Australian Academy of Science

East Asia and Pacific Summer Institutes for US Graduate Students

2005

NSF

Australian Government

Department of Education, Science and Training

East Asia and Pacific Summer Institutes for US Graduate Students

2005

Preface

It was a pleasure for the Australian Academy of Science to welcome the group of twenty outstanding students from the United States of America who participated in the second *Summer Program in Australia for US graduate students in science and engineering.*

The program, developed in collaboration with the National Science Foundation in the United States, aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will, hopefully, better enable them to collaborate with their Australian counterparts in the future. The program commenced on 15 June 2005 and lasted for eight weeks.

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

The enthusiastic participants of this year's program achieved their immediate research goals, but I see from their reports that they have achieved much more. Some students have established strong collaborative links that will provide the foundation for lifetime cooperative research. Some students have gained a wider perspective of the nature of research while others have been enriched by understanding another culture. I know that these graduate students and the young Australians with whom they shared their research will play a key part in advancing cooperative research between Australia and the United States in years to come.

I would like to thank the Department of Education, Science and Training for their support in funding the Summer Program and also to the National Science Foundation. Without their continued assistance and cooperation, this program could not have been achieved.

The Academy looks forward to welcoming a new group of students in 2006.

Dr W J Peacock
President
Australian Academy of Science

Contents

East Asia and Pacific Summer Institutes for US Graduate Students

Orientation program

Wednesday 15 June

9.00	Students begin to arrive in Canberra.
12.30	BBQ lunch at Ian Potter House (Australian Academy of Science).
14.00	Administrative procedures and check-in to Liversidge Apartments.
4.30	Official opening of the NSF-AAS Summer Institute Program. Welcome by the Chair of the Academy's North America Committee, Professor Ian McDougall and by the Executive Secretary of the Academy, Professor Sue Serjeantson.
5.00	Talk by Professor Hugh Tyndale-Biscoe, Fellow of the Australian Academy of Science, on marsupials in Australia and around the world.
5.45	Dinner at the Shine Dome.

Thursday 16 June

9.30	Meet with the Acting US Ambassador, Bill Stanton.
10.45	Tour of Australian National Botanic Gardens.
12.45	Lunch at Parliament House.
14.00	Attend *Question time* at the House of Representatives.
15.00	Tour of Parliament House.
16.05	Short tour of main public buildings and monuments along Lake Burley Griffin and Mt Ainslie.
18.00-20.00	Pizza dinner to meet with Australian graduate students.

Friday 17 June

9.00	Visit Black Mountain Tower.
10.00	Visit Mt Stromlo Observatory.
12.00	Lunch at Cuppacumbalong.
14.00	Visit Tidbinbilla Tracking Station.
15.30	Return to Ian Potter House.
16.15	Visit National Museum *(optional)*.
	Evening free.

RESEARCH REPORT

Name: Susan E. Cameron

Institution: University of California Davis

Hosts: Dr. Chris Margules and Dr. Kristen Williams

Institution: CSIRO Sustainable Ecosystems

Research Project: *Designing nature reserves in Melanesia: Community-based conservation in a biodiversity hotspot.*

Research Description:

The East Melanesian island arc is a global biodiversity hotspot and the island of New Guinea is one of three remaining tropical wilderness areas in the world. This unique region faces increasing threats to its native biota through logging acquisitions, settlement, and over-harvesting. An effective conservation project must incorporate an analysis of foregone opportunity costs into systematic conservation planning; ensuring that maintenance of local livelihoods and biodiversity preservation are compatible. My role in this project is to design and implement a systematic conservation planning framework that accounts for these opportunity costs. This project is in collaboration with researchers from CSIRO Sustainable Ecosystems and Conservation International. The goals of this project were to design a conservation framework and strategy, and to present an example from Milne Bay Province. The outputs of this research project will help inform and direct Conservation International's ongoing conservation implementation in the region, including within Milne Bay Province.

Milne Bay Marine and Terrestrial Corridor Planning workshop 22-26 August 2005.

Research Activities:

Based upon recommendations from research team members and stakeholders from Milne Bay, we designed a planning framework to capture biodiversity representation and ecological processes within the constraints of three development scenarios. The three scenarios were agriculture and food security, economic development, and biodiversity threat. I designed a planning database incorporating watershed sub-catchments as planning units. This involved creating a hydrological model for the study region, including delineating streams, basins, and sub-catchments based upon a 90 meter digital elevation model.

I then designed a planning database within a systematic conservation planning framework that included spatial information about the distribution of vegetation, important ecological processes, and opportunity costs throughout the region. This database will serve as a prototype for future conservation projects in the region, as well as a practical tool for identifying areas of conservation priority within Milne Bay Province. We also addressed the issues of multiple constraints and probability of persistence.

These research results and recommendations were presented in a training workshop for field teams working in the Mamberamo Basin in Papua, Indonesia and to a Conservation International management team meeting in Jayapura, Papua on 10-14 September 2005. Our results will be presented in a technical methods report to Conservation International which will be peer-reviewed in a workshop in early December in Atherton, Australia. We anticipate submitting our research results to a conservation biology journal for publication.

Perspective of Research after this Program:

This program gave me insight into research within a governmental research organization as well as within a larger international non-governmental organization. I have gained applied conservation research experience that I would not otherwise achieve in my PhD experience. I have also made connections with my research collaborators, both at CSIRO and Conservation International, to continue this type of applied conservation research in the future.

Advisors Remarks:

Susan has made unprecedented progress toward achieving her research goal and has also achieved the project goals of the CI and CSIRO teams. She has been dedicated, hardworking, organised and consistent throughout her stay. She takes direction and has demonstrated leadership, adaptability and selflessly collaborates with a wide range of project team members. Susan has made an enormous impact upon the scope and direction of the project, enabling the development of a practical tool for identifying areas of conservation priority within Milne Bay Province. If the Australian Academy of Science recognizes participants, I would like to nominate Susan Cameron for her dedication and research excellence during the summer program in Australia.

Milne Bay Corridor planning workshop, 1-8 July 2005. Back row (L to R) Dan Faith (Australian Museum), Susan Cameron (University of California), Kristen Williams (CSIRO Sustainable Ecosystems), Front (L to R) David Mitchell (Conservation International, Alotau), Chris Margules (CSIRO Sustainable Ecosystems).

RESEARCH REPORT

Name: Christina Crecca

Institution: University of Florida

Host: Professor Jill Gready

Institution: The John Curtin School of Medical Research

Research Project: *The protonation states of methltetrahydrofolate in methionine synthase.*

Research Description:

Methionine synthase is a cobalamin dependent enzyme that catalyzes the transfer of a methyl group from methyltetrahydrofolate (CH_3-H_4folate) to homocysteine (Hcy). The methyl transfer reactions are carrier out in three steps. A methyl group from CH_3-H_4folate is transferred to cob(I)alamin forming methlycobalamin and H_4-folate. Methionine is formed and Cob(I)alamin is regenerated when Hcy removes the methyl group from methylcobalamin. Flavodoxin transfers one electron to reduce cob(II)alamin. The newly formed cob(I)alamin is methylated by AdoMet. Only the ligand binding domains have been crystallized.

An important step in the methyl transfer from CH_3-H_4folate to cob(I)alamin is the activation of the N5 methyl donor group (see figure 1). Protonation of N5 makes the methyl group more electrophilic and, therefore, more susceptible to nucleophilic attack by cob(I)alamin. After N5 protonation, H_4folate would also be a better leaving group. No obvious proton donor appears in the crystal structure.

In addition to N5, several other positions on the methyl-pterin ring can be protonated. We examined various protonation states of CH_3-H_4folate within the protein environment in order to determine the most favorable protonation site. The following sites were protonated: N1, N5, and O4. In vacuo calculations [Hernan Alanso, personal communication] have shown that N5 is the preferred protonation state.

Due to the extensive hydrogen bonding network between the protein and the ligand, the preferred protonation state of the ligand within the active site will be highly influenced by the presence of key residues. These residues include aspartes 358, 390, 473 and asparagines 360, 411, 508. From the crystal structure, it appears that ASP 358 has a hydrogen bond to ASP 390. ASP 390 forms a hydrogen bond with the H of N8 and is therefore directly associated with the pterin ring. ASN 360 does not appear to have any hydrogen bonds in this particular crystal structure, but it may have some interactions in another structure. ASN 411 hydrogen bonded with N1 as well as with H2. ASP 473 forms what has been called a pterin hook, a particular interaction that has been seen in other enzymes that bind folate and its derivatives. This pterin hook is formed by hydrogen bonds between the carboxylic group of ASP 473 and H2. ASP 473 also interacts with O4 through a bridging water molecule. ASN 199 is also important as it interacts with N5. We have constructed several point mutatants in order to see the effect on the ligand's stability. The following mutations were employed in this study: ASP 390 ASN, ASP 473 ASN, and ASN 508 LYS. Experimentally, ASP 390 ASN binds the ligand with higher affinity than ASP 473 ASN.

Research Activities:

The starting structure of the methinoine synthase complex containing homocysteine and CH_3-H_4folate was obtained from the protein data bank (PDB ID 1Q8J). Using Rasmol, the C-terminal region, CH_3-H_4folate binding domain, was isolated. Only six waters were selected. The waters were chosen based on distances and Hydrogen bonding interactions with the ligand, to be consistent with those selected in previous studies of a similar system [Hernan Alanso, personal communication]. Mutations of the protein were generated using DS modeling. The following mutants were made: ASP 390 ASN, Asp 473 ASN, and ASN 508 LYS. The different protonation states of the ligand, N1, N5, and O4, were also created using DS Modeling. ASP358 was protonated in all but the ASP473ASN mutant.

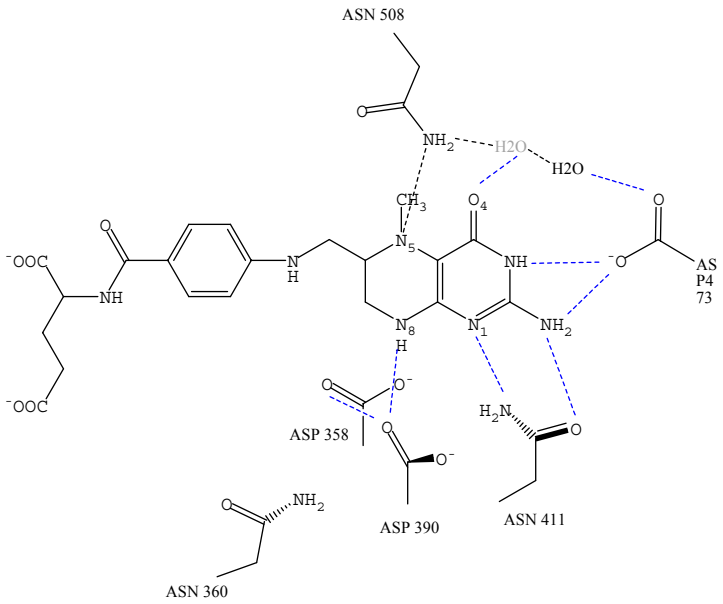


Figure 1: Hydrogen bonding network of methyltetrahydrofolate in methionine synthase based on crystal structure

Using the xleap module of Amber8, the protonated and nonprotonated ligands were combined with the mutated and wild type proteins. Additional MM parameters for the CH_3-H_4folate were obtained from the Amber 96 force field. The protein was also protonated using xleap. Coordinate and topology files were created as input files for the energy minimization step.

