RESEARCH REPORT

1. Name: Rose Z. Abramoff （ID No.: SP10001）

2. Current affiliation: Boston University

3. Research fields and specialties:
Biological Sciences

4. Host institution: Tokyo City University

5. Host researcher: Dr. Hiromi Kobori

6. Description of your current research

My current research focuses on the phenology of plants and animals with a specialization in temperate deciduous tree phenology. In Boston I have been tracking spring phenology for one year on an urban-to-rural gradient from Back Bay westward to Waltham. I am observing the following commonly found trees and shrubs: Weeping willow (*Salix babylonica*), Red maple (*Acer Rubrum*), Norway maple (*Acer platanoides*), Gray birch (*Betula populifolia)*, Magnolias (*Magnolia*) Forsythia (*Forsythia*), Lilac (*Syringia*), Rhododendron (*Rhododendron*), and Sumac (*Rhus*). I hypothesize that the warmer city center will have earlier spring phenology as characterized by leaf out and first flowering date. I have placed temperature loggers at five locations along this transect in order to capture the temperature gradient. I plan to continue this project next year and to extend my transect to include the edge of the Charles River Watershed.

I am currently pursuing a certificate in Terrestrial Biogeosciences in addition to my doctorate at Boston University. As part of our coursework, I and other graduate students are collaborating with Professor Adrien Finzi using metanalysis techniques to see how grain yield, nitrogen trace gas emissions, and runoff would change with a 50% reduction in nitrogenous fertilizers in four United States watersheds.

When I return to Boston University in the fall, I hope to plan a precipitation manipulation experiment to assess how flowering duration and leafing out respond to heavy rainfall and drought, as a real world test of some of the statistical correlations found in the data set and analysis described below.

7. Research implementation and results under the program

Title of your research plan:

Impacts of climate variability and urbanization on Prunus yedoensis

Description of the research activities:

I first attempted to define an appropriate urban impact area. In order to set up an urban-rural gradient we had to identify JMA stations with similar climate and elevation with different levels of urbanization. We established three different gradients on three different latitude lines, including the following cities: 1) Matsumoto, Maebashi, Kumagaya, Utsunomiya, Mito; 2) Iida, Kofu, Choshi, Yokohama, Tokyo; 3) Hamamatsu, Shizuoka, Tateyama, Oshima.

However, after creating plots of the standard deviations of the Julian day of phenological events over time for these

stations, I found the variation to be too small to make statistically significant comparisons with weather data.

I then decided to look not at variation in the phenological event, but at another expression of variability, flowering duration. Flowering duration indeed changes dramatically over time and in response to temperature and precipitation. A collaborator in my advisor's phenology group, Jeff Diez, is conducting statistical analysis on models he built specifically to analyze *Prunus yedoensis*, and we hope to write a paper together once the analysis is completed. To date, there is little evidence for the expansion of flowering duration due to climate warming in temperate cherry trees, or for trees in general. There has also been no exploration into the effects of precipitation and extreme climate event effects on flowering duration. Using a 53-year data set of detailed flowering phenology and climate data across 74 stations in South Korea, we determined that flowering duration is increasing in tight correlation with warming temperatures. Although precipitation alone has a non-significant effect on flowering duration, heavy rainfall events and interaction effects with temperature have created some significant trends.

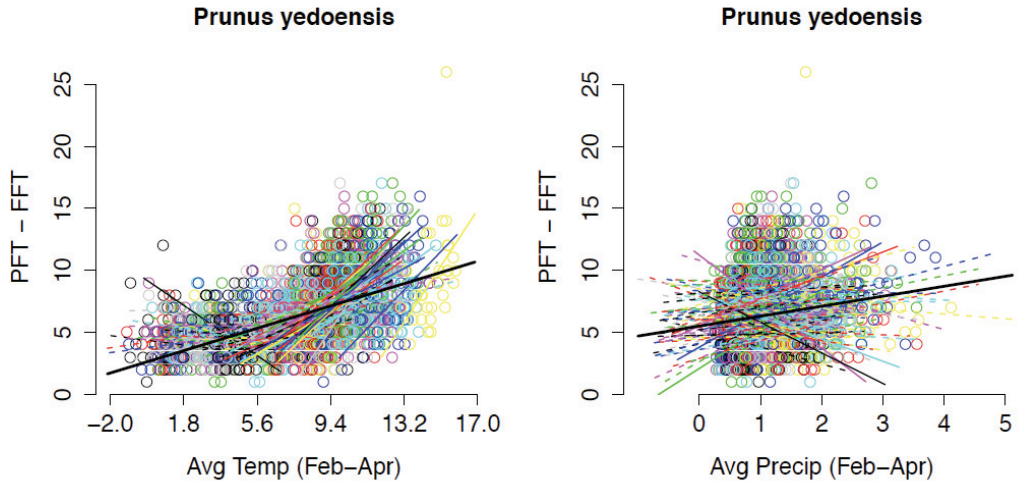


Figure 1: Duration increases with average winter temperatures but precipitation effects on flowering duration are minor (Jeff Diez, unpublished figure) s

I also became involved in another project in Kobori lab in which I am one of the primary investigators. In conjunction with Sonobe-san and Taguchi-sensei we have taken a thorough population size and biodiversity census in Mitzuike Park and 11 urban dragonfly habitats in Yokohama as well as noted habitat characteristics in order to determine the success of this conservation project to date and also establish goals for future management. 20 years ago the Yokohama city government established a conservation project to create urban habitats for dragonflies, involving many local industries in the creation and management of dragonfly ponds in urban Yokohama. We have examined these 11 habitats as well as one reserve in the Green Belt of Yokohama, a potential source of dragonfly populations to the urban ponds. This source reserve, Mitzuike Park, contains three large ponds and many smaller streams and ponds, as well as a small rice paddy field totaling 16,251m^2 of open water.

Using mark and recapture methods we will estimate the population size of common dragonfly species at these 11 habitats. We will correlate population size to the following habitat characteristics:
1) Water quality as characterized by ORP, EC, pH, COD, nitrates, nitrites, ammonia, phosphate, temperature and turbidity, 2) Pond size and depth, 3) Pond location, 4) % of shoreline with emergent plants, 5) % of surface with floating plants, 6) % of shoreline shaded, 7) % of surface shaded, 8) % of shoreline with trees and shrubs.

Although we are not finished with our analysis, we expect that there will be more dragonflies and greater diversity at ponds that are large, sunny, close to other ponds, have better water quality, and are close to Mitzuike Park and the rest of the Green Belt.

RESEARCH REPORT

1. Name: Jennifer Apell （ID No.: SP10002）

2. Current affiliation: University of Florida

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Hokkaido University

5. Host researcher: Dr. Katsuki Kimura

6. Description of your current research

My previous research explored the viability of combining anion and cation exchange resins into a single completely mixed flow reactor to remove both anionic and cationic contaminants. The two contaminants of interest, dissolved organic matter (DOM) and hardness ions, were effectively removed when used in a single reactor. The removals of DOM and hardness from the use of ion exchange resins individually and using the resins in sequence (i.e. treating the water with one type of resin followed by the other type) were comparable to the removals attained when using both resins simultaneously in a reactor.

This treatment process was proven useful in treating natural water that has a high concentration of DOM and hardness, but other possible applications were considered. Since both organic matter and calcium have been shown to be major foulants in high-pressure membrane systems (nanofiltration and reverse osmosis), combined ion exchange could significantly lower the fouling of these treatment systems and possibly make them more economical to operate.

7. Research implementation and results under the program

Title of your research plan:

Combined Ion Exchange as a Pre- and Post-Treatment of Nanofiltration

Description of the research activities:

The objective of my research at Hokkaido University was to verify that combined ion exchange would alleviate the fouling of nanofiltration membranes.

I prepared two types of synthetic waters to imitate concentrations found in raw drinking water sources. Both synthetic waters had approximate concentrations of 20 mg/L Ca^{2+}, 30 mg/L SO_4^{2-}, and 4 mg/L of dissolved organic matter. The first synthetic water used Aldrich humic acid (AHA) as the source of organic matter while the second synthetic water used Suwannee River natural organic

matter (SRNOM). SRNOM is derived from an aquatic source and is considered typical of aquatic organic matters. Aldrich humic acid is a peat-derived organic matter, but it has been used extensively in previous membrane fouling research.

Preliminary tests were conducted to select optimum ion exchange doses for the AHA-containing synthetic water, and preliminary nanofiltration experiments were conducted to determine the volume of water to be filtered. A recovery, or the percentage of treated water collected, of 70% was chosen as the end-point for the filtration runs.

The removals achieved, approximately 45% DOM and 85% calcium, in the AHA-containing water were able to decrease the fouling observed in the nanofiltration membrane. For untreated water, the flux through the membrane decreased to 42% of its initial value. When treated with combined ion exchange, the flux decreased to only 75% of its initial value.

After the initial filtration, the concentrate (the fraction of water that does not pass through the membrane) of the treated water was treated again with combined ion exchange. The treated concentrate was then filtered through a new membrane. Significant flux decline was observed after filtration of 70% of the concentrate with the final flux being 50% of the initial flux. However, when the untreated concentrate was filtered through a new membrane, the final flux was 30% of the intial flux.

In contrast, the synthetic water containing SRNOM experienced much less flux decline at a recovery of 70%. The final flux ranged between 77 and 84% of the initial flux for both treated and untreated waters. Despite this, the filtration of concentrates did show a considerable difference in flux declines with the untreated water reaching 45% of the initial flux and the treated water reaching only 60% of the initial flux.

8. Please add your comments (if any):

This work has been selected for poster presentation at the American Water Works Association Membrane Technology Conference.

This experience not only provides an opportunity to gain scientific knowledge and experience but also allows people to grow by living in another culture quite different from their own.

