research aims were to assess the differences, or lack thereof, between intrafamilial sexual abuse by biological and non-biological fathers (eg, step-fathers). Most correctional policies and practices, fuelled by media coverage of child sex offenders, imply that intrafamilial sex offending warrants less attention than extrafamilial offending. However, the facts do not support this assertion. Approximately 78 to 86% of child sexual abuse is perpetrated by male family members against females under the age of twelve, for an average period of three years. Moreover, estimates indicate that 10 to 15% of offenders will recidivate within five years (40% in 25 years). Researchers have postulated that intrafamilial sexual abuse is the most under-reported group due to the unique environmental context of the abuse and the likelihood that victims of such abuse may themselves adopt the stigma of such abuse posed by the media and societal regulations. As such, uninformed policies that focus on extreme cases of extrafamilial abuse may prove detrimental by providing the illusion of effective policies, when in fact the majority of abused children are unnoticed. Such policies also infer that biological fathers are presumed to pose less risk to their daughters than do non-biological fathers; however, this distinction is unclear in the literature. My immediate aim is to illuminate the dynamic nature of sexual abuse, informing who pose the greatest risk for child sexual abuse and show how acknowledging these distinctions in the media, educational resources, the legal system and public policy may prove vital in preventing further abuse.

2. Research activities:

My research typically spans an array of areas within Clinical and Forensic Psychology, from basic characteristics of mental illness to specialised trial consulting research. My EAPSI experiences afforded me the opportunity to work in all of these areas, specifically the following five areas: 1) Law and Mental Health Policy and 2) Treatment of Severe Mental Illness in the Community: The research proposed above will advance both these areas of research and practice. Furthermore, projects stemming from these analyses will influence additional manuscripts; for instance, debunking the myths of intrafamilial child sexual abuse, disputing the role of the 'Traditional Family' as protective against child sexual offending, the impact of victim self-blame on disclosure and reporting of intrafamilial sex abuse and how the social stigma of child sexual abuse translates to the family unit; 3) Forensic Assessment: Forensic practice lacks an empirically validated measure for assessing risk of Intrafamilial Sex Abuse in community offenders. The abovementioned treatment program data offers an opportunity to validate the Violence Risk Scale – Sexual Offender (VRS:SO) version on a community sample. Working with my mentor and her colleagues, and the creators of the VRS:SO, I was able to develop a coding scheme to adapt the VRS:SO items to this sample, laying the groundwork for such a validation study; 4) Police Procedure: At the Australian Graduate School of Policing I was able to liaise with two of the primary researchers in the field of investigative interviewing tactics for police. We are collaborating on a literature review of the gaps in empirically-based trainings for interviewing vulnerable (eg, intellectually disabled or mentally ill) populations; 5) Trial Consulting: I was able to apply my knowledge of jury deliberations and expert witness testimony to assist with research design for several of my host mentor's studies investigating expert witness credibility. My mentor also introduced me to her research on improving juror comprehension of DNA evidence, which has spurred additional collaborations assessing juror bias and their evaluations of DNA evidence. Lastly, I was delighted to learn that a research project my United States mentor, Dr Stanley Brodsky, and I were pursuing, exploring live versus video-taped court testimony, was also being pursued by my host mentor. We have joined forces in expanding this project to an international investigation of this phenomenon.

3. Perspective of research after this program:

'Conversation is a meeting of minds… Conversation doesn't just reshuffle the cards: it creates new cards.' - Theodore Seldin

Initially, I had hoped that the EAPSI program would lead to new research perspectives. However, it is now clear that I underestimated its worth as an avenue for professional and personal growth. A researcher like me cannot truly appreciate the value of a program like EAPSI until she is given the opportunity to become a part of it. Accustomed to studying in a very collaborative research lab in the United States, I had not anticipated the rousing energy and momentum that working in a new research lab can create. I found myself living Seldin's assertion that communication not only provides new perspectives on old ideas, but also motivates new ideas.