Two steps of energy minimization were performed using the Sander module in Amber8. The first minimization step involved 500 steps of relaxation of the hydrogen atoms only. The second minimization included 200 relaxation steps of everything but the oxygen atoms of the water molecule. Coordinate files were saved after minimization and viewed along with the topology file generated in xleap using VMD. MMpro was used to to generate Gaussian03 input files from the topology and coordinate files.

All ONIOM calculations were performed using Gaussian03. The QM region was treated using HF/3-21G. The HF/6-31G* calculations were run initially, however, in the interest of time, a smaller basis set was used. When the 3-21G calculations were finished, the force constants were read from the checkpoint file and used as an initial guess for the 6-31G* calculations. The 6-31G* calculations have not yet been analyzed.
The QM region included CH_3-H_4folate, two water molecules, and the side chains of the following (hydrogen bonding) residues: ASP 358, ASN 360, ASP/ASN 390, ASN 411, ASP/ASN 473, and ASN/LYS 508. The water molecules were chosen as they are hydrogen bonded to the pterin ring. The MM region was treated using Amber 96 force field. During the optimization, the entire QM region was allowed to relax. Residues which contained side chains in the QM region were also allowed to relax completely. The remaining MM region was fixed.

Comparisons of the total ONIOM energy were not possible as the systems presented did not have MM conformity due to the initial energy minimization performed in Amber. Since the protein chains were not the same, the origin of the differences in energy could not be attributed to a particular factor unequivocally. Therefore, relative energy comparisons were made only for the QM energy between structures with the same number of atoms in the QM region.

Perspective of Research after this Program:

It was great. I learned a lot. I would like to continue this type of research in the future.

Advisors Remarks:

As indicated in Christina's report I assigned her a fairly demanding project in protein simulation and computation which provided her with exposure to QM/MM calculations (ONIOM within GAUSSIAN) on an enzyme; she had indicated she wanted to extend her current experience with QM methods of much smaller molecular systems to more complex computational methodologies on protein systems. Doing these calculations requires a substantial phase of setup, during which she also needed how to visualize (Rasmol) and modify (DS modeling) protein coordinates and prepare input files (xleap) for necessary refinement of the coordinates (Amber) before constructing the GAUSSIAN input files (MMPro). Fortunately from her previous strong background in computation, application to the task and expert guidance from one of my PhD students, Hernan Alonso, whose project her work intersected with, she was able to accomplish all these stages and get to an actual initial set of results. Overall, the project and her visit were very successful on all scores; she enjoyed herself and gained a lot, and she got on well with my Group.

RESEARCH REPORT

Name: Scott A. DuFrane

Institution: University of New Mexico

Hosts: Professor Simon Turner and Dr. Rhiannon George

Institution: Macquarie University

Research Project: *Isotope and trace element characterization of magma-genesis in the Lesser Antilles island arc.*

Research Description:

The Primary goal of this research was to further quantify the role of sediment and fluid in generating magma beneath the Lesser Antilles island arc. Generally magma-genesis at island arcs is associated with lowering of the peridotite solidus through the addition of a subducted component, most conspicuously water rich fluid from a subducting slab, but also sediments and oceanic crust. It has previously been inferred that the role of fluid is more prominent in the northern section of the Lesser Antilles arc grading to a more sediment dominated system in the south, though these conclusions were based on lavas that were potentially modified while traversing the crust. Thus we made further measurements with newly acquired samples that have experienced less modification (e.g. they are considered more primary) which will both enhance the current database and provide the basis for new perspectives for magma-genesis beneath the Lesser Antilles.

Research Activities:

I performed a literature search and compiled a range of geochemical data (major, minor, trace element, and isotopic data) for lavas of the Lesser Antilles. In addition we measured ($^{230}Th/^{238}U$) activities and Nd, Pb isotope compositions of seven recently acquired lavas (< 10000 yr). The samples were dissolved in HF-HNO3 solutions in sealed savillex beakers after which U and Th were separated using standard ion chomotographic techniques. U-Th isotope measurements were carried out using a Nu instruments multi collector inductively coupled plasma mass spectrometer (MC-ICP-MS) at the GEMOC center, Macquarie University. Modeling of these data supports the existing database and suggests sediment involvement increases from 0.25% in the north to ~ 2% in the southern part of the arc. Sediment addition to the mantle in the southern arc is likely occurs as a partial melt. Fluid addition along the arc is nearly constant, from 0.5-1%.

Perspective of Research after this Program:

The EAPSI program allowed me to work with new laboratory equipment and interact with a premier researcher in the field of isotope geoscience. Additionally I anticipate publishing these findings in collaboration with my hosts. In short the whole experience has been invaluable and exposed me to new approaches to solving problems related to island arc magmatism and the possibility of future collaborations.

Advisors Remarks:

We were delighted to have Mr DuFrane visit our laboratories on this scheme and the benefits were mutual and significant. Andy is a careful and assured young scientist who has a very bright future ahead of him. During his stay he undertook complex numerical modelling of existing data sets and we had many enjoyable discussions on how to approach arc data sets. He proved to be an excellent analyst with strong laboratory skills to the extent that he assisted others on several occasions. He also spent significant time learning new analytical techniques on our Nu instruments machine. In summary this was a very satisfying experience and I would recommend Andy strongly for post-doctoral research. Ideally, I would like to get him to come back to Macquarie to undertake such research in our new group.

RESEARCH REPORT

Name: Matthew Fujita

Institution: University of California, Berkeley

Host: Dr Steve Donnellan

Institution: South Australia Museum

Research Project: *Mitochondrial genome evolution in unisexual Australian lizards.*

Research Description:

Usually a compact with little variation in gene content in vertebrates, the mitochondrial genome in parthenogenetic lineages of lizards invariably have large duplications that often include several genes. My research involves studying these duplications with the goal of understanding the processes driving their evolution. Parthenogenetic (all female) lineages of the Bynoe's gecko (*Heteronotia binoei*) harbor mitochondrial genomes with large duplicated regions, while their sexual relatives do not. These duplications are known to contain non-functional coding regions (pseudogenes), which provides the unique opportunity to study neutral evolution in mitochondrial DNA (mtDNA). The research group at the South Australia Museum has recently discovered that another widespread Australian lizard, the skink *Menetia greyii*, also has parthenogenetic lineages. We hypothesize that the mitochondrial genomes of the parthenogenetic *Menetia* also have duplications. Thus, my research currently involves dissecting the evolution of the duplications in the gecko *Heteronotia*, and scanning the mitochondrial genomes of *Menetia* for the presence of potential duplications.

Research Activities:

Traditionally, large amounts of mtDNA were isolated from tissue that allowed for laboratory procedures such as restriction profile analysis and mapping in order to gauge the size of the duplications. However, *Menetia* are some of Australia's smallest reptiles, and obtaining enough DNA for such analyses is infeasible from direct extraction. Thus, we went about investigating whether *Menetia* had duplications in their mitochondrial genomes using two approaches. First, we experimented with a novel technique for amplifying circular genomes (such as the mitochondrial genome) called rolling circle amplification (RCA). Second, we used a more established method of long range polymerase chain reaction (long PCR) amplification of the genome. Both methods need minute amounts of starting material to generate enough DNA for the downstream applications necessary for measuring the content of the genomes. We are still optimising RCA, and have ideas on how to fix the requirement of having very pure mtDNA extracts. We have just initiated the long PCR experiments, which will continue as part of my research at UC Berkeley.

We also accomplished an important collecting trip in the South Australian deserts. Along with my host and myself, three other herpetologists visited habitat perfect for *Heteronotia* and *Menetia*, as well as other reptiles. Our sampling was important for studying the systematics of *Heteronotia*, as well as initiating studies of genome evolution in asexual lizards.

Perspective of Research after this Program:

Before this program, I had not yet seen a living specimen of my research organism. Coming from a field where inspiration and motivation stems from the organism, being able to observe *Heteronotia* was immensely important for me. Having accomplished this goal has thus provided a pivotal experience in my graduate studies. In addition, conversations with my host and other scientists at the South Australia Museum have provided important motivation to pursue avenues of research that, until now, I had not yet thought of. Indeed, I am anxious to continue my research back in the US, with fresh motivation and novel perspectives.

Advisors Remarks:

It was a pleasure to host Matt at the South Australian Museum. His enthusiasm is backed up by substantial intellect, which provided numerous opportunities for lengthy discourses on his research topic and related areas. We were able to develop some interesting and promising additional on the evolution of asexual lizards that are likely to form parts of his graduate research program. He introduced new technological approaches into our laboratory, which will be of benefit to several existing research projects.

I'm sure that Matt will continue to collaborate with myself and other scientists in our research group beyond the life of his graduate program. One additional benefit of Matt's visit was that we were able to organise a field trip with one of his advisors from Berkeley, Craig Moritz, and an early career researcher from Melbourne, Dr Mike Kearney, which provided a fantastic opportunity for interactions among leading researchers investigating the evolution of asexuality in the Australian arid zone. Matt would have derived long-term benefits from this opportunity as well as the more immediate benefits of the development of good functional personal interactions with these researchers and directions for this graduate research program.

Matt is the third EAPSI student that the SA Museum/University of Adelaide has either solely or partly hosted over the past 2 years and in each case the experience has been tremendously valuable and productive for our institutions.

RESEARCH REPORT

Name: Rene David Gabbai

Institution: Rutgers State University

Host: Professor John Sheridan

Institution: Monash University

Research Project: *Vortex-induced oscillations of a tethered cylinder.*

Research Description:

An experimental examination was undertaken of a portion of the parameter space associated with the self-excited oscillations of a tethered cylinder in a uniform, smooth flow of water. In particular, the effects of the mass ratio (i.e., the ratio of the cylinder mass to the mass of water it displaces), the tether length, the cylinder diameter, and the water flow speed on the cylinder displacement were investigated. The cylinder displacement was characterized by (i) its mean layover angle from the vertical, and (ii) its instantaneous oscillations about the mean angle. From the cylinder displacement data, the frequency spectra for a variety of points in the parameter space can be obtained and subsequently compared. This will ultimately shed some light on the parameters that have the most profound effect on the "two-state" response sometimes seen with the tethered cylinder system.

Research Activities:

(i) Assisted Mr. Patrick Browne, one of Professor Sheridan's postgraduates, with the experimental programme. The experimental programme was conducted in the FLAIR water channel and utilized a specially designed experimental rig. (ii) In parallel with the experimental programme, worked on developing a MATLAB computer program to extract and plot the frequencies present in the cylinder oscillation time traces. The program uses the Fast-Fourier Transform (FFT) and generates a Power Spectral Density (PSD) plot. Work on this computer program continues & will shortly be sent to Mr. P. Browne in the hopes that it will help him interpret the results of the experiments.

Perspective of Research after this Program:

The research conducted during my time at Monash was very rich in interesting phenomena. I feel that in the brief time I spent working on the project, I only touched the tip of the iceberg. Nonetheless, I suspect that data collected during my stay will indeed lead to a better understanding of the cylinder response and of the frequencies characterizing this response. Of course, a full picture will only emerge when force and fluid field measurements are implemented.