RESEARCH REPORT

1. Name: Matthew Campbell (ID No.: SP10003)

2. Current affiliation: Department of Biology and Wildlife, University of Alaska Fairbanks. University of Alaska Museum of the North

3. Research fields and specialties:

Biological Sciences

4. Host institution: Natural History Museum and Institute, Chiba

5. Host researcher: Dr. Masaki Miya

6. Description of your current research

A general consensus of the higher relationships among the basal Euteleostei (=Protacanthopterygii) is emerging from the increased number of both taxa and loci in molecular data sets. These molecular hypotheses of basal euteleosts provide stability in what has been from the time of inception of the subdivision Euteleostei in 1966 a controversial and difficult area.

Although molecular phylogenies of basal Euteleosts are generally consistent, the selection of taxa and characters result in different phylogenies. Often, it is thought that the phylogenies with unexpected results are a due to base composition bias. To address questions regarding placement of taxa, we used mitogenomic data and sequenced additional salmoniform and esociform species. These new data were used in the creation of an alignment of 100 taxa specifically designed to target basal Euteleost relationships.

Several approaches are underway to determine the effect of base composition evolution, character selection, and model choice on the phylogeny of basal Euteleosts. This approach has never been undertaken with fishes, and novel techniques to quantify and describe base composition evolution are being employed.

7. Research implementation and results under the program

Title of your research plan:

Deploying novel tools in the study of nucleotide composition evolution

8. Please add your comments (if any):

This joint JSPS-NSF program provided an amazing opportunity for me to interact and work with an eminent ichthyologist (Miya-san) as well as to get to know his post-doc who will undoubtedly achieve additional scientific recognition. I was extremely well supported and generously hosted during this time and surpassed my working goals. I hope that what started this summer will continue.

9. Advisor's remarks (if any):

Matthew Campbell is a hard working person, yielding as many as five whole mitochondrial genome sequences from his group of fishes. This is far beyond my expectation and I enjoyed discussions on his research and exchanges of ideas with him. NSF/JSPS should be highly praised for doing such an international program and I look forward to hosting additional students in the near future in my lab.

RESEARCH REPORT

1. Name: David Cashin （ID No.: SP10004 ）

2. Current affiliation: University of Michigan, Economics Department

3. Research fields and specialties:

Social Sciences

4. Host institution: Kobe University

5. Host researcher: Professor Takashi Unayama

6. Description of your current research

My current research focuses on the effects of consumption tax rate changes on consumer spending as well as the resulting implications for optimal consumption tax policy.

Specifically, a consumption tax rate increase should affect consumer spending in two ways. First, it should induce consumers to push forward purchases to avoid higher future prices. This is known as the intertemporal substitution effect. As a result, we would expect to observe a spike in household spending prior to the rate increase, and a decline thereafter. Second, a consumption tax rate increase effectively reduces a household's purchasing power, and as a result, household consumption should fall. Thus, we would expect to observe a decline in real household spending following announcement of the tax change or its implementation, with the former being the response of a 'rational' consumer, and the latter the response of what is known as a 'near-rational' consumer.

The magnitudes of the intertemporal substitution and income effects are crucial to designing optimal consumption tax policy. For example, Japanese policymakers are currently debating whether to gradually phase in a large consumption tax rate increase, or impose the rate increase all at once. If the intertemporal substitution effects of a modest rate increase like Japan's 1997 rate increase are large, and the income effects are small, this would suggest that a gradual phase in of a consumption tax rate increase is preferable for the following reasons:

1) Given the sizeable substitution effects of a modest rate increase, the effects would likely be much greater for one large rate increase. This would induce substantial macroeconomic fluctuations around the time of the tax change, and the government would sustain large revenue losses due to the tax avoidance behavior on the part of consumers.
2) If the income effects of a modest rate increase are small, real household spending should remain relatively stable as the tax rate increase is gradually phased in. On the other hand, one large rate increase may induce a large fraction of households to reduce their consumption immediately, causing a sharp reduction in household spending.

In closing, our study aims to quantify the intertemporal substitution and income effects of the 1997 VAT (Value Added Tax) rate increase in Japan, and use our results to make conjectures about optimal consumption tax policy.

7. Research implementation and results under the program

Title of your research plan: The Income and Intertemporal Substitution Effects of a VAT Rate Increase: Evidence from Japan

Description of the research activities:

Using the Japanese Family Income and Expenditure Survey (JFIES), we examined average monthly household expenditures in the months surrounding the April 1997 VAT rate increase from three to five percent.

To identify the intertemporal substitution effects, we differenced expenditures. This means that we subtract last month's expenditures from this month's expenditures. After controlling for seasonal variation in expenditures, we interpreted the remaining difference as the substitution effect. We found that household expenditures increased substantially in the first quarter of 1997 as a result of the impending VAT rate increase. In the months following the tax change, substitution effects were negative, as expected, and were spread out over several months, suggesting that Japanese households are quite forward looking.

To identify the income effects of the tax change, we made the following three assumptions:

1) The positive substitution effects prior to the tax change and negative substitution effects following the tax change cancel out.
2) Other factors affecting household spending did not significantly change from 1996 to 1997.
3) The income effects of the tax change were not present until implementation, a finding corroborated by Watanabe et al. (1999)

Provided these assumptions are correct, summing the monthly deviations in spending in 1997 relative to the 1996 comparison period should yield the income effect, since the positive and negative substitution effects will cancel when summed. The results of this method suggest that the income effects of the tax change did not significantly differ from zero.

As a result, we conclude that the intertemporal substitution effects associated with a modest VAT rate increase are large, the income effects are negligible, and thus a gradual phase in of future VAT rate increases is preferable to one large rate increase.

8. Please add your comments (if any):

Professor Unayama and I will be presenting our results at the Ministry of Finance on August 23rd. Also, I met with Professors Eiji Tajika of Hitotsubashi University and Charles Horioka of Osaka University this summer, both of whom provided useful comments regarding our study.

RESEARCH REPORT

1. Name: Morgan Churchill （ID No.: SP10005）

2. Current affiliation: Department of Geology and Geophysics, University of Wyoming

3. Research fields and specialties:

Mathematical and Physical Sciences, Biological Sciences

4. Host institution: National Museum of Nature and Science, Tokyo

5. Host researcher: Dr. Naoki Kohno

6. Description of your current research

My area of interest is the transition of tetrapods (birds, mammals, and reptiles) from terrestrial environments into aquatic environments, and the evolutionary history and ecological changes associated with taxa that underwent these changes. In particular, my current research is focused on the evolution and paleoecology of the Pinnipedia (seals, sea lions, and walruses), with an emphasis on the North Pacific. In regards to this focus, my dissertation research is focused on understanding the evolution of suction feeding within pinnipeds using two-dimensional morphometric analysis of palate shape; the evolution of body size within pinnipeds and methods to estimate the body size of extinct species from cranial measurements; and the systematics of pinnipeds using combined evidence analysis of morphological and molecular character datasets.

7. Research implementation and results under the program

Title of your research plan:

Inference of Ecology in Fossil Pinnipedia (Mammalia: Carnivora) based on Palate Shape and Body Size

Description of the research activities:

The main goal of my research activity in Japan is to examine Japanese fossil pinnipeds as well as to assemble a baseline dataset of pictures of extant pinniped skulls in order to examine differences in palate shape between different species, prey types, and foraging strategies, and determine if these differences may be useful in determining the lifestyle of fossil pinnipeds. In addition to this, I am also collecting a dataset of modern pinniped cranial measurements. Measurements of different features of the cranium can then be plotted against body weight and length of modern species, in order to create a set of linear equations that can be used to calculate the body size of fossil pinnipeds, few of which are known from complete skeletons.

To facilitate this research, I have visited a number of museums across Japan to collect data. These include both the fossil and modern collections of the National Museum of Nature and Science in Tokyo, the Kyoto University Department of Zoology, the Gunma Museum of Natural History, the National Museum of Japanese History in Chiba, the Hokkaido University Museum, the Hokkaido University Botanical Gardens, Historical Museum of Hokkaido, and the Fisheries

Department at the Hokkaido University in Hakodate. At present I have examined ~250 specimens, with further specimens to be examined in the next two weeks. These include globally rare species such as Caspian and Baikal Seal, as well as the recently extinct Japanese sea lion. I have also observed important fossil fur seal and walrus material unavailable outside of Japan.

Preliminary data supports the idea that palate shape clearly distinguishes suction feeding from regular raptorial (pierce with teeth) feeding within the fur seal and sea lion families, as well as within the earless seals. The leopard seal, a pinniped whose diet regularly consists of other seals and penguins, also can be clearly distinguished from other seals based on palate shape. Other foraging strategies or prey item however cannot be clearly distinguished, including filter-feeding or squid-feeding. Preliminary results also support the idea that the width of the ear and the width across the occipital condyles, in comparison with other measurements of the cranium, may provide the most accurate estimations of body length within pinnipeds. Body weight appears to be poorly correlated with measurements of the skull, likely a result of substantial seasonal changes in body weight due to fasting. However much of the data collected so far in Japan has yet to be processed and analyzed, and results may change.

8. Please add your comments (if any):

Overall I enjoyed this program and thought it was well run. I was able to do a large amount of data collection that probably would have been difficult to do perform otherwise this summer, met and developed relationships with important workers in my field, and have a better understanding of research possibilities and collections in Japan. Dr. Kohno was a wonderful host and went out of his way to help with my research, and I also was able to learn quite a bit from conversations with him.

My only suggestion would be perhaps to either move the orientation from Sokendai or perhaps shorten the orientation. I think many of the students this year were ready to head to their host institutions and had grown weary of the orientation, and towards the end it became hard to really stay focused on language sessions.