My host research team afforded me with a breadth of collaborative opportunities. I learned novel methodological approaches in my area of research and was introduced to an entirely new field (risk assessment and treatment of intrafamilial child sexual offenders). Prior to my EAPSI participation, sex offending was the only area within forensic psychology that I could not envision myself applying to my research or practice. However, my host mentor's eagerness to teach me about this area, and her willingness to share a unique data set with me provided the ideal mechanism for me to understand this work's importance. The knowledge I have gained of forensic risk assessment and community-based pre-trial diversion treatments alone is invaluable to me as a researcher and practicing forensic clinician. My experiences taught me to push my comfort level beyond what I considered it to be and to learn how outside areas can influence my primary area research aims.

Another area I underestimated was the reciprocal nature of the research. I did not expect to see so many parallels in my work with that of my host's research, nor the extent to which we could learn from each other. Through assisting my host mentor with research development on projects, for the first time in my graduate career I learned the extent to which my research could potentially influence these areas on a larger scale and to which the concepts I study operate on an international level. Legal and societal policies that govern these systems in the United States can learn from how mental health and judicial systems function internationally (Australia, UK, New Zealand, etc.), and vice versa.

Lastly, my time as a research scholar in Australia has widened my perspective of what a research career can be like. It has taught me the value of learning from multiple mentors, the benefit of thinking outside the box when seeking research funding and the many lessons that can be learned from practicing such a high stress career in such a laid back culture. The 'publish or perish' world of academia has occasionally prompted me to question my interest in a research career. My EAPSI experiences have rejuvenated these interests in the short- and long-term.

4. Australian advisor's remarks:

Caroline rapidly established herself as a productive and enthusiastic contributor on several diverse projects and research teams, liaising with a wide range of colleagues, including students, practitioners and academics in multiple disciplines. Although her visit to Sydney was relatively brief, Caroline's accomplishments in this time were impressive and cemented a basis to continue mutually beneficial professional and research activities in the future. The EAPSI program advanced Caroline's career development by familiarising her with new research methods and topics on sex offending and by providing opportunities to participate in many different phases of research activities. My research also benefited as Caroline introduced me to measurement scales that she is using in her PhD research to assess expert evidence and witness credibility, and I subsequently incorporated these in a current ARC-funded Australian study.

Caroline successfully facilitated adaptations to a data collection instrument to gather information on dynamic factors that can more accurately predict sexual re-offending. This groundwork progressed a substantial field research project with an international team of experts in Canada, the UK, the USA and Australia. In the past month we continued interacting to co-author papers with a colleague in Germany for conference presentations in the USA and Australia, and wrote an article for submission to Psychology, Public Policy and Law. In addition, we are drafting an international ARC and/or NSF grant proposal to foster ongoing psycho-legal research collaboration on jury decision making. Hosting and mentoring Caroline has been a pleasure and I look forward to continuing this association.

Participant

Holly Noelle Woodward Ballard

Johns Hopkins University

Australian research advisor
Professor John Mattick,
University of Queensland

Title of research proposal:

Using osteohistology to gain further insights into the growth, physiology and behaviour of the high latitude dinosaurs from Victoria, Australia

1. Research description:

During the Early Cretaceous period, 112 million years ago, Australia was in the process of separating from Antarctica as the southern hemisphere supercontinent Gondwana continued to fragment. Because of its location in southern Australia, Victoria was either within or very close to the Antarctic Circle in terms of latitude during this time. Although the average annual temperature is debated, animals living in this environment would have undoubtedly experienced prolonged periods of light and dark. It is possible that other aspects of the environment were different from the more arid to temperate conditions found at lower latitudes during the Cretaceous, and therefore the dinosaurs living in this area would have had to cope with unique stresses.

Dinosaur fossils have been found predominately from two localities in Victoria, one near Inverloch and the other near Cape Otway. To date, no complete skeleton has been found for any dinosaur from Victoria. It is more typical to find isolated limb bones instead. Because of this, it is difficult to form a picture of the dinosaurs that lived there and reconstruct how they grew and developed. In fact, the majority of fossils collected are from herbivorous dinosaurs that would have been equivalent to a large dog in size. This raises the question of whether or not this was the adult size of the animals or if there was simply a higher selective pressure against immature individuals.