Advisors Remarks:

Rene was a great addition to our lab while he was with us. He worked closely with a local postgraduate student on a research topic that is quite new but which Rene could certainly bring new insights to, as it had a close discipline relationship to his own thesis research. His contribution to both the experiments and the analytical work was excellent and much-valued by everyone in the lab. Rene will remain in contact with us and we expect to continue his involvement in this research. We recognise that this will be difficult given the other demands on his time but would like to ensure his contribution to the work is acknowledged. The success of Rene's visit has encouraged us to be even more receptive to having visiting researchers at this level engaged in our work and we will look at other opportunities to facilitate this. For us the scheme was very beneficial and we than the sponsors for making it happen. At a personal level, Rene was great fun to have around. He seemed to enjoy the Australian lab environment, which is quite different to that in the US. He engaged with people from a wide range of backgrounds and was liked and respected. Overall, from our perspective, this was a great experience.

RESEARCH REPORT

Name: Melissa Green

Institution: Princeton University

Host: Dr. Julio Soria

Institution: Monash University

Research Project: *2D PIV of a Pitching Aerofoil.*

Research Description:

As part of this program, I was trained to use the experimental measurement technique called *digital particle image velocimetry* (DPIV.) Once mastered, I applied this non-intrusive measurement technique to study the wake structure of a pitching aerofoil.

Research Activities:

Once I mastered the basic experimental and analysis procedures on both a uniform flow and stationary aerofoil, I measured the two-dimensional velocity field of the flow around a purely pitching NACA 0020 symmetric aerofoil. I performed the experiment at a range of Reynolds and Strouhal numbers to study the generation and morphology of the vortical structures due to the motion of the aerofoil. The first set of experiments studied the velocity field in a window 2.3 chord length wide by 1.8 chord lengths tall. To further investigate vortex interactions near the surface of the aerofoil, I used a lens with a longer focal length to make measurements in a window 0.89 c x 0.71 c.

Perspective of Research after this Program:

The research conducted in the Laboratory for Turbulence Research in Aerospace & Combustion (LTRAC) at Monash was intended to be an introduction to PIV, and I plan to use the technique in my future PhD research. I would like to study flexible membrane propulsion, for which a complete understanding of the wake structure generated by the actuated surface would be necessary. Further collaboration will be pursued as the results of this work will presented at the Australian Conference on Laser Diagnostics in Fluid Mechanics and Combustion and the 58th Annual Meeting of the American Physical Society Division of Fluid Dynamics.

Advisors Remarks:

Melissa Green is a most remarkable young investigator and it has been a pleasure to host such a talented and enthusiastic researcher at LTRAC. Melissa started her work at LTRAC by being instructed in the experimental methodology known as particle image velocimetry (PIV) by Kamal Parker – a Research Fellow at LTRAC. This included: (1) the theoretical basis underlying this technique, (2) instruction on the equipment that is used for PIV at LTRAC including exposure to real time control of this equipment using a software program developed at LTRAC that operates under the RTAI Linux OS, (3) the design of PIV experiments and (4) setting up for PIV including the preparation of the seeding particles. She was also instructed in the design of the motion control of the dynamic airfoil using computer controlled stepper motors. There are two parts to PIV the experimental part and the post-processing part of the single-exposed PIV image pairs. In this latter aspect Melissa was introduced and instructed in the use of the multigrid cross-correlation digital PIV analysis program, which I developed.

Following this instructional and training period where Melissa showed competence and mastery of all aspects of the PIV technique and the operation of the experimental facility, she undertook a study of the two-dimensional velocity field around a purely pitching NACA 0020 symmetric aerofoil to investigate the flow structure as a function of the Reynolds number and Strouhal number. The results of this study will be presented at two conferences in the fourth quarter of 2005. We expect to continue this most fruitful collaboration with Melissa and her supervisors at Princeton University in the future.

RESEARCH REPORT

Name: Gwendolen E. Haley

Institution: University of Wyoming

Hosts: Dr. Brian Oldfield and Dr. Micheal McKinley

Institutions: Monash University and Howard Florey Institute

Research Project: *Neuroscience.*

Research Description:

Using immunohistochemical labelling techniques, I was able to determine the differences in gene expression, calcium binding proteins expression, and NADPH-diaphorase staining in response to an osmotic challenge in rats.

Research Activities:

*Live animal research
*Immunohistochemical analysis of neurons
*Neuron staining
*Light and fluorescent microscopy
*Retrograde neuronal tracing using viral vectors (side project)

Perspective of Research after this Program:

The time I have spent in Australia will have a great impact on my future as a Neuroscientist. First, my knowledge of different staining techniques has grown immensely. I learned how to use a pseudorabies virus to trace neurons in a retrograde fashion from the cortex to their origins in the hypothalamus, a technique that I can use in my own research. Also, I learned how to label NADPH-diaphorase positive neurons, c-fos neurons, and specific calcium binding proteins within neurons, all of which I had no previous knowledge of and can be used with my research back in the states. Furthermore, having the opportunity to work in a different research lab I was able to use different equipment and learn alternative ways to solve a problem. Learning to diversify my knowledge on equipment, techniques, and overall knowledge of the nervous system will help develop my scientific career. Finally, the connections I have made with my two hosts, Dr. Oldfield and Dr. McKinley, as well as other scientists in the Monash University and Howard Florey Institute groups will be very beneficial to me in the future. These benefits will remain with me throughout my career and I feel very privileged to have been given this opportunity.

RESEARCH REPORT

Name: Valentine Hemingway

Institution: University of California Santa Cruz

Hosts: Lee Berger, Lee Skerratt and Richard Speare

Institution: James Cook University

Research Project: *Habits of a Pathogen: Investigation into Attractants and Repellents of the Amphibian Pathogen* Batrachochytrium dendrobatidis.

Research Description:

My research focused on the habits of the chytrid *Batrachochytrium dendrobatidis* as a way to narrow where it may be found in the environment. To this end, I asked four questions:
1) does *B. dendrobatidis* display positive or negative attraction to light?
2) on what substrates will *B. dendrobatidis* grow?
3) does *B. dendrobatidis* respond chemotactically to any particular substances?
4) how far will *B. dendrobatidis* travel vertically?
Using a variety of lab techniques, I explored these questions with lab-reared strains of *B. dendrobatidis*.

Research Activities:

To look at the first question, I used a standard method in the lab to test for positive or negative taxis in reaction to light. For the second question, I cultured various environmental substrates with *B. dendrobatidis* and prepared them for scanning electron microscopy. They were imaged by two collaborators at James Cook University in Cairns. The experiment exploring chemotaxis followed a published method for other chytrids. Unfortunately there were technical problems and I was unable to conclude the experiment during my time in Australia. I will continue this research at my home university. I designed the equipment and technique to explore *B. dendrobatidis* vertical travel and my collaborators at James Cook University are continuing with the experiment.

Valentine and Jodi Rowley Attaching Transmitter to Frog at Frenchman Creek

Perspective of Research after this Program:

I gained an enormous amount from the collaboration with my colleagues in Australia. My time there reinforced my perspective of international collaboration as essential to furthering research goals. I gained experience with numerous techniques, and the collaborative atmosphere sparked many interesting research questions and ideas.

Advisors Remarks:

Val was a great advocate for the program! She worked well with the research group on our ongoing amphibian disease projects and also designed and initiated her own projects with the collaborative involvement of advisors and other staff. Val's projects were exploratory, entering areas about which we have only hypotheses. She developed and tried various techniques to study the behaviour of the amphibian chytrid, *Batrachochytrium dendrobatidis*, in the environment. This was demanding and potentially frustrating work, but Val worked industriously and enthusiastically. Her efforts have resulted in projects which are ongoing within the group and we will maintain collaborative links via email and teleconferences in the first instance. Val proved to be a major asset to our group!

RESEARCH REPORT

Name: William Holland

Institution: University of Utah

Hosts: Ted Kraegen and Greg Cooney

Institution: Garvan Institute of Medical Research

Research Project: *The role of ceramides on signal transduction.*

Research Description:

We have been investigating the mechanisms by which different fats (saturated, unsaturated) inhibit insulin signal transduction. We previously hypothesized that two distinct lipid metabolites, ceramide and diacylglycerol, were required for saturated fats to inhibit insulin signal transduction. Using ceramide synthesis inhibitors, we have been able to ascertain that different fatty acids can indeed influence insulin signalling via distinct mechanisms, discerned by their reliance on ceramide.

Research Activities:

This fellowship has aided me in the learning of several techniques and key observations:

1) Ceramide is required for saturated fatty acids to inhibit insulin signalling in isolated muscles. Using protocols developed at the Garvan Institute which allow for prolonged treatment of the tissue. A prolonged incubation, required to allow free fatty acids to inhibit signal transduction, is difficult to achieve using the standard technique used by many in the US.

Soleus muscles were isolated from ~200 gram male Sprague Dawley rats and then transferred to 25-ml Erlenmeyer flasks containing 2 ml of Krebs-Henseleit buffer containing 2.5% bovine serum albumin (BSA), 8 mM glucose, and 10 mM HEPES (pH 7.2). Muscles were maintained in a shaking water bath at 29°C while being continuously gassed with 95% O_2/5% CO_2. Following this incubation, muscles remained fully insulin responsive, as the hormone stimulated rates of 2-deoxyglucose uptake 5-fold throughout the course of the incubation (data not shown). The inclusion of palmitate (1mM, 6 hours) conjugated to BSA during the incubation markedly inhibited insulin-stimulated 2-deoxyglucose uptake, while nearly doubling ceramide and diacylglycerol accumulation (data not shown). To ascertain if ceramide mediated the antagonistic effects of palmitate, identical groups of muscles were treated with fumonisin B1 (50 μM), myriocin (10 μM), or cycloserine (1 mM). The inclusion of these compounds blocked the palmitate-induction of ceramide, and reduced muscle ceramide levels to ~67% of basal (data not shown). None of the drugs affected DAG, which also accumulated in muscles exposed to palmitate (data not shown). As shown in Figure 1, the inclusion of any of these drugs completely negated the antagonistic

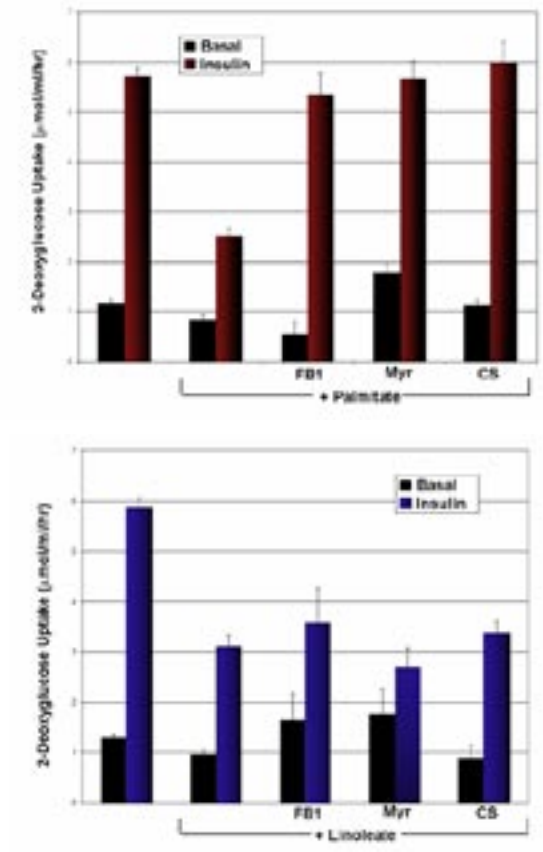


Figure 1. Soleus muscles were isolated and incubated for 6 hours in the presence or absence of 1mM palmitate (upper panel) or linoleate (lower panel) in the presence or absence of fumonisin B_1 (FB1, 50 μM), Myriocin (Myr, 10 μM), or cycloserine (CS, 1mM). Tissues were then stimulated with insulin (300 μU) for 60 minutes and the incorporation of ^{3}H-2-deoxy-D-glucose was assessed using the method of Brozinick and Birnbaum (2). The inhibitors did not significantly affect basal or insulin-stimulated glucose uptake rates in the absence of palmitate, but space limitations precluded the inclusion of these data.

effects of palmitate on insulin-stimulated 2-doxyglucose uptake.