9. Advisor's remarks (if any):

This program was a good opportunity also for me as an advisor to review the present status of studies on the Japanese fossil pinnipeds and also to clarify the locations of specimens available for studies. Mr. Churchill was highly active in spending lab works at respective universities and museums, and he was able to exchange useful information with many professors and graduate students at respective institutions he visited. Hopefully, some publications will stem directly from this Summer Program, and quite a few publications may involve fruits of this program, too. In this regard, however, substantially less than two months for study may be quite a bit insufficient to complete the research plan in the field of natural sciences, although concerning the purpose of the Summer Program.

RESEARCH REPORT

1. Name: Adam S. Cohen (ID No.: SP10006)

2. Current affiliation:

University of California, Santa Barbara

3. Research fields and specialties:

Social Sciences

4. Host institution: Showa University and University of Tokyo

5. Host researcher: Dr. Nobumasa Kato and Dr. Noriaki Yahata

6. Description of your current research

My research in Tokyo consists of two projects, one on the neural systems that underpin social reasoning and the other on the neural systems that support social attention.

Neural Systems Underpinning Social Reasoning

Converging evidence from functional magnetic resonance imaging (fMRI) shows that a network in the human brain that includes bilateral tempero-parietal junction (TPJ), medial prefrontal cortex (MPFC), and inferior frontal gyrus (IFG) activates during social reasoning tasks. Computational processes instantiated in these areas of the brain appear to deploy a social logic which enables reasoning about social behavior. For instance, one common type of inference these systems appear to support is computing an action prediction based on another person's belief and desire: given 1) person P wants object O and 2) P believes O is in location L, then 3) ceteris paribus, P will search for O in L. Action prediction is just one of many social inferences that are likely to be coded in the areas of cortex that make up the social reasoning network. More generally, these inferences are essential to generating the wide range of cooperative and competitive behaviors humans (and other social species) engage in; yet, despite the central importance of social reasoning to discovering the laws that govern human (and non-human) social behavior, research into the underlying mechanisms of this ability is still in its infancy.

In trying to shed light on how the neural mechanisms work, Dr. Yahata and I have worked on two questions about these systems: how specialized are they for social reasoning, and is the degree of specialization the same across cultures? Based on reaction time evidence I collected in the US, I predicted that these systems are specialized for social reasoning but can be co-opted to do other kinds of non-social reasoning under certain conditions. As for cultural variation, I proposed that while reasoning is constrained by evolutionary considerations, it is far from fixed. Within the constraints imposed by evolution, I predicted that differences in cultural values, beliefs, practices, and products will affect how social reasoning systems develop. For instance, if attending to the thoughts and feelings of others is valued in the culture, social reasoning systems should activate more frequently and become more expert at making social inferences over development.

Using fMRI repetition suppression, a method for habituating neurons, our experiment involved acquiring images of the brain while subjects, all Japanese adults, completed a task consisting of reasoning problems that required inferences about social and non-social information. If the same neural areas habituate to both social and non-social information, but more strongly to social stimuli, that would suggest these areas can be co-opted, but are better tuned and therefore specialized for social reasoning. On the other hand, if they activate selectively for social reasoning, that would suggest a high degree of specialization without the capacity for co-opting. In addition, using data on US adults collected before I came to Tokyo, we can compare the pattern of activity from the Japan data to the US data to determine if the extent of specialization is modulated by culture.

Neural Systems of Social Attention

Many if not most social interactions require that we first *attend* to social information, including facial expressions, eye direction, body posture, and actions (often in order to make *inferences* about social behavior, as discussed above; social attention can be thought of as a pre-requisite for social reasoning). Previous research has shown that neurotypical adults automatically shift their attention in the direction of another person’s eye gaze, an evolutionarily important social cue. Several studies have gone on to show

that patients with autism spectrum disorder (ASD), like normal adults, automatically shift their attention to eye gaze, consistent with claims that social impairments in ASD do not stem from abnormalities in the attention system. However, others have challenged this evidence on the grounds that previous experiments were confounded with motion cues that enabled shifts of attention without having to activate the neural systems that are sensitive to social cues. They then showed that when these cues were removed, adults with ASD were impaired on the task. Having established an impairment at the level of attention and located the nature of it to social and not motion cues, an important question is whether it is possible to alter social attention shifting in ASD to equivalent levels seen in healthy adults. While there are no pharmaceutical treatments that specifically target social impairments in ASD, recent research has demonstrated that the neurohormone oxytocin facilitates a range of social behaviors in both non-human species and humans. This makes oxytocin an ideal candidate to enhance social attention in adult ASD.

Dr. Kato's research team has been developing a protocol to nasally administer oxytocin to persons with ASD in hopes that it may alleviate some of the social difficulties they encounter. With Dr. Kato, I have been testing whether nasal administration of oxytocin affects attention shifting to eye gaze. Our research strategy was to run a pilot study to simply replicate the basic finding of an impairment in social attention, and then run an experiment to assess improvements as a result of oxytocin administration.

7. Research implementation and results under the program

Title of your research plan:
Experiment A:
Examining neural systems specialized for social reasoning: Can they be co-opted for other types of reasoning, and are they influenced by culture?
Experiment B:
Does oxytocin facilitate social attention in adult ASD?

Description of the research activities:

During my first two and a half weeks, I worked with Dr. Yahata and Dr. Ryu-ichiro Hashimoto on translating stimuli for the fMRI study from English to Japanese. This included 12 story-based reasoning problems, each about a ¼ page long, as well as other study-related text (e.g., questionnaires, instructions, etc.). Most of the time during this early stretch I worked on the US data that was collected in the spring, writing the first set of Matlab scripts to process and analyze this data.

Starting around week 3, I began creating the ASD experiment, including creating/editing the stimuli and programming the experiment. Most of the work involved editing images in Photoshop and developing and testing the program. During this time, I also helped troubleshoot problems with the eye tracker at Showa Hospital, as we planned to use it as part of the ASD study (to ensure participants don't move their eyes and that any effects are due to attention and not eye movements).

During week 5, we piloted the fMRI and ASD study. Because piloting went well, we collected the "official" data for both studies over the remaining four weeks. In total we have run 12 participants in the fMRI experiment (each person takes about an hour because we acquire structural scans in addition to the functional images). As the data was being collected each week, I wrote and ran scripts in Matlab along with standard fMRI data analysis software to process and analyze the data.

For the attention-ASD pilot experiment, we have tested 10 ASD patients and 3 healthy adults. As the data was collected, I processed and analyzed it using a combination of Matlab and OpenOffice spreadsheet.

Preliminary results (also, please see attached).

Briefly, we have evidence that specialization for theory of mind is lateralized such that the temporal parietal junction (TPJ) in the right hemisphere is selective for social reasoning, while the left TPJ is co-opted for non-social reasoning. We are short on data to make a comparison between the US and Japanese participants, but Dr. Yahata's group will continue collecting the rest after I leave.

For the ASD data, the results so far replicate the selective impairment to eye gaze in autism. Given this clear replication, we plan to extend our collaboration as members of Dr. Kato's group will collect the data using the oxytocin manipulation after I leave.

In two weeks I will present the preliminary fMRI data at the Japanese Neuroscience Society meeting in Kobe.

RESEARCH REPORT

1. Name: Marilyn N. Cruickshank （ID No.: SP10007）

2. Current affiliation: Moss Landing Marine Laboratories

3. Research fields and specialties:
Biological Sciences

4. Host institution: Hokkaido University

5. Host researcher: Dr. Yutaka Watanuki

6. Description of your current research

Seabirds have long been useful as environmental indicators. My current research focuses on Rhinoceros Auklets, a species of seabird in the alcid family. Because of their unique habits of breeding on land at a certain time of year and use of patchy prey in the ocean, these birds allow us to examine not only the health of their populations but also that of their prey. Additionally, their diet makes them sensitive to changes in oceanographic conditions, human-induced or otherwise, providing a cost-effective way to monitor the health of the oceans. Thus, by monitoring the population dynamics, breeding success, and diet of seabird species, it is possible to monitor the oceans as a whole, especially when these factors are compared between populations of the same species in different areas of the world. Specifically, these comparisons allow us to explore the scope of a species' ability to adapt to differing environmental conditions and how biological and oceanographic conditions, such as fish abundance and sea surface temperature, in one year affect populations in various locations.

Determining genetic boundaries is another way in which monitoring seabirds is useful. By comparing the DNA of birds in different populations, it is possible to figure out their evolutionary origins, and how these invisible population boundaries may have been affected by important ecological events of the past, such as glacial movements or natural climate change. In addition, by examining a healthy, un-endangered population such as Rhinoceros Auklets, it may be possible to compare their genetic structure with that of endangered species such as the Marbled or Japanese Murrelet, in order to figure out how diverse their populations once were.

In light of these facts, my objective for this summer was to compare the diet, as well as growth and survival rates, of Rhinoceros Auklet chicks on Teuri Island to those back in California on Southeast Farallon Islands. This long-term monitoring is important to create a baseline for how these populations may react to climate change, human-induced or natural, in the future. I hypothesized that the earlier the diet switched to anchovy, the faster the chicks would grow and the heavier they would be upon fledging. Also, I hypothesized that while the two populations would exhibit similar behaviors, the timing would be affected by the different oceanographic characteristics. Additionally, I wanted to collect blood samples for genetic analysis to take back to the United States to compare with Rhinoceros Auklets there for my master's thesis.

7. Research implementation and results under the program

Title of your research plan:

Comparing Rhinoceros Auklet (*Cerorhinca monocerata*) chick diet and growth on Teuri Island, Japan and Southeast Farallon Island, USA

Description of the research activities:

To implement my research this summer, I journeyed to Hakodate, Hokkaido to meet my host researcher, and from there travelled to Teuri Island further north. On Teuri, after helping to capture the auklets, I gathered blood samples for my master's thesis from which we also took diet samples and morphometric (body measurement) data. I also helped to monitor the chicks for the growth study, as well as searching for auklets robbing fish from each other for another student's study. In addition, I assisted with a yearly Spectacled Guillemot survey.