However, with the use of osteohistology-the study of bone microstructure- the complete skeleton is not required to infer aspects of an animal's life. This information is recorded in bone tissue and can be observed by looking at thin slices of bone with a microscope. Microscopically, bone records features such as growth rates, age and even if it was an adult or juvenile. There is only so much to be learned from the overall shape of a bone. A bone can be measured, photographed and even replicated in the form of a cast. Once this is done, in order to learn even more about an extinct animal, the internal structure of the bone must be examined.

The goal of this research is to develop a more accurate picture of Victorian dinosaur diversity, physiology and strategies for surviving in a unique environment with the intention of applying what is learned to dinosaurs as a whole. This is achieved by: 1) histologically examining multiple dinosaur bones to observe trends in bone tissue microstructure; 2) attempting to confirm the maturity status of the specimens; 3) determining if the diminutive size of the fossils is a result of dwarfism or simply immature individuals; 4) estimating growth rates through either the use of known bone apposition rates for tissue types or by growth models.

2. Research activities:

Upon arrival at the Melbourne Museum, the first batch of dinosaur fossils to be histologically examined was selected. To prepare them for microscopic analysis, the fossils were sketched, photographed and measured. A piece of bone was removed from each sample, which was then moulded and cast, exactly replicating the shape of the piece removed. This cast piece was then painted to resemble the original bone in colour, and reinserted into the real bone. In this way the original shape of the bone is preserved.

The real pieces removed were processed further by embedding them in a polyester resin for strength and then taken to Monash University where several thin slices were cut from the embedded bone using a rock saw. The rest of the process was performed at the Melbourne Museum. Slices were glued to frosted glass thin section slides and ground thin using progressively finer grit papers on a lapidary wheel. The final thickness of the samples was only tens of micrometers- thin enough to allow the passage of light through the sample so that the bone microstructure could be observed with the use of a transmitted light microscope.

After the initial batch of bones was analysed, several more batches were processed in the same manner. The original proposal concerned examining only herbivorous dinosaurs, but the study was expanded to include several bones from carnivorous dinosaurs as well. The project was also extended to include the unique case of pathological dinosaur bone in order to compare the structure of a diseased bone to normal bone tissue. In addition to dinosaur bone microstructure, several side projects were also initiated to examine the microstructure of extinct as well as modern marsupials.

3. Perspective of research after this program:

My research has resulted in numerous interesting and surprising discoveries that will be instrumental in reconstructing the lives of the dinosaurs that used to live in Victoria. The EAPSI program has given me the opportunity to visit a country I would otherwise not have the means to visit, and my research project would have remained in the idea stage. Any chance to do research in another place for a length of time provides one with a different perspective not only on science but on life in general, and this is one of many things I took away from Australia. Equally important, I was able to share my knowledge of osteohistology and preparation techniques with museum researchers and students, hopefully sparking interest in continuing this line of research not only in dinosaurs but other fossils in the Melbourne Museum collection as well. An unexpected outcome of the EAPSI program was being able to interact with other EAPSI fellows on a regular basis and learn about various fields of study that I would not have otherwise been exposed to in my own department back home. This gave me a new perspective on research in other fields and also how other graduate departments operate. Finally I am very grateful for the opportunity to meet the researchers and students associated with the Melbourne Museum and Monash University and have established ongoing collaboration between these institutions and my own Museum of the Rockies.

4. Australian advisor's remarks:

Holly's investigation of the histology of the polar Cretaceous ornithopod dinosaur limb bones from the State of Victoria that were her original objective has proved to be most informative. Amongst other things, she demonstrated that a previous interpretation of such material of fundamental significance for understanding the mode of life of these dinosaurs was based on an inadequate technique. This alone means that the fundamental hypothesis of how these dinosaurs coped with the polar conditions in which they lived must be reanalysed. That result alone certainly was a major step forward and an unexpected outcome. In addition, her work provided insights into the growth pattern of these dinosaurs which had previously not been available. That she was able to accomplish so much in such a short time was truly remarkable.

The Australian Academy of Science together with the National Science Foundation of the United States are to be commended for this program which made Holly's trip to Australia for the purposes of this investigation possible.

Holly is to be congratulated for the success of her study and commended for her initiative and perseverance in obtaining this critical support that enabled her to carryout this investigation that proved to be so much more fruitful than could be possibly be anticipated when she planned it.

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