2)In vivo electro gene transfer.
In vivo electro gene transfer is a recently developed technique which allows for transient transfection of genes into muscle. Our previous studies in Utah analysed the efficacy of acid ceramidase (AC) overexpression as an inhibitor of ceramide synthesis. In brief, stable AC overexpressing C2C12 myotubes were shown to maintain normal ceramide levels and insulin signalling in the presence of palmitate. Thus, we hypothesized that overexpression of acid ceramidase in the tibialis muscle *in vivo* will protect against insulin resistance when rats are maintained on high fat diets enriched in palmitate.

Perspective of Research after this Program:

My immediate research goals are to complete analysis of the experiments performed in Australia. Over 100 tissues were collected during my 8-week stay at the Garvan Institute. These tissue must be analysed for tissue specific incorporation of 2-deoxyglucose, incorporation of glucose into glycogen, and incorporation of lipids into, ceramide, Diacylglycerol and triglyceride. While awaiting customs approvals and shipping I am continuing studies in isolated soleus muscles whereby I hope to pinpoint the insulin signalling defects induced my different free fatty acid species.

Before the completion of my thesis project I hope to follow up the studies performed at the Garvan Institute. In the duplicate studies, rats will be maintained on the Copha enriched diet for a longer period to insure the development of insulin resistance. In addition to measuring the metabolic parameters mentioned above, I hope to perform these studies to analyse the cell signalling defects *in vivo.*

Additionally, we are breading mice that are genetically incapable of producing biologically active ceramide. Using techniques established during this fellowship period I will be: 1) evaluate the effects of myriad species of free fatty acids on insulin sensitivity in soleus muscles 2) evaluate the susceptibility of these mice to whole body, liver, and tissue specific insulin resistance when maintained on high fat diets 3) restore normal ceramide synthesis using muscle specific electro gene transfer. Furthermore these techniques will be taught to my labmates and cohorts of numerous other labs interested in metabolism at the University of Utah and my future places of employment.

The information I have gleaned in my short tenure as a visiting scientist and the Garvan Institute will be an excellent asset as I pursue my current thesis research, postdoc positions, and positions as an independent scientist. Additionally, I have learned to overcome many of the routine obstacles hindering the development of international collaborations. This has been a life-changing event that will continue to shape my ideas as a researcher and a citizen.

Advisors Remarks:

Will Holland spent 8 weeks working with me in the Diabetes and Obesity Research Program at the Garvan Institute of Medical Research in Sydney. Will is nearing completion of his PhD project at the University of Utah. Will chose to visit our Group because his PhD project involves similar investigations on the effects of different fat diets on insulin action in muscle. Will's time in the laboratory was extremely productive both from his perspective in learning our techniques and actually producing experimental data and from our perspective because of some specific techniques he was able to teach us. Will was an excellent ambassador for his Laboratory and his country. He was an enthusiastic contributor to the experimental work as well as contributing to the general scientific discussion of the laboratory. He was also able to show us several techniques that he uses in his laboratory that will be of significant benefit to many of the research projects we are currently undertaking.

As a general comment I would say that scholarship schemes like this are of immense value to sponsoring and host country. While students and supervisors can read about the research work of other laboratories in the scientific press, the ability to talk and discuss on a one-to-one basis about technical problems or results of failed experiments or unpublished data brings with it immense respect for fellow investigators and hopefully a confirmation of the fact that despite differences in geography and resources we are all striving to contribute to improving scientific knowledge. I would be very happy to participate in the scheme again, particularly if the standard of scholarship winner was similar to Will Holland. It was an enjoyable and scientifically beneficial experience to have him in our Institute.

RESEARCH REPORT

Name: Shaun C. Howard

Institution: University of Cincinnati

Host: Dr. Vincent Craig

Institution: Australian National University

Research Project: *Fundamental colloid and interfacial science; membrane technology.*

Research Description:

The focus of my research is to develop an enabling technology for the fabrication and characterization of novel membranes. A membrane is a device that separates, delivers or discriminates between molecules or particles by allowing selective permeation of one or more relative to the others. The field of biomimetics reveals that the membrane cell walls in the human body can discriminate between molecules nearly one million times better than the best synthetic membranes currently available. Membranes scale linearly, which means that if you have ten times the material to separate, you will need ten times the amount of membrane. This has limited the use of membranes for high volume applications; however, this property becomes an advantage on the micro scale. If concepts such as pharmacy-on-a-chip are to become a reality, significant advances in membrane science will be required.

Research Activities:

The underlying goal for the NSF/AAS-EAPSI program was to broaden my knowledge and experience in the field of colloid and interfacial science, and train on unique experimental equipment.

The very short time frame of the EAPSI program was not suited to undertaking any significant new experimentation. Instead I focussed on learning the experimental techniques and methodologies used by Dr. Craig's research group. I was able to train on several pieces of equipment and assist with ongoing experimentation both within Dr. Craig's group and elsewhere in the university.

The knowledge gained during my time at the ANU will prove vital to the success of my research, and has yielded several new ideas that will lead to further collaboration in the near future. Plans are already being made for another trip to Canberra for an extended period of time.

Perspective of Research after this Program:

The opportunity to live and study in another country has provided an invaluable perspective on the benefits of international collaboration. Although the time was very short, it has spawned several new ideas that I'm certain will lead to future exchanges and collaboration.

Advisors Remarks:

I greatly enjoyed hosting Shaun. He quickly learnt several techniques that are available in our lab, which he had not had prior experience with and contributed a new perspective to many of our research programmes. He is a gifted scientist. I have no doubt that we will work with him more in the future.
Shaun was also a great ambassador. He engaged socially with the department and availed us of many new cultural experiences and in turn embraced our culture.

RESEARCH REPORT

Name: Phillip Johnson

Institution: Texas A&M University

Hosts: Ian Johnson and Andrew Wilson

Institution: University of Sydney

Research Project: *GIS in Archaeology.*

Research Description:

Application of GIS to archaeological data. Investigating the benefits and methods of applying GIS to data recovered from archaeological site investigation.

Research Activities:

Worked on two major projects.

The first was the digitization and geo-referencing of Pacific language maps for a project endeavour between the ACL and PARADESIC at UC-Berkeley. This initiative allows web access to in depth geo-referenced indigenous language maps of the Pacific. These maps will now be available online for access to anyone interested in the geographic location of indigenous Pacific languages.

The second project involved applying the use of ArcGIS software to archaeological data of Samoan mountain settlements. This project is a joint endeavour of my home institution, Texas A&M University and the American Samoa Historic Preservation Office. Dr. Andrew Wilson of the ACL instructed me in the application of ArcGIS software in creating data-rich maps of previously unreported prehistoric mountain villages of Tutuila, American Samoa. The power of this software allowed me to create several new maps that I previously had been unable to create using the software available to me at Texas A&M. My involvement in the EAPSI program will drastically enhance the end-product of this specific project as well as my future abilities to record, present and interpret spatial representations of archaeological data.

Perspective of Research after this Program:

My participation in the EAPSI Australia 2005 program has been extremely beneficial to my current and future research, both through skills acquired in my time in Sydney and through valuable connections made with other researchers. The program allowed me to accomplish the major goals of my proposal, giving me insight into the use of GIS in archaeology, as well as the opportunity to meet and develop contacts with archaeologists (Professors and students) in Australia. The program exposed me to the inter-disciplinary opportunities of spatial analysis in archaeology that I can take with me back to my host institution and incorporate into my future research as well as my academic career as a future instructor of archaeology.

RESEARCH REPORT

Name: Matt Kraybill

Institution: University of Utah

Host: Dr Nancy Pachana

Institution: University of Queensland

Research Project: *Neuropsychology.*

Research Description:

The aim of this research project was to evaluate the clinical utility of the "cogni-screen" computerized memory assessment task as well as the electronic version of the Behavioural Dyscontrol Scale. These tasks are intended to assess early memory and executive function impairment in older adults without a diagnosis of dementia.

Research Activities:

The activities of this project included cognitive testing of nursing home subjects as well as community-dwelling older adults.

Perspective of Research after this Program:

Ageing and cognitive impairment is an important area of research in both the United States and in Australia. The assessment tools that are being developed in both countries will hopefully aid an understanding of what processes are involved in cognitive decline and may serve as early detection and monitoring devices.

Advisors Remarks:

I would like to let you know how very much I enjoyed hosting Matt Kraybill in his recent posting here for his fellowship as part of the East Asia and Pacific Summer Institutes for U.S. Graduate Students.

Matt was a delightful student who became very involved in two of our large research projects here in the School of Psychology. The first is a large study investigating how to help general practitioners detect early declines in cognitive functioning in older adults. The second is a study of hazard detection processing in older adult drivers. The feedback on Matt's contributions to these projects by all investigators was exceedingly positive. I also thought that the Australian Academy of Science did a great job in acclimating him prior to his arrival here in Brisbane.

All in all we were very impressed with the fellowship scheme. I personally would not hesitate to host another overseas scholar as a part of this program.

RESEARCH REPORT

Name: Keith Marsolo

Institution: Ohio State University

Host: Dr. Rao Kotagiri

Institution: The University of Melbourne

Research Project: *Characterization of protein structure for SCOP fold recognition.*

Research Description:

Proteins are macromolecules that play a role in countless biological processes. They include enzymes, hormones and antibodies. Each protein consists of a sequence of amino acids. Sequential amino acids form interacting subunits called secondary structures. Interactions between these secondary structures determine the global shape of the protein. This shape, in turn, influences a protein's biological function. Therefore, developing a method of classifying protein structures has potential benefits for applications such as drug discovery.

Unfortunately, the most appropriate method for the classification of protein structures remains an open problem. While the number of solved protein structures (30,000+) trails that of known protein sequences (2.1 million), additional structures are added daily. As such, the need for an efficient, automated classification solution is increasing. In order to classify a protein structure with any accuracy, however, an effective representation must be chosen. My research focused on creating such a representation. In particular, I was concerned with developing a method that would expose the underlying structural features but maintain any spatial relationships that may exist, all while reducing the overall dimensionality of the data. I was successful in my efforts, creating two different approaches that each improved classification accuracy by 8-10% over previous results.

Research Activities:

My research addressed two different areas. The first involved improving techniques I had developed in the US. In that work, I created a representation method where I would convert a protein structure to a distance matrix based on the inter-residue distances of the underlying amino acid sequence and then transform that matrix into a feature vector using two wavelet-based decompositions. This feature vector could then be used as input to a classifier. Discussions with my host and other postgraduate students lead me to an optimization of my existing approach where I would only focus on the "important" amino acid residues that were part of protein secondary structure elements. Using this technique, I was able to significantly improve classification accuracy, to approximately 82%, an increase of 8-10% over my previous results.

The second part of my research involved creating an entirely new method of representing protein structure. Rather than focus on the global inter-residue distances, this method deals with the interactions between the secondary structures of the protein. A set of interactions is created for each protein and the distances between the residues involved in these interactions are again converted into a feature vector. While still in its infancy, preliminary results indicate that this method again improves classification accuracy to approximately 82%. Further experimentation may yield an additional increase in accuracy.