When I returned to Hakodate 5 weeks later, I began extracting DNA from the 55 blood samples I had collected, to fine-tune the method and make sure it had been collected correctly. Additionally, I quantified the DNA and concentrated or diluted it as needed. The samples will be shipped to America for analysis for my thesis once the permits have finished coming through. I also helped a student edit a research poster and a scientific paper for possible publication.

For the diet and chick growth data comparison, I was unfortunately unable to acquire the data from the Farallones in the time allotted. Their researchers are busy, and were finishing up their own season of data collecting. However, I began compiling the data from Teuri with the help of the students at Hokkaido University, and learning the statistical program R in order to analyze the data. Once back in the United States, I plan to continue the comparison to shed light on the differences between bird populations and locations during the summer 2010 breeding season.

Although I haven't performed the comparison yet, preliminary analysis for the auklets of Teuri suggests that although there seemed to be energy-rich anchovy in the diet, the fledging rate and growth rate was low in comparison with other years. The warm water brought by the Tsushima Current seemed to arrive on time for the chicks to be fed during their peak season, but the breeding rate was not as high. Anchovy stock information was not available yet for the relevant period, but the numbers may have decreased, making it difficult for all the auklets to breed. A more likely culprit is the late snow, as per Dr. Watanuki's observation, which affects the initial egg-laying dates, and which may have forced the hatch date after the peak anchovy time period. The exact reasons remain to be seen, but no doubt the analysis and comparison will shed light on this unique year.

8. Please add your comments (if any):

The above data does not begin to express the amazing things I have absorbed this summer; I ate, said, heard, and learned new things every day. I definitely felt that no matter what I did, my hosts helped me more than I helped them, but as my host researcher says, this is par for the course when you are working in a foreign country. It's a favor that I won't forget and that I plan to repay one day. The kindness and understanding of he and his students touched me deeply, and inspired me to continue with my exploration of Japanese culture and language. The communication challenge exhilarated me and I immensely enjoyed meeting new people and experiencing a new place. The science is important in light of the state of the environment, but the ability to interact and share ideas, scientific or every day, remains the most important thing I will take away from this journey. I have gained not just that knowledge, but the desire to use it in the future.

9. Advisor's remarks (if any):

Marilyn had done a good job in working both in the field and laboratory with Japanese students very friendly. Interesting comparison of the Rhinoceros Auklet biology between California and Hokkaido is expected. I believe this, though preliminary, should be a good start of collaboration between young seabird researchers in US and Japan. Yutaka Watanuki

RESEARCH REPORT

1. Name: Charles DeVore （ID No.: SP10008）

2. Current affiliation: University of Southern California, Los Angeles, CA

3. Research fields and specialties:
Engineering Sciences

4. Host institution: University of Tokyo

5. Host researcher: Yozo Fujino

6. Description of your current research

My research investigates methods of using structural control devices to improve system identification to improve damage detection. Specifically I am interested in developing techniques to use ambient wind vibrations to as an excitation source. This complicates the identification because wind is spatially correlated and the identification needs to take this into account.

7. Research implementation and results under the program

Title of your research plan:

Controlled Substructure Identification of Building Structures under Wind Excitation

Description of the research activities:

A numerical simulation is undertaken where a vertical profile of wind pressures is simulated and applied as loads to a reduced order model of a structure. Structural responses as floor acceleration is computed and recorded. Different levels of signal noise is added as gaussian white noise at various levels. The identification routine is run and statistics are computed on the identified parameters.

8. Please add your comments (if any):

My research activities were eclipsed this summer by the opportunity to develop curriculum for a summer school hosted by my lab for 45 international PhD students. The summer school lasted for three weeks and I was responsible for developing and teaching the control lab and competition portions of the summer school. I was extremely satisfied by this opportunity and learned a lot about the teaching process. Additionally, I was able to work closely with the staff and develop close relationships that will help for many years.

RESEARCH REPORT

1. Name: Timothy L. Downing （ID No.: SP10009）

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Kyoto University, Center for iPS Cell Research and Application (CiRA),

5. Host researcher: Dr. Shinya Yamanaka

6. Description of your current research

Hallmark signs of spinal cord injury include cavity formation that interrupts the directional architecture of the cord and cell death (i.e., neurons, oligodendrocytes, and precursor cells). Considering this, a successful therapy will likely include new structural support for directed axon growth as well as replacement cells. Electrospun nanofibrous scaffolds present a potential platform to help rebuild this lost architecture. Electrospinning is a technique that uses an applied electric field to draw out fibers of submicron to micron diameter from viscoelastic substances (e.g., a poly-l-lactide (PLLA) polymer dissolved in an organic solvent), creating biodegradable scaffolds that closely mimic the topography of the extracellular matrix. With the alignment of these fibers, greater control over cell orientation, migration, and process outgrowth can be achieved. This result has been shown with primary nervous tissues as well as embryonic stem cells; however, this method has yet to be tested with induced pluripotent stem cells (iPSCs). iPSCs are a population of adult cells that have been genetically reprogrammed to a pluripotent state, thus, obtaining the ability to differentiate into progeny characteristic of all three germ layers. These cells are of great interest because they mitigate much of the ethical and immunogenicity concerns that arise with embryonic stem cell therapies. My research aims to explore how nanofibrous scaffolds can be used in combination with iPSC-derived cells to improve functional recovery.

7. Research implementation and results under the program

This summer I conducted experiments that focused on improving methods of iPSC generation. To this end, we used PLLA nanofibrous scaffolds for polyelectrolyte absorption of cationic lipid-DNA plasmid complexes for the local delivery to cells. The results of this study show that EGFP transfection in adult human dermal fibroblasts using this method was present after 4 days but the today number of transfected cells were very low. In addition, we also tested neurite outgrowth from iPSC-derived neurospheres on aligned nanofibrous scaffolds. The results of this study show that a higher degree of unidirectional neurite outgrowth is feasible with aligned fibers compared to random fibers.

Title of your research plan:

Electrospun Nanofibrous Scaffolds and iPSCs for Spinal Cord Repair

Description of the research activities:

This summer I generated iPSCs from adult human fibroblasts. To start, we made retroviruses containing transcription factors for Oct4, Sox2, Klf4, and L-myc. We then introduced these viruses into adult human dermal fibroblasts. After transduction of these genes we reseeded the cell into embryonic stem cell conditions and after 22 days iPSC colonies formed in culture. We then isolated 14 individual colonies, from which we continued the culture of 6 different cell lines. Also, we generated neurospheres from human iPSCs. To do this we dissociated iPSC colonies into single cells and culture them in non-adhesive round bottom 96-well plates. After EB formation we began neural induction for at least 14 days to obtain neurospheres. After 14 days the newly formed neurospheres were seeded onto random and aligned nanofibers and cultures for up to 3 weeks. Images were taken using confocal microscopy. Finally, we attempted to transfect adult human dermal fibroblasts using a cationic lipid-DNA plasmid (EGFP) complex absorbed to the surface of PLLA nanofibrous scaffolds. These scaffolds were treated with NaOH to induce surface hydrolysis, imparting a negative charge on the scaffolds surface. The lipid-DNA complex was then allowed to absorbed to the surface of the scaffold for controlled local delivery to cells. Once we seeded fibroblast onto the surface of these scaffolds we analyzed the culture are days 4 and 9 for EGFP transfected cells.

8. Please add your comments (if any):

This summer has been an amazing experience. Thank you so much for the opportunity. I only wish that everyone could experience the greatness of Japan in the way that I have through the JSPS summer program.

RESEARCH REPORT

1. Name: Michael John Eagle （ID No.: SP10010）

2. Current affiliation: The University of North Carolina at Charlotte

3. Research fields and specialties:

Social Sciences, Engineering Sciences

4. Host institution: The University of Electro-Communications

5. Host researcher: Dr. Akihiro Kashihara

6. Description of your current research

The goal of our current research is to develop rigorous scientific methods that leverage data to build adaptive personalized support for learning. These data driven techniques will greatly reduce the required time to develop intelligent tutoring systems, expediting the adaptation of personalized learning.

The advancement of personalized learning is part of the *National Academy of Engineering's 14 grand challenges.* Creating technologies, such as intelligent tutoring systems, that can adapt education to individual students has the potential to *transform education*. The PUMP Algebra intelligent tutor, used in thousands of schools, improves student performance on standardized tests by 15—25%. However, it takes between 100—1000 work hours to create one hour of intelligent tutor content. This research aims to enhance infrastructure for education by designing faster methods to create and improve intelligent tutoring systems.

We propose to use data-driven techniques to automatically generate the basic structures of an intelligent tutoring system. Intelligent tutoring systems are often described as having two loops; the *outer loop* selects appropriate multi-step problems for students based on knowledge tracing, or assessment of student knowledge; the *inner loop* tracks students for each sub-step of the problem in a process called model tracing. This research is an expansion of recent methods developed at the University of North Carolina at Charlotte; a novel, domain-independent technique for data-driven model tracing. This method uses *Markov Decision Processes* crated from past student data, and generates *inner loop* feedback and hints based on past work by students with similar problem solves techniques.

7. Research implementation and results under the program

Title of your research plan: Automated Personalized Learning through Data Driven Knowledge Tracing

Description of the research activities: For this summer research project we focused on the design and evaluation of data-driven methods of generating basic intelligent tutoring system behaviors. In order to investigate the effects of our methods on student learning and motivation we have arranged for the collection of student data via online courses teaching propositional logic (spring 2009, and fall 2009) before the start of the EAPSI summer program. The data comes from datasets generated from an innovative Computer Aided Instruction system used to teach propositional logic at the University of North Carolina at Charlotte. The students in this dataset have taken pretests at the start of the course and posttests at the end. In this dataset we have controlled for semester, professor, course type (online, classroom), and automatically generated hints (hint group, no hint group). We also have several large sets of historical data in this area. These sets are composed of student data from college level Philosophy courses in introductory logic.

The raw data was processed to make it easier for evaluation. We then proceeded to evaluate the results of the automatically generated hints by only evaluating the results of the pre and posttests. Preliminary results of this analysis found no significant difference between the hint and no hint group. These results are not surprising given that the pretest and posttest are based on the entire course and we are not currently able to isolate the propositional logic portion of the tests. However, there seems to be a significant effect on retention rates between the two groups. That is, students in the hint group were more likely to remain in the study and complete all questions of the computer aided instruction system. We plan to further evaluate the results when the propositional logic questions can be isolated from the overall pretest and posttest.

The next step this summer was to develop new methods of evaluating the data without the aid of the pretest and the posttest, as they are not always practical to administer and not always provided with intelligent tutoring system datasets. The data from this domain describes a student's step-by-step process of solving a propositional logic proof. This results in a sequence of steps that lead to a final solution. Since students are able to take any number of different paths to reach the solution, the paths from the starting state to the ending state are limitless. Another problem is that each step is marked as either "correct" or "incorrect" based on whether the proposed step is legal, without any attention given to if the step is actually useful in solving the proof. To remedy this we developed a way to code each step with an additional binary value of "useful." Therefore, there are now four possible descriptions for each step: 1) Correct-Useful – Good rule application, good strategy 2) Correct-NotUseful – Good rule application, poor strategy 3) Incorrect-Useful – Poor rule application, good strategy 4) Incorrect-NotUseful – Poor rule application, poor strategy. The next step is to change the way the automatically generated hints are generated including this information. We hypothesize that this will further improve the student learning by adding hints based on problem solving strategy. For example, a student who completes a Correct-NotUseful step can be offered a hint such as "past students did not find this step to be useful in the derivation of this proof." Students who receive Incorrect-Useful can receive a message that tells them that what they are attempting to do is correct, but that they should focus on the rule application. Our future work will include incorporating these new hints into the tutor and looking for differences in student learning and motivation.

8. Please add your comments (if any):

The entire JSPS program was a wonderful experience. I would like to thank the EAPSI program, the NSF, and JSPS for giving me this international research opportunity. I am also thankful for Dr. Akihiro Kashihara, the University of Electro-Communications, and the entire Kashihara lab. This program has opened several gateways which will enable international collaboration in my future career. I will continue to communicate with many of the people I have met this summer. I am planning on meeting Dr. Kashihara and his students at several international conferences, at which we both publish, this following year. I will strongly recommend this program to all of my friends and coworkers, and once I am a professor, to all of my future students.

RESEARCH REPORT

1. Name: James Ellinger （ID No.: SP10011）

2. Current affiliation: University of Wisconsin-Madison

3. Research fields and specialties:
Biological Sciences

4. Host institution: RIKEN Yokohama Insitute

5. Host researcher: Dr. Jun Kikuchi

6. Description of your current research: My current research aims are focused on the development of NMR-based metabolomics tools and its application toward solving relevant biological problems. The major goal of metabolomics is to study metabolism through a systems-level approach. We hope that studying metabolism from the level of the whole organism will allow us to gain new insights about the complex interactions that occur within and between metabolic pathways. As we seek alternative energy sources to replace diminshing levels of fossil fuels, I believe that metabolomics will play a vital role in our efforts to harness microorganisms' ability to produce fuel from biomass feedstocks. Combining metabolomics with other systems-level strategies such as transcriptomics and proteomics we can use this information in an iterative process to engineer microorganisms capable of producing and tolerating large quantities of biofuels such as ethanol or butanol. The goal of my short project at RIKEN was to learn an *in vivo* method for monitoring extracellular metabolite production and subsequent multivariate analysis. Keeping in line with my interest in biofuels, I monitored extracellular metabolite production while *E. coli* was treated with butanol.

7. Research implementation and results under the program

Title of your research plan: NMR-based study of extracellular metabolites produced by *E. coli* K12 under butanol stress

Description of the research activities: The major goals for this project were to 1) learn about *in vivo* NMR techniques, 2) learn how to use a multivariate statistical analysis technique called principal component analysis (PCA) and 3) investigate a metabolic response to butanol induced stress in *E. coli*. The first phase of this project was to determine growth parameters for *E. coli*. Previous studies investigating the response to butanol stress in *E. coli* have been conducted in minimal and rich media. The media used in the current study (Silantes OD2) is a rich medium and we found that at 0.5% and 1.0% butanol that *E. coli* was capable of growing at rates comparable to those previously published for other types of media (rich and minimal). However, it was discovered that *E. coli* could not grow in an NMR tube at the 1% level. This was most likely due to the anaerobic conditions generated by the tightly sealed cap that must be placed on the NMR tube. Therefore *in vivo* studies were conducted by treating *E. coli* with 0.5% butanol in the media.

To determine if the source of carbon used for growth plays a significant role in the response to butanol stress, we also analyzed growth parameters when *E. coli* were supplemented with either

glucose or xylose in the media. I hypothesized that a different set or levels of metabolites might accrue due to different growth on different carbon sources. Previous studies indicate that glycolysis is significantly affect by butanol stress, therefore xylose was chosen as an alternative as it is metabolized through the pentose phosphate pathway. An interesting result to note is that *E. coli* grown in glucose supplemented media treated with 0.5% butanol were unable to reach a population equivalent to the other conditions and supplements. This result will be further addressed shortly.

To monitor the production of extracellular metabolites I conducted a series of 1D and 2D NMR experiments. These experiments were designed by Dr. Kikuchi's group for real-time monitoring of small molecule metabolism *in vivo*. The data was analysed by PCA in order to determine which peaks in the spectra had time-dependent correlations. Once peaks were identified as having significant change over time, these peaks were identified by submitting queries to small molecule databases that contain chemical shift information based on standard compounds.

In my experiments I found the major metabolites that were consumed were the designated carbon source (glucose or xylose) and the amino acid aspartate. The major metabolites produced were acidic compounds such lactate, succinate, formate and acetate. One exception was lactate production in xylose supplemented media. Relative to glucose supplemented media, xylose did not promote the production of lactate. However, this made sense since lactate is a product of glycolysis and xylose is metabolized via the pentose phosphate pathway, a fraction of which terminates in glycolysis. Finally I observed the production of ethanol.

In general, I observed that the production of these metabolites was increased in samples that were supplemented with glucose and treated with 0.5% butanol. Lactate, as previously mentioned, was less abundant in xylose supplemented media and further reduced when treated with 0.5% butanol. Ethanol was significantly more abundant in glucose supplemented samples treated with 0.5% butanol and I believe this is the reason for my earlier observation that these conditions did not allow the cells to reach a high population density.

8. Please add your comments (if any): I would like to thank NSF and JSPS for the opportunity to conduct research in Japan. This has been a very valuable and rewarding experience. I feel that I was able to successfully accomplish the goals that I had set during my stay at RIKEN. While there was minimal interaction between Dr. Kikuchi and me, I was able to effectively communicate with my peers and I feel now, more than ever, that the key to advancing science will be through forming international collaborations and friendships. I look forward to future opportunities in which I can return to Japan to maintain the friendships I have made and to form new ones.

RESEARCH REPORT

1. Name: Benjamin Engel （ID No.: SP10012）

2. Current affiliation: University of California, San Francisco

3. Research fields and specialties:
Biological Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Ritsu Kamiya

6. Description of your current research

I use the single-cell green algae *Chlamydomonas reinhardtii* as a model organism to study eukaryotic flagella (also known as cilia), hair-like organelles that project from the surface of cells into the extracellular environment. Flagella serve as a means of propulsion for unicellular organisms and generate fluid flow in multicellular organisms (such as the multicilliated epithelium in the trachea, which helps move mucus in the throat). However, it was recently discovered that flagella also act as the cell's "antennae", which senses both mechanical and chemical signals. Flagellar proteins are highly conserved from single cell eukaryotes (such as *Chlamydomonas*) to humans, and defects in flagella (and loss of their signaling function) result in a diverse set of human diseases, including polycystic kidneys, extra fingers (polydactyly), reversal of the asymmetry of internal organs (situs inversus), and accumulation of fluid in the brain (hydrocephaly).

I specifically study the control flagellar length. Interestingly, when flagella are amputated they grow back to exactly the same length, meaning that the cell possesses a sensing mechanism to measure and change the length of flagella. Crucial to the process of length control is the traffic of protein trains carrying flagellar building blocks to the flagellar tip (intraflagellar transport). I study how altering the transport of these protein trains affects flagellar length. Understanding how the cell precisely tunes the size of one of its organelles is a fundamental biology question and is also medically relevant, as abnormal flagellar length causes the diseases mentioned above.

7. Research implementation and results under the program

Title of your research plan:

Characterization of the motility and flagellar ultrastructure of a novel *Chlamydomonas* mutant.

Description of the research activities:

I brought a mutant strain of *Chlamydomonas* that I isolated several years ago to my host laboratory. The mutant cells lose their flagella at high temperature due to a temperature-sensitive defect in retrograde intraflagellar transport (protein traffic from the flagellar tip back to the base). We characterized the phenotype of this mutant using several techniques that my host lab specializes in. We found that upon exposure to high temperature, the mutant experiences a large reduction in swimming speed and flagellar beat frequency as well as defects in phototaxis (swimming towards light), suggesting that molecular signaling processes may be affected. However, the waveform of the flagellar beat appears unchanged when observed by high-speed camera and the ultrastructure of the flagella and adjoining basal bodies look unaffected by when viewed by transmission electron microscopy. While anterograde intraflagellar transport (flagellar base to tip) is required for the assembly of the flagellum, this data suggests that retrograde transport is more important for signaling. I plan to add my host researchers as authors on my paper for their invaluable contributions.

8. Please add your comments (if any):

My summer in Japan was one of the best and most productive experiences in my research career. I made significant progress on my research, learned many new techniques, and most importantly established strong friendships and collaborations with my Japanese hosts that I expect will last the rest of my life.