Perspective of Research after this Program:

It was very beneficial to have the opportunity to speak with other students and researchers who could view my work from a completely different perspective. Our discussions allowed me to improve my existing work, create an entirely new transformation method and gave me a number of potential avenues to explore when I resume my research back home. Whenever I do get around to graduating, much of my Ph.D. research will be based on my work here. I also feel that by facing an 8-week deadline, I was forced to work a bit quicker than I normally would, allowing me to accomplish more than I would have if I had stayed in the US this summer.

So in that sense, this visit has been invaluable.

Advisors Remarks:

It was a pleasure working with Keith during his visit. Our research discussions were fruitful and formed the groundwork for experiments that led to several publishable results. He also interacted well with the other postgraduate students within the department. We feel this program has been a worthwhile experience for the both of us and look forward to additional collaboration in the future.

RESEARCH REPORT

Name: Timothy D. Meehan

Institution: University of North Carolina at Chapel Hill

Hosts: Kevin Jack, Matt Trau (UQ) and John Hunt (UCQ Bundaberg)

Institutions: University of Queensland and Central Queensland University

Research Project: *Magnetic manipulation of ferritin functionalized hydroxyapatite nanoparticles. Nanoscience and nanotechnology outreach.*

Research Description:

My EAPSI work involved elements of both bench work and nanoscience outreach. I will discuss each in turn.

The ability to manipulate nanoparticles provides the potential to influence the structure of composite materials from the nanometer scale up. My research conducted at the University of Queensland (UQ) involves the attachment of the iron containing protein, ferritin to hydroxyapatite (HA) nanocrystals. Subsequent magnetic manipulation of the ferritin labelled HA crystals was demonstrated qualitatively. Ferritin is a physiologically derived protein and is biologically compatible. This method of manipulating HA has the potential to serve as a useful method of ordering HA / polymer composites. Such composites would be useful as material for bone replacement therapy. The ability to manipulate the HA would give added control over the nanoscale structure of the material. By controlling the nature of the material at the nanoscale improved macroscopic characteristics such as shear strength may be possible.

As nanoscience and nanotechnology become increasingly important in society, the ability for educators, students, and the general public to become familiar with the basic ideas of this burgeoning discipline will become likewise relevant. Lectures John Hunt and Rosie Thrupp at the University of Central Queensland (UCQ), Bundaberg Campus facilitated my interaction with education students, secondary school teachers and members of Queensland Department of Education. This interaction increased my understanding of the benefits and challenges of bridging the gap between cutting edge research and fundamental education.

Research Activities:

Hydroxyapatite (HA) was synthesized and successfully labelled with ferritin. Specific labelling with ferritin was confirmed by transmission electron microscopy performed at University of Queensland's Centre for Microscopy and Microanalysis. Qualitative magnetic manipulation of the ferritin labelled HA was demonstrated.

I visited UCQ, Bundaberg where I was a guest speaker in an Education class entitled "Technologies" where I introduced the concepts of nanoscience and nanotechnology. We discussed the characteristics of nanoscience that make it unique and discussed several current, and up and coming, technologies that have come about as a result of studying the nanoscale. This was a wonderful opportunity to interact with some of the future teachers of Queensland, and discuss some of the technologies which will be ever more present in their student's lives. While in Bundaberg I also had the chance to visit Bundaberg State High School where I met with Keith Holledge, a teacher who has developed a unique high tech approach to practical arts. I also had the pleasure to participate in Cyberstem, an ongoing program run cooperatively by John Hunt and University of Queensland's Centre for Microscopy and Microanalysis.

Perspective of Research after this Program:

The research conducted at UQ has allowed me to develop the method for magnetic manipulation of nanoscale structures using ferritin into a potentially medically beneficial application. The facilities and fellow researchers at UQ have given me the tools and the ideas necessary to enhance my dissertation thesis. It is my hope that continued collaboration with my host will allow this work to develop further and permit collaborative publication of the results.

The opportunity to describe my area of work in nanoscience to such a diverse group of individuals working in the field of education was very rewarding. The chance to talk with non-scientists was beneficial in helping me re-define nanoscience and nanotechnology. I believe that hearing from a researcher working in this field was a unique and valuable experience for the educators and students with whom I spoke as well.

Advisors Remarks:

Remarks of Kevin Jack
It has been a pleasure to have hosted Tim in our Centre for this (too brief) time. In addition to his excellent research work he has added to our group with both his intellectual and cultural input. During this visit he has made a significant contribution to our research program, which we aim to both publish and continue our collaborations in the future. In addition, Tim has managed to pursue his interests in scientific education, participating in an 'outreach program', and has taken the time to better acquaint himself with life in Australia.

Remarks of John Hunt
From the perspective of Central Queensland University, Tim's time here has been extremely productive. Although we were constrained by distance, Tim was able to visit our town and campus for 3 days and partook in a series of workshops with our Futures and Technology students, as well as visiting a local secondary school that utilises a high tech approach to Technology Studies. Tim also assisted me in the delivery of 2 CyberSTEM (SEM over IP) workshops to remote locations: one to a local school and the other to York University (UK) where I was working for a short time. Tim has made an enormous contribution to both the understanding my students have of science and nanotechnology and my own personal notions of science.

RESEARCH REPORT

Name: Alexander Mikheyev

Institution: University of Texas at Austin

Host: Ross Crozier

Institution: James Cook University

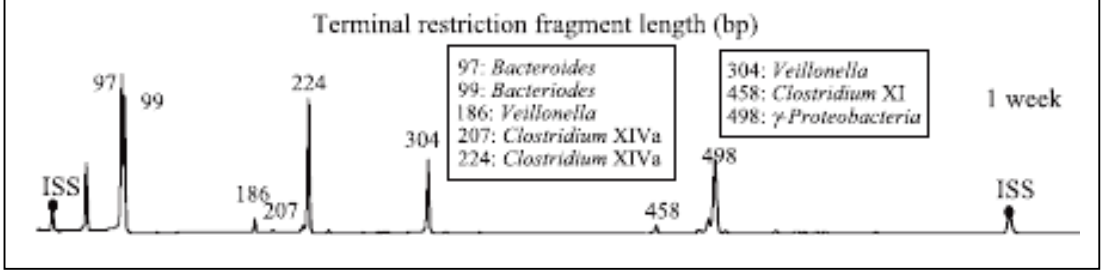
Research Project: *Theoretical microbiology/community sampling.*

Research Description:

It can be argued that microbial activity drives most major ecological processes. Microbes are also important pathogens and agricultural pests. However, our knowledge of microbial community ecology is quite limited, owing largely to (a) the incredible diversity of microbes in any given environment and (b) our limited ability to study them, given that most species cannot be cultured in the lab. The modern methods of choice for the study of microbes revolve around the polymerase chain reaction (PCR), a technique that allows the amplification of specific regions of an organism's genetic code. The "gold standard" approach involves sequencing all the microbes in a given community following PCR. Although effective, this method is nonetheless prohibitively time consuming and expensive. Thus, surveys of large numbers of microbial communities using sequencing are impractical. Another approach involves PCR-amplifying an entire microbial community and then cutting the product with a restriction enzyme, which generates DNA fragments of varying length. This approach has the advantage of being extremely fast and relatively inexpensive, but provides little information about actual community composition, since a microorganism cannot be confidently identified using the length of a single enzyme-cut DNA fragment.

One variant of the restriction enzyme-based community analysis method is terminal restriction fragment polymorphism (TRFLP) analysis, where the PCR procedure is modified produce genetic fragments that are fluorescently labeled on one end. After enzymatic restriction, the length of fluorescently-labeled fragments is detected using sequencer machine, producing a profile of DNA fragment lengths, such as illustrated in Figure 1. In this way, each microbe produces just one fragment. My goal was to improve the identification power of TRFLP by using several separate restriction enzyme reactions and taking advantage of natural variation in microbial community composition. Namely, differences in species composition across several communities could be used to assemble combinations of DNA length fragments from different enzymes into "fingerprints". In turn, the fingerprints could be used to identify individual species of microorganisms.

Figure 1. TRFLP profile of a bacterial community (from Wang et al, 2004. *J. Microb. Meth.*). Peaks correspond to lengths of DNA of a given length, as indicated by numbers above them. Boxes list peak lengths and corresponding bacterial genera.



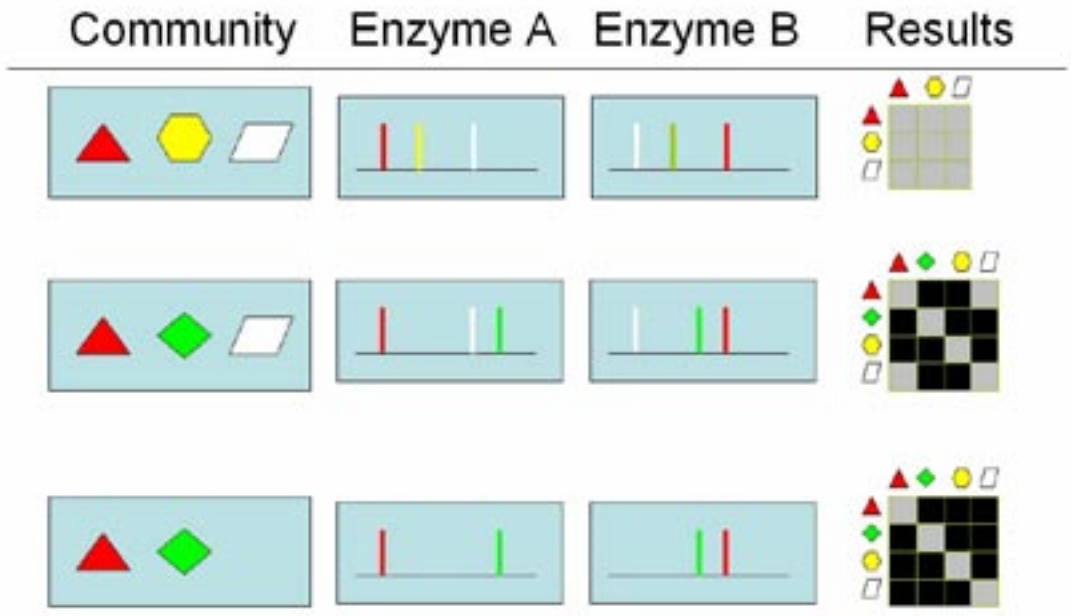
Research Activities:

I will illustrate the logic behind my fingerprint assembly procedure via a simple example (Figure 2). Imagine a species pool of four organisms, which are represented by different colors in the figure. One community (Figure 2, top line) consists of three species (red, yellow and white), which give rise to DNA bands of three different

lengths when digested with a restriction enzyme A. They give three additional bands when digested with restriction enzyme B. Given the restriction profiles of this one community, we cannot tell which peaks correspond to which of the three species. However, as we sample another, related, community (Figure 2, center line), we are able to considerably refine our association matrix by noting synchronous appearances and disappearances of peaks. Namely, peaks for green and yellow organisms are now fully resolved, though the associations between peaks from the red and white organisms are still ambiguous. However, this ambiguity is resolved by the next sample (third line of Figure 2). Thus, we are capable of providing unique genetic fingerprints for each species by repeated sampling of several closely related communities.