RESEARCH REPORT

1. Name: Arthur Evans （ID No.: SP10013 ）

2. Current affiliation: University of California, San Diego

3. Research fields and specialties:

Mathematical and Physical Sciences, Biological Sciences

4. Host institution: Tohoku University

5. Host researcher: Takami Yamaguchi and Takuji Ishikawa

6. Description of your current research

Fluid mechanics in a biological context has important consequences both for living organisms and for understanding complex physical processes. Most bacteria are so simple that a large part of their survival strategy hinges upon successful navigation of their fluid environment, and how disturbances in the fluid affect their behavior and that of their neighbors. As a biologist, studying collections of micro-organisms yields insight into the evolution of multicellularity, the nature of organic fluid transport, and a multitude of applications for disease control and drug delivery. From a physical standpoint, a suspension of active swimmers in viscous fluid is a complex system the study of which may lead to discoveries in the notoriously difficult field of non-equilibrium statistical mechanics.

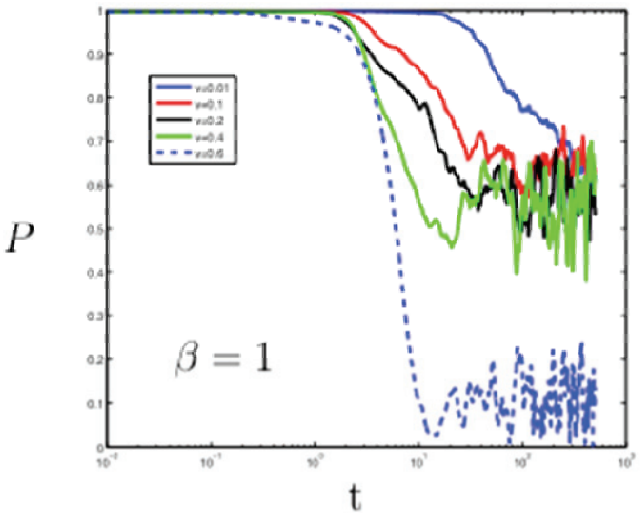


Figure 1: Alignment of swimmers over time for several exemplary volume fractions. For low and intermediate values of the concentration there is some finite value of order that is achieved, indicating that the swimmers are all oriented in the same direction; however, at larger concentrations the suspension becomes isotropic

7. Research implementation and results under the program

Title of your research plan:

Orientational instabilities in concentrated active suspensions

Description of the research activities:.

Consider the following: given a collection of microscopic swimmers initially having no common direction, will they spontaneously generate directed motion, like a flock of birds or a swarm of bees? It is known that bacteria swirl and swarm, and while there has been some work dedicated to understanding these phenomena, our numerical work this summer is the first to focus on the orientational instabilities in concentrated suspensions of such organisms.

Using a robust numerical scheme developed by Professor Takuji Ishikawa, we simulated concentrated suspensions of model micro-organisms. This technique allows examination of systems of model swimmers at various volume fractions, from dilute to very concentrated. We also have the ability to change the strength of the swimming stroke in the form of the parameter beta, indicating how large an amount of fluid is pushed or pulled away every second.

Our results show that for a variety of different initial conditions, global orientational order amongst the swimmers develops and is maintained indefinitely. This behavior is contrary to that predicted by continuum theories, which have shown that such order cannot persist due to long-range hydrodynamic interactions in the dilute limit. We hope that this work shall be the first in tying such theories together with rigorous numerical schemes that incorporate short-range hydrodynamics in concentrated suspensions as well as long-range effects in the dilute limit.

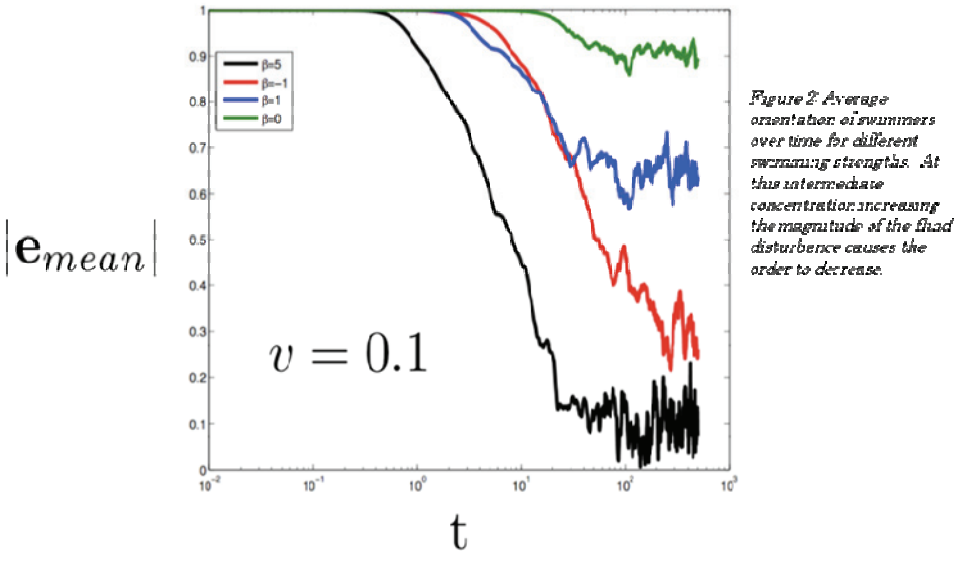


Figure 2 Average orientation of swimmers over time for different swimming strengths. At this intermediate concentration increasing the magnitude of the fluid disturbance causes the order to decrease.

RESEARCH REPORT

1. Name: David W. Fallest （ID No.: SP10014）

2. Current affiliation: North Carolina State University

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Institute for the Physics and Mathematics of the Universe, University of Tokyo, Kashiwa Campus

5. Host researcher: Dr. Ken'ichi Nomoto and Dr. Takaya Nozawa

6. Description of your current research

Comic dust, once thought to be little more than a nuisance to astronomical observations, is now one of the most interesting areas of astrophysical research today. We now know that dust is integral to the life cycles of molecular clouds, galaxies, and stars. Gas and dust grains in molecular clouds coalesce to form stars, planets, and other objects. Some stars, having exhausted their nuclear fuels, end their lives in spectacular explosions called "supernovae", and eject gas and dust back into the interstellar medium. This gas and dust is then free to perhaps become part of the next generation of stars or other objects. Observations of the early Universe, say 12.5 billion years ago, show large amounts of dust available for forming various astronomical objects. An open question in astrophysics, however, is how much of this observed dust could have come supernovae. Unfortunately, supernovae from this time have been unobservable, so we must infer the supernovae contribution by accurately predicting the amount of dust produced in younger, observed supernovae and then extrapolating results based on the types of stars thought to have existed 12.5 billion years ago.

My current PhD research focuses on predicting the amount of dust formed, due to nucleation, after a supernova explosion. Currently, theory of dust nucleation uses a thermodynamic approach, however, this approach assumes certain physical properties of the dust grains that may not be true in all circumstances. The thermodynamic approach assumes that all dust grains, regardless of size, are spherical, and that all molecules of the same material as the dust grain that come into contact with the grain, will adhere to the grain. Most notably, however, the thermodynamic approach assumes the dust grains are in local thermodynamic equilibrium with the environment; the dust and surrounding environment are at the same temperature. My research seeks to utilize a different theoretical approach that allows for non-spherical grains and the possibility that not all molecules will adhere to the grain, and relaxes the requirement of thermodynamic equilibrium.

The motivation for this work is that current dust nucleation theory tends to overestimate the amount of dust that should be produced by a supernova explosion when compared to observations of known supernovae. Current theory uses parameters that result in a maximum nucleation rate – how many dust grains are formed for a given volume of supersaturated gas in a given time. The use of a kinetic theory of nucleation model will allow for easier varying of the "stickiness" and shape parameters, as well as allowing for fluctuating temperatures of the grains.

7. Research implementation and results under the program

Title of your research plan:

Shape and stickiness: how dust cluster properties affect the evolution of the Universe.

Description of the research activities:

For part one of this project, a parametric study of the shape and “stickiness” of dust grains has been undertaken to understand how changing these parameters alters the amount of dust produced from a supernova explosion. Since the Drs. Nomoto and Nozawa are skilled at the use of the thermodynamic approach to dust nucleation, this approach has been retained throughout this summer project. The equations governing dust nucleation have been generalized by assuming the dust grains are not spherical, nor are they always “sticky”. In this way, we were able to discern where the shape and “stickiness” of the grain will influence the outcomes of the equations.

As in previous work, the “stickiness” of the grain, described by a sticking coefficient in the nucleation equations, was not assumed to change with the shape or size of the grain. The sticking coefficient is simply the probability that a molecule will adhere to the grain. In previous work the sticking coefficient is set to unity, corresponding to molecules always adhering to the grain. Through reworking the nucleation equations, it became apparent that these equations are simply proportional to the sticking coefficient, meaning that if the probability of a molecule sticking to the grain is reduced by half, the nucleation rate is also reduced by half. The dependence of the nucleation rate on the shape of the grain, described by a parameter known as the shape factor, was found to be more complicated. The overall effect is that a increase in the shape factor results in a reduction of the nucleation rate. The shape is thought to need to be increased because spheres have a minimum shape factor. Thus, any other shape for a grain will result in a higher shape factor.

These results are in agreement with our predictions that using a sticking coefficient set to unity and the shape factor for a sphere will result in a maximum nucleation rate. Thus by reducing the sticking coefficient and increasing the shape factor, we will reduce the nucleation. Since, in general, current nucleation theory overestimates the amount of dust produced in a supernova explosion, adjusting the sticking coefficient and shape factor could result in more accurate predictions through the resulting decrease in the nucleation rate.

Part two of this project was aimed at including these more generalized equations into the dust production models and is ongoing at this time.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

The fellow's research on dust nucleation holds striking originality and will play a critical role in exploring the origin and properties of solid materials in the universe. He developed a more general formula for nucleation of dust than before and completed the computation code to estimate the mass of dust formed in supernovae. I consider his research objective in this project to have been almost accomplished. I am really happy to have made a meaningful and fruitful study with the fellow.

RESEARCH REPORT

1. Name: Felice A. Forby （ID No.: SP10015 ）

2. Current affiliation: Ohio State University

3. Research fields and specialties:

Social Sciences

4. Host institution: Kobe University

5. Host researcher: Dr. Kaoru Maeto

6. Description of your current research

I am in the rural sociology program at Ohio State University with a specialization in environmental sociology. My background is in Japanese and East Asian studies and I have spent time living in Japan before. I became interested in firefly ecology and conservation after learning the insect was a threatened species in Japan. There are numerous firefly conservation groups in Japan, the majority of which are small and citizen-organized. A small proportion of the groups work specifically with the hime-firefly species (*Luciola parvula)*, a species about which there is still relatively little known. Hime-firefly conservation groups play an important role in gathering data, disseminating information and garnering interest in the hime-firefly; however, there have been little or no studies conducted specifically on these types of groups. In order to begin getting a more detailed picture of hime-firefly conservation, my master's research focuses on how these citizen-run groups in Japan function and operate. My research is based on similar studies about collaborative watershed groups and other environmental groups in Ohio and other parts of the U.S. which have found useful implications for groups themselves, environmental managers, policy makers and researchers. I hope to contribute further research to the existing literature base on collaborative and grassroots environmental groups, as well as provide information useful for the hime-firefly groups here in Japan.

7. Research implementation and results under the program

Title of your research plan:

Rural and Urban Hime-firefly Conservation Groups in Japan: Exploring Place-based Influences

Description of the research activities:

This summer I visited various places in Japan in order to meet with and interview members of hime-firefly groups. I asked questions about a variety of topics including groups goals, activities, and accomplishments; resources available to groups, difficulties groups may encounter and factors important for future success. One objective of my study is to compare groups in urban and rural areas on these aspects. I was able to visit three urban groups (one in Suita City and two in Nagoya), two rural groups (Tanba and Wadayama in Hyogo Pref.) and one group in Gotemba City which size is between urban and rural. Another interview with a rural group in Niimi City in Okayama Pref. was scheduled but the interview ended up cancelled. Furthermore, I was able to observe the actual hime-firefly habitats of each locale, collected document data and attended two hime-firefly viewing/appreciation events. After conducting my interviews, I spent time transcribing each interview and summarizing their contents. Preliminary results were shared and presented at the COP10 Hime-Firefly Summit in Nagoya on August 21st.

In the end, being able to interview hime-firefly groups operating in a variety of settings allowed me to get a good general picture of how what groups are trying to accomplish and how; what difficulties groups face and factors they feel are important for the future success; what resources are available them; recommendations they have for other groups, and so on. Although all groups get together for the sake of hime-fireflies, goals and activities varied a great deal and did not center solely on firefly conservation/protection. For instance, some groups placed emphasis on building connections between people, while others used fireflies as a way to attract tourism or as a way to build appreciations for the local area.

Perhaps some of the most important information gained from the summer's research was factors that might greatly improve both groups' operation and firefly conservation in the future. Based on interviews, there is a pressing need to learn more about habitat management for hime-firefly conservation, which could perhaps be accomplished more effectively if researchers and groups were able to increase collaborative activities. Related to this, groups also expressed a desire to increase communication of information both between groups and with researchers; however, at the present time it is difficult to exchange information effectively due to the lack of a central network. If it were possible to create a network for information exchange, data uploading and communication, it would have great potential to help both researchers and firefly groups.

I will be analyzing documents I received from each group at a later time and writing up the full results and conclusions after the summer. At this point, it is difficult to make generalizations about the differences between urban and rural groups, especially since one rural group could not be interviewed. Furthermore, there was much more variety among hime-firefly groups than expected and therefore it may be useful to conduct more interviews or to send out a written survey in order to collect more data.

8. Please add your comments (if any):

I enjoyed my time collaborating with my host professor Dr. Kaoru Maeto and Tsuyoshi Yagi at the Museum of Nature and Human Activities, Hyogo. Besides being able to collect data for my own project and learning about hime-firefly conservation, I was able to make many connections with firefly group members and learned a great deal about the insects of Japan. Furthermore, I was surprised to learn that many areas and topics concerning just fireflies still need to be studied in order to have a full understanding. I also gained knowledge of how research is done in Japan, and how professors and graduate students work in Japan as compared to the U.S. I am especially happy that I get the chance to share some of the knowledge I gained from this summer at the COP10 Hime-Firefly Summit in Nagoya.

9. Advisor's remarks (if any):

Kaoru Maeto (host researcher): This is the first intensive survey of local groups promoting conservation of this firefly in urban and rural areas in Japan. They all are very active, very diverse in purpose and activity, although having some common problems. Results of this research should be published in any form to encourage grass-roots movement for biodiversity conservation in Japan.

RESEARCH REPORT

1. Name: Angela Rose Galotti (ID No.: SP10016)

2. Current affiliation: The State University of New York at Stony Brook

3. Research fields and specialties:

Engineering Sciences

4. Host institution: National Institute of Advanced Industrial Science and Technology

5. Host researcher: Dr. Ryoji Kurita, Ph.D.

6. Description of your current research This summer, I began a project to develop a point-of-care blood test for cardiovascular disease risk assessment. There are certain molecules in the blood that, at certain concentrations, may indicate high risk for heart disease. I have been working on a sensor to measure the concentration of these molecules (proteins) by employing the sandwich immunoassay to capture the target protein on a paper platform, and then tag them with an enzyme that will produce an electrical current in the presence of a substrate and applied voltage. This current will be proportional to the concentration of the disease risk marker.

During the JSPS Summer Program, I have been learning new techniques—electrochemical detection, electrode sputtering, photolithography, using analytical and design software, and ELISA. Additionally, I worked on several aspects of the biosensor design. I worked out a protocol to fabricate the paper-based platform successfully using photolithography, immobilize the capture antibodies in the test zones of the paper, block the test zones from nonspecific binding, and wash away unbound molecules. I designed several photo-masks to fabricate test zones, and demonstrated that several tests could be done simultaneously on the same test plate, using interconnecting channels between wells. I used a model analyte in my experiments for optimization of the system, and used a colorimetric tagging molecule in the preliminary tests.

7. Research implementation and results under the program

Title of your research plan:

Immunoelectrochemical Detection of Disease Risk Markers Using Paper-Based Microfluidics

Description of the research activities:

Photolithography

At my host institute, I learned the process of photolithography on a silicon disk, but then needed to adapt this procedure for a paper substrate. Using optimization experiments and the literature, I developed a repeatable method for photolithography on Whatman Chromatography Paper No. 1, using SU-8 2035 photoresist and a UV source. Below are the characteristics of a good photo-plate, in my opinion:

•clearly defined hydrophilic wells that penetrate the thickness of the paper

•test zone wicking speed of sample is the same as untreated paper

•test zones are free of residue (identical in appearance to untreated paper)

•polymerized photoresist penetrates the paper and forms hydrophobic barrier

•sample added to test zone should not bleed into hydrophobic region

•sample added to hydrophobic zone remains surface and does not penetrate paper

•uniform distribution of photoresist throughout the hydrophobic region, no bubbles

•Front and back look identical

I attempted photolithography with several types of photoresist, until I found one that penetrate the thickness of the paper, polymerize within the paper matrix under UV light to form a hydrophobic plate, and wash away entirely from masked zones during developing to reveal hydrophilic test zones.

The photoresist impregnated paper is baked before UV exposure (pre-bake), and then again after UV (post-bake). I found it optimal to suspend the photo-paper on a pipette box top, and pre-bake it in an oven at 110°C for 10 minutes, and post-bake the paper for 5 minutes at 110°C. After post-baking, I soaked the cooled photo-paper in an acetone bath for 15 minutes to remove unpolymerized photoresist. The paper was then rinsed twice with isopropyl alcohol and allowed to dry completely.

I designed several photo-masks using PowerPoint, to create the microfluidic systems. I constructed circular test zones interconnected by channels, to investigate multi-analyte single-sample testing. This is when a sample can be added to a central point and wick outward to several test zones containing different capture antibodies, and a labeling antibody can be added to respective test zones in prescribed quantities, and will be mostly contained in its zone.

The photo-mask dimensions we designed for a finger-prick sample of blood (~10uL) or less. In this calculation, I needed to account for paper fiber volume, thickness of paper, and placement of sputtered electrodes. To impregnate the paper with photoresist, I laid the paper flat on a surface and poured some photoresist onto side A of the paper, and evenly coat the entire surface. Then I allowed photoresist to penetrate the paper vertically, then poured and lightly smeared off excess photoresist. Once excess photoresist is removed, flip over the paper and repeat the process for side B. Side A will be sticky so I suspended the photo-paper. I also optimized the UV polymerization exposure time, and found 90 seconds is very good.

Electrochemical detection

At AIST, I learned how to use the metal electrode sputtering equipment. I also learned basic electrochemical techniques, such as electrode polishing and hardware setup, and voltammetry software. I constructed a model calibration curve by preparing several concentrations of an electrochemically-active molecule, applying a cyclic voltage and measuring the resulting oxidation current. I then plotted data points of current versus concentration, which can be used to determine the concentration of a sample from a measured current.

Paper Experiments

I attempted paper experiments with chromatography paper and nitrocellulose membrane. I carried out control washing trials to ensure that my blocking and washing steps were effective, and compare the two washing techniques. In these trials, I blocked the wells with two types of blocking agents and various cycle numbers of blocking and drying before attempting to immobilize the biotinylated antibody on the paper. I then washed the paper with an experimental protocol, six to ten times, with PBST, then added Streptavidin conjugated to horseradish peroxidase (Strep-HRP), and washed again 6-10 times. Last, I added the substrate that is meant to react with HRP. The washing trials were deemed successful if no signal appeared (color change from clear to blue). Only residual signal appeared.