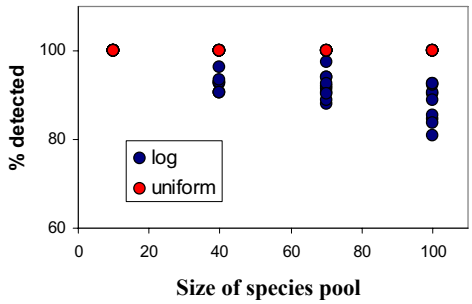
Simulation results from the genetic fingerprint assembly algorithm. In order to determine whether the power of fingerprint assembly extends beyond simple scenarios such as the one described above, I conducted a number of simulations using artificially generated species assemblages. In particular, I studied the relationship between the accuracy of the algorithm in distinguishing individual species and the number of enzymes used (2-4), the percentage of missing data (0-40%), the percentage of peaks shared by different organisms (0-40%), the number of species in the species pool (10-100), and the number of communities sampled (10-100). The simulations were carried out using different species frequency distributions: a uniform distribution and a more realistic lognormal(0,1) distribution.

Figure 2. Fingerprint assembly of a hypothetical four-species community digested with two separate restriction enzymes. The peaks produced by restriction digestion are color-coded to correspond to the organism from which they are derived (note that actual TRFLP data are not color coded). The matrix on the right is created by considering information obtained from communities going from the top down. Grey cells in the matrix represent peaks combinations that are consistent with the given data, while black cells indicated peak combinations that should be excluded given these data.

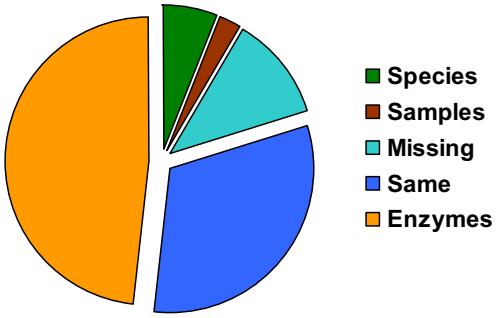


Since the efficiency of the algorithm depends on the degree to which sequentially sampled communities vary in species composition, greater variability of a uniform *vs*. lognormal species abundance distribution results in substantially improved performance, as can be seen in the left hand panel of Figure 3. This panel also illustrates that a comparison of just 40 communities permits fairly complete characterizations of microbial assemblages of up to 100 species. Indeed, as seen by the right hand panel of Figure 3, the number of species in an assemblage and the number of communities sampled play a relatively minor role in the efficiency of the model, a convenient property that implies that even large assemblages can be relatively easily evaluated. The right side panel also shows that the major source of error is the sharing of restricted DNA fragments by different organisms.

Figure 3. Performance of the genetic fingerprint assembly on simulated data.



Percent species detected after forty communities have been sampled using three restriction enzymes (no missing/shared data).



Relative contributions of simulation parameters to algorithm's ability to detect species in an assemblage. Performance is improved by increasing the number of samples and enzymes. All other parameters harm performance.

Perspective of Research after this Program:

Significance of research. Being able to rapidly assemble genetic fingerprints for species in closely related communities provides a powerful tool for microbial community ecology and the study of community evolution. Although the individual fingerprints are not necessarily readily convertible into species identifications, they can nonetheless be used to trace the presence and absence of individual species across communities. Eventually, if this approach proves useful, libraries of TRFLP genetic fingerprints can be assembled for rapid identification of important microorganisms. However, much community ecology can be carried out using species labels, without the benefit of exact species identification.

Future research. I am currently improving the algorithm in order to deal with systematic sources of error introduced when restriction digests of DNA from unrelated microorganisms produces fragments of the same lengths, which is the major limitation of the earlier algorithm. In addition, I am developing a range of quality control statistics for the algorithm, such as a species richness estimator and estimates of the reliability of deduced genetic fingerprints. Additionally, I am acquiring real data sets that can be used to test the algorithm.

Advisors Remarks:

I was very impressed with Mr Mikheyev, and very glad to have had him with me. He showed an impressive ability to change his study topic when it became clear that it would be hard to gather sufficient samples, and switched to a quite different one, yet as it happens still one that is of interest to me. With respect to this second project, I am convinced that it will probably be of great interest to microbial ecologists as offering a method much in advance of any now available. I certainly hope that he will find time to complete the method soon, as I believe that it would greatly help with a project I hope to embark on next year.

RESEARCH REPORT

Name: Aaron Rundus

Institution: University of California, Davis

Host: Dr. Chris Evans

Institution: Macquarie University

Research Project: *Modelling the dynamic motion characteristics of the Australian death adder* (Acanthophis antarcticus) *caudal luring display.*

Research Description:

Over the last few decades the field of animal communication has been quite successful in the quantitative analysis of both acoustic signals and static visual signals. Much less is known, however, about signals that are primarily defined by the characteristics of their movement. Using techniques pioneered by the Animal Behaviour Lab at Macquarie University, we examined the dynamic motion characteristics of the caudal luring behaviour performed by the Australian death adder, used to attract prey items to within striking range.

Research Activities:

In order to better understand the motion characteristics of caudal luring behaviour, how this signal is perceived by potential prey items of the luring snake such as Jacky Dragon lizards, and how this signal is deployed during predatory encounters we began the following:

1) 3D computer modelling of the death adder caudal luring display for use in playback studies to a variety of prey species including Jacky Dragon lizards
2) Analysis of the dynamic motion characteristics of the adder's luring display using software (Analysis of Image Motion) developed by the Macquarie University Animal Behaviour Lab
3) Comparison of the motion characteristics of the luring display with the motion characteristics of several food items of the Jacky Dragon lizard
4) Playback experiments involving manipulation of key motion parameters of the caudal luring display to Jacky Dragon lizards

Perspective of Research after this Program:

This research into the caudal luring display of the Australian death adder has proven to be very fruitful and will be continued by Dr. Evans lab during my absence. Our work thus far will also serve as the basis for a postdoctoral fellowship through the NSF, allowing me to continue investigating the motion characteristics and evolution of the caudal luring behaviour of both Australian elapids and North American vipers.

Advisors Remarks:

It was a real pleasure to have Aaron Rundus as a visiting researcher in the lab. He tackled his part of a collaborative program on the visual ecology of lizards with energy and enthusiasm, achieving considerable progress during his relatively brief visit. Aaron used 3-D animation software to create a life-sized predatory snake, modelled upon the morphology and movement of a death adder. In addition, he explored signalling motor patterns by digitising video sequences and applying optic flow algorithms to extract changes in velocity characteristics over time. These novel techniques, which were developed in Australia, will now be applied to the mammalian systems studied in Prof. Don Owings' lab at UC Davis, further strengthening the collaborative links between our two groups.
Aaron is now close to completing his PhD and hence considering postdoctoral positions. He was greatly encouraged by the opportunities for behavioural research in Australia and now plans to submit an NSF fellowship proposal to continue his work in my lab. Naturally, I am delighted by this outcome. Aaron's application will receive strong sponsorship support from our Centre for the Integrative Study of Animal Behaviour.

RESEARCH REPORT

Name: April Smith

Institution: Rice University

Host: Dr. Laura Poole-Warren

Institution: University of New South Wales

Research Project: *The activation and stimulation of leukocytes by poly vinyl alcohols (PVA) as well as the synthesis of carboxylated PVA (PVA-COOH).*

Research Description:

I tested four different PVA polymers for stimulation of leukocytes. The PVA polymers were PVA 3-83 (14kDa MW), PVA 3-98, PVA-NH_3 and PVA-COOH. Samples of PVA were incubated in whole blood for 1 hour at 37 °C. The leukocytes, specifically monocytes and neutrophils, were isolated and fixed. Cells were then stained for the CD11b surface receptor and viability. Up-regulation of CD11b and percent viability were assessed using flow cytometry.

Research Activities:

I tried two methods for synthesizing PVA-COOH and used NMR to determine if we were successful. I learned how to work with whole blood. I learned how to use the flow cytometer as well as how to analyse the data obtained from it. I gained more experience in planning my own experiments.

Perspective of Research after this Program:

I still like research and would be willing to do another program like EAPSI. I believe it is very important for graduate students to work in another lab outside of their home university as you learn so much more.

Advisors Remarks:

April was an excellent student who achieved a considerable amount in the short time she spent in my lab (only 2 months, compared with the more typical 3 to 6 months that practicum students spend here). Prior to her arrival, we started with a protocol and hypothesis in place and had suggested some background reading. The first (and major) part of her work involved training both in our lab safety procedures and in the specific techniques themselves. I don't believe this could have been accomplished in a shorter time period. The experimental part, as April points out, was by necessity compacted into the final couple of weeks and her results, although interesting, were not conclusive. I was very happy with her performance, not only in terms of her technical skills, but also in her approach to teamwork and her ability to get along with everyone in the lab. In terms of the program, it is a good one for giving a "taste" of how Australian labs work, but the task or programs given to students need to be very well planned prior to arrival which often gives less scope for creativity on the part of the visiting student. Overall, the experience was a very positive one and one which I would be prepared to repeat in the future.

RESEARCH REPORT

Name: Joseph P. Smith

Institution: Environmental, Earth, and Ocean Sciences (EEOS) University of Massachusetts

Hosts: Dr. Gregg J. Brunskill and Dr. Gary Hancock

Institution: Australian Institute of Marine Science

Research Project: *Environmental Biogeochemistry (Radiochemistry)*
The Dynamic Equilibrium Sediment Surface (DESS) concept: Investigating sediment accumulation in coastal "hot-spots" of the inner shelf of the Great Barrier Reef (GBR) Lagoon.

Research Description:

Catchment studies and models in Northern Queensland, Australia suggest erosion rates may have increased by as much as a factor of 4-6 since pre-colonial times due to increased agriculture (sugar cane) and ranching (cattle farming), especially since the 1950's (Prosser et al., 2002). Increased erosion has been linked to increased sediment delivery to the coast and to the inner shelf of the Great Barrier Reef (GBR) Lagoon (McCulloch et al., 2003). Although the premise of an increase in fine-grained sediment supply to the coast is widely accepted, the magnitude of this increase and the actual fate of the fine-grained material is highly debatable (Larcombe and Woolfe, 1999; Neil et al., 2002; McCulloch et al., 2003; Orpin et al., 2004).

There exists little scientific evidence of any negative impacts on the coral reefs of the GBR from anthropogenic increases in sediment supply (Larcombe and Woolfe, 1999). Regardless, there is a widely held perception among the media, environmental managers, and the public that this increased sediment flux to the coast is having a negative impact on the corals of the GBR due to increases in turbidity and sedimentation. This perception has led to many, expensive ecological and hydrological studies regarding the implications of fine-grained sediment "pollution" impacts on the GBR with little integration of regional geochemistry and the underlying geomorphology of the system.

Sediment accumulation patterns in coastal and estuarine systems generally exhibit a high degree of temporal and spatial variability in both the quality and quantity and quality of material accumulated. Observed variability can be linked to the physical dynamics (i.e. tidal flow, freshwater flow; wave energy) or fluid energy of the system (Woodruff et al., 2001; Brunskill et al. 2002; Smith, 2003; Orpin et al., 2004; Smith and Olsen, 2005 (submitted)). Olsen et al. (1993) introduced the concept that fine-grained particle (and associated contaminant) accumulation in the sediments of estuarine and coastal systems is primarily governed by the extent to which the sediment surface has attained "equilibrium" with the dynamic physical (fluid) regime. This concept is based on the established geomorphological principle of an equilibrium profile. The particulate load tends to bypass equilibrium, high-(fluid) energy areas (through a series of deposition and resuspension events) and accumulate in low-(fluid) energy, non-equilibrium areas where the probability of accumulation and burial is high (Sanford, 1992; Olsen et al., 1993). Such areas are out of equilibrium as a result of natural processes and/or human activity. Ten years later, only a generalized acknowledgement of the concept has been manifested in coastal sedimentation studies. There is still little application of the concept towards quantifying and qualifying sediment accumulation patterns in estuarine and coastal systems.

Previous research and the research of others has shown evidence for sustained, rapid accumulation (>0.5g/cm^2-yr) of fine-grained particulate materials in the sediments of low-energy, "non-equilibrium" sites in coastal systems over time scales spanning months to years to decades (McKee et al., 1993; Olsen et al., 1993; Brunskill et al., 2002; Smith, 2003; Orpin et al., 2004; Smith and Olsen, 2005 (submitted)). These sites not only represent significant short to medium sinks for sediment, contaminant, and organic carbon accumulation but also serve as natural recorders of sedimentary processes in and material inputs to estuarine and coastal systems (Smith, 2003; Smith and Olsen, 2005 (submitted)). When constructing material budgets for coastal systems, fine-grained sediment accumulation in these localized "hot-spots" can account for a disproportionately large amount of material (Olsen, 1979; Olsen at al., 1993; Chillrud et al., 1996; Brunskill et al., 2002; Orpin et al,

2004). Accumulation in non-equilibrium areas is therefore a significant factor to be considered in local, regional, and even global material budgets and models (sediment, contaminant, and carbon); especially in anthropogenically-perturbed systems (Olsen et al, 1993; Brunskill et al., 2002; Smith, 2003; Orpin et al, 2004; Smith and Olsen, 2005 (submitted)).

Revisiting the Equilibrium Surface Concept (Olsen et al., 1993) and expanding it to develop a Dynamic Equilibrium-Sediment Surface (DESS) conceptual model may begin to provide insights as to how physical factors interact to determine fine-grained sediment accumulation patterns in coastal systems. This new, conceptual model should attempt to integrate geochemical data with (geo-) physical data to elucidate sediment accumulation patterns on different spatial and temporal scales. Such a model could be applied to investigating the sources and fate of fine grained sediment on the inner GBR shelf. Results could then be used to address the question of sediment pollution impacts on the corals of the GRB using an integrated geophysical, geochemical, and ecological approach.

Research Activities:

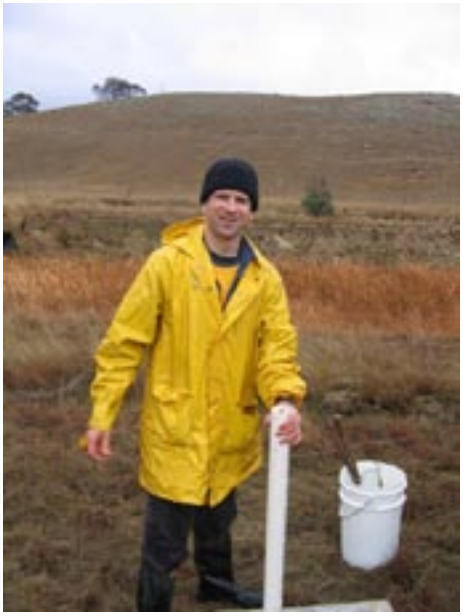
June 20-24, 2005 - Dr. Gary Hancock, CSIRO Land and Water, Canberra ACT, Australia:

Project 1:

Sediment core and soil core samples were collected from a sampling site at Binalong Ranch, ACT, Australia. The site is a CSIRO monitoring station along a small streambed that is subject to significant sediment inputs due to surface and gully erosion during rainfall events. The goal of the study by Dr. Gary Hancock is to investigate sediment retention (before and after significant rainfall events) by in-stream wetlands in a rural setting using ^{7}Be ($t_{1/2}$ = 53.2 days). Sediment retention at the Binalong site has implications for downstream water quality in the Murrumbidgee River, a major tributary of Australia's largest river system, the Murray River.

Beryllium-7 is a cosmogenically-produced radionuclide that is introduced to terrestrial land and aquatic systems primarily through wet (and dry) atmospheric deposition. Beryllium-7 sorbs onto the surfaces of particles that can then, in turn, be deposited in the sediments. Beryllium-7 has been shown to be an unequivocal tracer of sediment focusing and recent sediment accumulation (Olsen et. al., 1986; Smith, 2003; Smith and Olsen, 2005 (submitted)).

Three sediment cores were collected from within the in-stream wetland to investigate changes in the retention of eroded sediments over time.



Each core was sectioned in the lab and then dried at 60°C. Once dried, the cores will be homogenized

(mechanically ground) and analysed using gamma spectroscopy to measure sediment retention over time. Two transects of 4-5 soil cores were also collected along the top of ridgelines above the streambed. Cores were sectioned at intervals from 0-2 cm, 2-5 cm, and 5-10 cm. Surface intervals from each transect were combined to form a depth specific composite sample. In the lab, each composite sample was weighed wet, dried, weighed dry, and homogenized. Dried, homogenized samples were then pressed into containers for analysis by gamma spectroscopy. Radiochemical results from the soil cores will be used to quantify the surface erosion source function for fine grained sediment and quantify retention in the stream bed.

June 27-August 24, 2005 - Dr. Gregg Brunskill, AIMS, Townsville, QLD, Australia:

Research activities at AIMS were spent conducting two separate sub-projects aimed at investigating sediment accumulation patterns on the inner shelf of the GBR lagoon. Project 2 was a simple laboratory study to measure ^{137}Cs desorption from riverine suspended matter and coastal sediments in seawater. Project 3 was a data interpretation, extrapolation, synthesis, and modelling effort aimed at developing and demonstrating the DESS model using geochemical and geophysical data from the inner shelf of the GBR Lagoon.

Project 2:

Cesium-137 is a fission-produced radionuclide that is a recognized tracer for use in erosion and coastal sedimentation studies. It can be used to develop geochronolgies and serve as a tracer for riverborne particles that have been derived from eroded drainage basin soils and transported through the estuary. Its usefulness in Australian waters is complicated by the lower fallout input and the lack of distinct fallout peaks in the Southern Hemisphere as compared to the Northern Hemisphere (Pfitzner et al., 2004). Its use a tracer for terrigenous sediment inputs to coastal systems is further complicated by potential post-depositional mobility due to increased ion competition in saline waters (Pfitzner et al., 2004). In order to use ^{137}Cs activities and inventories to develop geochronologies and construct sediment budgets in a system like the inner GBR shelf, one must constrain the input functions and mobility of the radionuclide.

A simple extraction experiment was conducted to measure the desorption of ^{137}Cs from particles in seawater. Three samples were used: 1) two samples of dried, homogenized Burdekin River suspended matter with ^{137}Cs activities of 1.1-1.7 Bq/kg; and, 2) one sample of dried, homogenized sediment from an archived sediment core section (Core 1260 40-44cm) with a relatively high ^{137}Cs activity of 4.3 Bq/kg). Core 1260 was taken from an area of known rapid sediment accumulation (2.3-2.5 g/cm^2-yr) (Pfitzner et al., 2004).

Samples were extracted in 120-150L of 35-36 PSU seawater in large plastic barrels for 2 weeks. Each day the samples were agitated using a small plastic paddle with an Al handle. The extraction barrels were kept outside, out of direct sun at an average temperature of 17-27°C.

After two weeks, sediments were allowed to settle out to the bottom of the extraction barrels. Seawater was slowly siphoned off. Precipitated samples repeatedly rinsed with Milli-Q water to remove salt. Precipitated samples were then dried (60°C), homogenized, pressed, and analysed by gamma spectroscopy. Experimental results are shown in **Table 1**.

Table 1:

Sample	$A_{0Cs-137(before)}$ (Bq/kg)	Error	$A_{0Cs-137(after)}$ (Bq/kg)	Error	$A0_{Cs-137(after)}/A_{0Cs-137(before)}$	Error	Net Change in ^{137}Cs (Bq/kg)	Error	Net Change in ^{137}Cs (Bq)	Error
BURD_SM_2002	1.16	0.45	3.21	0.45	2.77	0.81	2.05	0.91	0.17	0.08
BURD_SM_2005	1.68	0.33	2.79	0.39	1.65	0.29	1.10	0.72	0.12	0.08
C1260_40-44	4.27	0.52	5.76	0.08	1.35	0.04	1.49	0.60	0.16	0.06

The results in **Table 1** indicate ***sorption*** of ^{137}Cs from seawater instead of the little to no desorption that was expected. The results above mean one of three things:

1) There was experimental error (i.e. sample weights), or an error in how the gamma spectroscopic data was processed. But consistent errors in sample weights large enough to account for the measured increase in ^{137}Cs activity in all three samples are unlikely. A mistake in or incomplete data processing would be the more likely error. But the data processing and reduction techniques used were double-checked independently by another researcher (John Pfitzner) more familiar with the instruments and software used and no major errors were found.
2) Somehow there might have been ^{137}Cs contamination. This is highly unlikely and does not explain the concurrent increase in ^{40}K activity.
3) There actually was ^{137}Cs ***sorption*** instead of desorption or an additional input of ^{137}Cs to the particulate phase when extracted with seawater. It is theoretically possible, but seems unlikely. This result, however, would not be unprecedented (Lujaniene et al., 2005).

   Assuming an average dissolved ^{137}Cs concentration in the surface ocean waters of Northeast Australia is 1.9 mBq/L (Povenic et al., 2005), with a K_d for ^{137}Cs in seawater of 10^3 (L/kg), then the expected equilibrium partitioning for ^{137}Cs in the particulate phase would be 1.9 Bq/kg. If Burdekin River suspended matter enters saline coastal waters with ^{137}Cs activity depleted relative to this value, it could potentially provide a substrate for the sorption of ^{137}Cs. There would have to be a rapid (2 week) shift in equilibrium to explain the results.

   And why would the Core 1260 sediment ^{137}Cs activity increase as well? If all, or some of the ^{137}Cs was lattice bound, and therefore "irreversibly" sorbed, then the increase in sediment activity could represent "extractable" sorption to particle surfaces only. The net increase in ^{137}Cs activity in all three samples (1.1 - 2.0 Bq/kg) could be explained this way. Also, if one multiplies the average ^{137}Cs concentration in NE Australian seawater by the volume of seawater used in the extraction study, the 0.2 – 0.3 Bq present could support the average increase in particulate phase ^{137}Cs activity observed (0.09 – 0.2 Bq) but the new equilibrium partitioning values would not make sense in view of the results observed.

   One must also look at the Burdekin River suspended matter used in this study. The low illite content argues against ^{137}Cs incorporation into illite however there is documented evidence of ^{137}Cs sorption onto mica (McKinley et al., 2001) and the sorption into expanding clays which then "fold" in the face of a higher ionic strength to retain ^{137}Cs. These mechanisms may potentially be invoked in the case of the Burdekin. Another interesting potential variable in the study was the effect of organic matter on ^{137}Cs incorporation into the organic phase, especially considering the algal growth in the extraction tanks (Lujaniene et al., 2005).

At a minimum, at least in the case of the Burdekin River suspended matter samples, one could make the argument that significant desorption of ^{137}Cs present did not occur given the low starting activities and the present, measurable activities after the extraction. The idea of ^{137}Cs sorption onto Cs depleted particles is intriguing, especially in the Southern Hemisphere where particulate ^{137}Cs activities are significantly lower than in the Northern Hemisphere. The results merit further investigation, especially in light of some of the relatively high ^{137}Cs activities observed in near coastal surface sediments of the GBR lagoon as compared to Burdekin River suspended matter.

Project 3:
Dr. Gregg Brunskill at the Australian Institute of Marine Science (AIMS) has collected geochemical data from over 50 sediment cores and > 700 surface sediment grab samples from the central region of the GBR shelf over the past 14 years. AIMS also has an extensive array of geophysical data from the same region over similar time scales. This large integrated dataset presented an opportunity to develop a DESS model that could be applied towards the questions of the magnitude of increases in sediment fluxes to the GBR Lagoon over the last 100 years and the actual fate of this fine-grained material and its potential impacts on the GBR system.

The inner GBR shelf near the Burdekin River was chosen as an initial study area to attempt to develop a DESS model. In order to investigate whether increased erosion since pre-colonial times is leading to increased fine grained sediment input to the inner shelf of the GBR lagoon, it was first necessary to identify geochemical indicators of terrestrial vs. marine source material. Examples of indicators used are Al/Ca ratios and $^{137}Cs/^{40}K$ ratios. Secondly, it was necessary to be able to distinguish inputs from these respective end-members over time. This was done by using mass accumulation rates (MARs) estimated from radionuclide analysis in select sediment cores. Lastly, data had to be extrapolated from a few sediment cores to identify detailed sediment accumulation patterns over large spatial scales. This would allow for the calculation of a system mass balance, or sediment budgets (Brunskill et al., 2002). It was hoped that the DESS approach would provide a means to further extrapolate data to quantify sediment accumulation patterns over time.

The major challenge in developing a model like the DESS model was the interpretation and extrapolation of data into different temporal and spatial scales. I was unsuccessful at construct a model that realistically extrapolated geochronological data (MARs) from sediment cores to areas where only the surface sediment samples were sampled (sediment grabs). Geochemical data in the sediment cores could often be interpreted in multiple ways, leading to different paths in extrapolation. I can provide examples of different approaches in this report, but most led to "dead-ends" in terms of the development of a DESS model. Likewise, geochemical and geophysical data existed on different spatial and temporal scales so direct comparison and integration was difficult at best. The modelling approach quickly became a circular argument in that the physics of the system determines fine-grained sediment accumulation patterns, but the only way to quantify the detailed physics was by extrapolating geochemical results.

Perhaps the most meaningful result from this project came from discussions with my host on the challenges faced in such an approach. From these discussions, the following potential future research ideas were identified:

1. Compare MARs derived from radionuclides with different half-lives (^{210}Pb ($t_{1/2}$ = 22.3 years) , ^{137}Cs, ^{14}C ($t_{1/2}$ = 5730 years)) to look at long-term sediment accumulation (>1000 year) vs. medium term (< 100 year) accumulation.

2. Compare radionuclide-derived MARs to seismic thickness measured at the same sites.

3. Estimate how much "hot-spot" accumulation can be accommodated on time scales of <100 years in a given coastal area before export must take place (fluid energy vs. eustacy).

4. Use chemical gradients to quantify the net transport of terrigenous materials over time.

5. Estimate sediment inputs from a given river system (Herbert River) to the adjacent shelf over 1000 year time scales spread out to 120m depth. Compare this to the same amount of material accumulated in a small spatial area along the coast.

6. Employ additional tracers such as $^{87}Sr/^{86}Sr$ ratios to identify and quantify terrigenous material inputs.

Perspective of Research after this Program:

One week was too little time to finish the work in Project 1. But the research experience was invaluable in that it allowed me to see first hand the types of ranch land environments that are proposed to increase erosion in linked land-coastal systems in Australia. It also provided me an opportunity to exchange ideas with Dr. Gary Hancock as to how radionuclide tracers could be employed to investigate erosion rates and short-to-medium sediment accumulation patterns. It was among my first experiences in applying my research in a freshwater and terrestrial environment rather that estuarine or marine environment.

Although the results of the research conducted in Project 2 and 3 are incomplete and inconclusive, the experience and insights gained during the eight weeks spent on the two projects will provide a basis for future work and will be integrated into my current research activities as well. My experiences at AIMS with my host, Dr. Gregg Brunskill, enabled me to consider my research ideas on much larger scales, both spatially and temporally. This will benefit me greatly in my upcoming PhD dissertation and my future career as a researcher.

I hope to revisit the results of the ^{137}Cs desorption experiment conducted in Project 2 in collaboration with my host(s) at AIMS. I intend to conduct similar experiments at my lab in Boston, Massachusetts, USA to attempt to explain the results of the experiments conducted at AIMS. If the results are not due to contamination or experimental error, then they represent a finding that may be useful in coastal sedimentation studies in Australia and the Southern Hemisphere in the future.

I was a little disappointed with my lack of progress and accomplishment in conducting Project 3, the DESS data interpretation, extrapolation, synthesis, and modelling. This did not make the experience any less valuable. In fact, the experience to me further illustrates the need to develop a integrated geophysical and geochemical approach towards understanding fine-grained sediment accumulation patterns. I will use my "failures" during my EAPSI experience to guide my research activities in the future. Furthermore, I would like to return to do collaborative research in Australia in the future to address the issues I have discussed above.

Advisors Remarks:

As in many intellectual endeavours, it is often more important to consider whether or not you are asking the right questions of nature, and to explore alternate methods & pathways to understanding. Some of this happened during Joe Smith's visit to AIMS, and this enriched his and our group thinking. There was not enough time during his visit to incorporate the large body of geological, climatic, physical and chemical information to fully test the DESS model on our data base, but Joe made a valiant effort to explore this option. He has influenced us to think in directions not previously anticipated. G. J. Brunskill, AIMS, 4 October 2005.

During his short stay (1 week) at CSIRO Joe Smith provided valuable technical and scientific input to a small phase of an ongoing study here. Constructive discussions between Joe, myself and other CSIRO researchers on this study and other work have provided additional ideas with which to pursue our objectives. I hope to maintain collaborative contact with him.

RESEARCH REPORT

Name: Michael Shane Thompson

Institution: Virginia Tech

Host: Judy S. Riffle

Institution: University of Western Australia

Research Project: *Complexes of magnetic nanoparticles with block copolymers: Characterization of material and magnetic properties.*

Research Description:

The research carried out at the University of Western Australia was to learn techniques for the characterization of magnetic materials prepared at Virginia Tech in order to gain a better understanding of the overall project and to bring the knowledge gained back to our research group at Virginia Tech.

Research Activities:

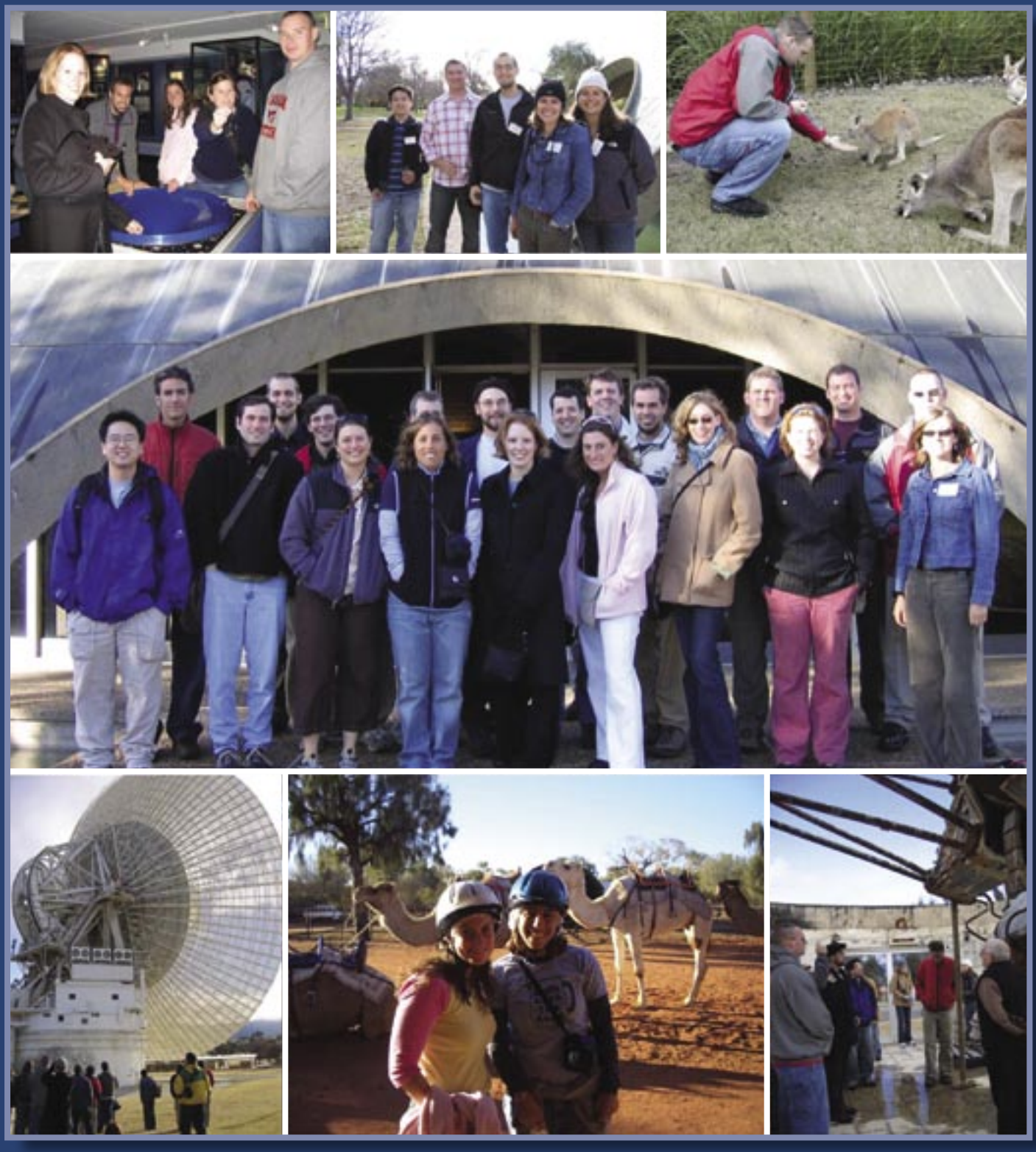
Magnetophoretic mobility studies were done on magnetic microspheres to determine their velocity through aqueous media in the presence of a magnetic field gradient. The magnetic microspheres were also characterized by transmission electron microscopy to determine the distribution of magnetic material in the sample. Scanning electron microscopy was also used to determine the size and size distribution of the magnetic microspheres.

Perspective of Research after this Program:

My perspective has changed after participating in the EAPSI program. Before participating in the program, I did not fully appreciate the importance of travelling abroad to see first hand how different countries and different disciplines within the sciences undertake research projects. Now I believe that travelling to different institutions and sharing all the different perspectives on research is vital to the advancement of science. During my participation in the program, I also developed a strong desire to travel more and experience how different countries preform research to broaden my perspective on science in general.

If you are interested in hosting a US graduate student, or would like more information about the program, please contact the International Programs section at the Australian Academy of Science, email is@science.org.au, phone (02) 6247 3966.

More information on the EAPSI Summer Program, including application forms and deadlines, is at the NSF Website: www.nsf.gov/funding/pgm_summ.jsp?pims_id=5284.



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