ELISA

Although the concept for my design will utilize electrochemical detection methods, it was favorable to begin trials with a colorimetric detection method for learning the techniques and designing preliminary experiments. Also, I began experiments with a model protein available to me in the lab that is not of direct interest to cardiovascular applications, but nonetheless was useful for experimentation. I found it very difficult to immobilize antibody on paper, but I did have a little success. I immobilized biotinylated antibody in varying concentrations directly onto the paper, then blocked, then attached HRP, and added substrate. I measured increasing signal at wells with increasing antibody concentration. This trend was not statistically significant but it was noticeable.

8. Please add your comments (if any): Dear JSPS, Thank you so much for this opportunity to gain international research experience, make professional connections abroad, to experience the culture of beautiful 日本 and travel throughout the country. I enjoyed every day of this program and will highly recommend it to my colleagues.

RESEARCH REPORT

1. Name: Tricia Gibo （ID No.: SP10017）

2. Current affiliation: Johns Hopkins University

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Advanced Telecommunications Research Institute International

5. Host researcher: Dr. Rieko Osu

6. Description of your current research

My current research is focused on studying the role of the cerebellum in basic human motor control of the upper limbs through the use of robotics and virtual environments. The eventual goal is to design potential rehabilitation strategies aimed at people with cerebellar damage.

Healthy individuals are able to adeptly control motion of their limbs and adapt their body movements to new dynamics in the environment. For example, when people make reaching movements with a robotic device that generates forces to perturb their movement, their arm motions are initially skewed but eventually return to an almost normal trajectory. Cerebellar patients, on the other hand, have poor motor control and it has previously been thought that they are unable to show such adaptation to new dynamics. Recent work from Johns Hopkins University has shown an intact ability of cerebellar patients to adapt, given that the perturbing dynamics are gradually introduced. I am interested in further examining this adaptation ability in cerebellar patients, as this has great potential for rehabilitation techniques.

My currently work involves much collaboration with my Mechanical Engineering advisor and our Neuroscience collaborator, as this project is very multidisciplinary. I design controllers and virtual environments for an exoskeleton robotic device for the arms. I then use the robot in human subject experiments with both healthy and cerebellar patient populations to help elucidate the similarities and differences between motor control in control and patient populations.

7. Research implementation and results under the program

Title of your research plan: A human-robot interaction study for interlimb transfer of learned dynamics

Description of the research activities: My project was focused on exploring more fundamental motor control issues in healthy individuals. We were interested in studying interlimb transfer – the ability of what was learned with one arm to influence movement of the other arm – of adaptation to a position-dependent force field. Previous studies suggest that the learning of motor skills depends on kinematic parameters (position, velocity, acceleration). This can be supported by physiological evidence that neural signals are correlated with these parameters and experiments that test generalization and interference of state-dependent dynamics. While there has been much work using force fields based on the velocity of the subject's hand, fewer studies have implemented force fields based on position.

At the beginning of the program, I designed the experimental protocol for the human subjects study and conducted preliminary experiments to make adjustments to the original protocol. I originally thought that I would be programming the bimanual manipulandum robotic device to be used in the experiments, but it turned out that there was a designated person to do all of the programming. Thus, my research mainly consisted of designing and overseeing the experiments, then analyzing the data. I did not have enough time to run all of the subjects for my experiments, so the remaining experiments will be run after I leave. I will continue to analyze the data from my home institution, but the following results are a good indication of the final expected results.

Previous work has shown that if one adapts to a velocity-dependent curl force field with the dominant arm, subsequent performance in the same force field in Cartesian space is improved for the non-dominant arm. However, we did not observe any transfer of learning in both the velocity- and position-dependent force fields in a variety of conditions. We tested for transfer in both directions (dominant to non-dominant arm, and vice versa), different curl force field directions (counterclockwise and clockwise), and different transfer coordinates (Cartesian and joint space). The discrepancy in results for the velocity-dependent force field may be related to differences in the experiments. Through comparison of the experiment setups and protocols, this discrepancy is not likely due to the force field itself, amount of practice trials in the force field, or visual feedback provided. The inconsistency in results may be due to differences in the robotic device used – previous experiments used one device for both arms, whereas our bimanual manipulandum required subjects to interact with a separate device for each arm. When the same robot is used for both arms, subjects may associate the forces experienced with that particular device, thus facilitating interlimb transfer.

A particularly interesting result was observed for the difference in adaptation to the velocity- versus position-dependent force field. Our subjects adapted to the velocity-dependent force field with one arm in the same way that many previous papers have shown. Arm movements are initially perturbed in one direction, depending on the direction of the force field, and arm trajectories gradually straighten out with practice. For the position-based force field, however, a different pattern of adaptation was observed. We discussed possible reasons for this difference in adaptation to the two fields and follow-up experiments to further examine this phenomenon.

8. Please add your comments (if any): Overall, this has been an incredible experience, both professionally and personally. My time in Japan flew by incredibly quickly, and I only wish I had had more time to modify the current experiments and assist with the follow-up experiments I had discussed with my labmates. It was a great experience to learn firsthand about how research is conducted in my host laboratory and in Japan in general. I especially enjoyed the time spent with my labmates, including the discussions over lunch (everything from research ideas to Japanese culture) and dinner and karaoke outings. I hope to continue the collaboration with my host advisor and laboratory and would love to have another opportunity to return to Japan.

9. Advisor's remarks (if any): (My advisor spends the majority of her time in her laboratory in Tokyo, so I did not have the opportunity during our last meeting at ATR to ask her to add any comments to this form.)

RESEARCH REPORT

1. Name: Peter Gin （ID No.: SP10018）

2. Current affiliation:

Stony Brook University

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Kyushu University

5. Host researcher:Atsushi Takahara

6. Description of your current research

I am currently investigating a "green" alternative polymer processing technique utilizing supercritical carbon dioxide ($scCO_2$). Unlike conventionally employed methods, $scCO_2$ energy responsible and environmentally friendly. Unfortunately, because of its chemically inert nature, few long-chained molecules are soluble in CO_2, limiting its potential to be a vital industrial processing tool. However, we recently found that under a specific set of conditions in the compressible region near the critical point, known as the density fluctuation ridge, anomalous adsorption of polymer thin films occurred. This enhancement in the solubility for thin films is a universal phenomena and independent of the polymer/$scCO_2$ combinations. By exploiting this unique trait, we showed that density fluctuating $scCO_2$ could be utilized as a valid polymer processing tool and for the fabrication of novel materials.

7. Research implementation and results under the program

Title of your research plan:

Synthesis of CO_2-miscible block copolymers for investigation in supercritical carbon dixide.

Description of the research activities:

Because most polymers have poor miscibility with CO_2, we need to determine the maximum potential of $scCO_2$ in "CO_2-philic" polymer systems. We previously showed that for block copolymer systems consisting of "CO_2-phobic" components, well ordered microdomain structures with controllable orientations could be achieved. However, this observation was mostly limited to ultra-thin films and the surfaces of thick films. Therefore, we wish to probe whether we could extend the effect of $scCO_2$ to thick films using CO_2-miscible polymer components. The Takahara group (Kyushu University) has

successfully synthesized fluorinated polymers, which have good miscibility in CO_2, using atom transfer radical polymerization (ATRP). In this research project, I aimed to synthesize a block copolymer system with a fluorinated component. After discussions with Dr. Takahara, it was decided that I should attempt to synthesize poly (hexylmethacrylate_-block- poly(2-perfluoromethacrylate) (PHMA-b-PFMA-C2) for this purpose. The synthesis procedure first involved the distillation of the ligand, initiator, and monomer used to polymerize the homopolymer (PHMA) to be used as the macroinitiator. Five successful ATRP attempts of PHMA yielded over 15 grams of the polymer. This product was subsequently utilized in the ATRP of the block copolymer. In order to attain a desirable composition, I systematically varied the polymerization time and temperature to tune the ratio of the components. It should be noted that gel permeation chromatography (GPC) was employed after each polymerization to quantify the molecular weight and polydisperity of the polymers. After several attempts, the time and temperate conditions were optimized for the desired block copolymer. The final polymerization yielded approximately 3 grams of PHMA-b-PFMA-C_2 with the desired composition. The product will be transported back to our research lab for investigation in $scCO_2$.

8. Please add your comments (if any):

Before arriving in Japan, I decided to plan a few different side projects utilizing equipment not available in my home laboratory. This proved to be very useful as there were times when I couldn't work on my main project due to some apparatuses being unavailable or broken. I had the opportunity to visit the synchrotron facility in SPring-8 National Laboratory to measure the grazing incidence small angle x-ray scattering (GISAXS) of a several samples which I transported from Stony Brook University. I also utilized the equipment in the Takahara lab to characterize other samples using techniques such as scanning electron microscopy (SEM) and *in-situ* atomic force microscopy (AFM).

RESEARCH REPORT

1. Name: Christine M. Hartzell (ID No.: SP10019)

2. Current affiliation: University of Colorado at Boulder

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Institute of Space and Astronautical Science/JAXA

5. Host researcher: Junichiro Kawaguchi

6. Description of your current research:

During the Apollo-era explorations of the moon, instruments and astronauts observed a glow above the lunar horizon after sunset. It was proposed that this so-called 'Lunar Horizon Glow' could have been light scattered by micron-sized dust particles floating above the lunar surface. The dust particles were thought to have been launched off the surface of the moon due solely to electrostatic forces. It was then hypothesized that a similar phenomenon would occur on asteroids, since their gravitational attraction is weaker than that of the moon. In our observations of asteroids, we have seen that the smallest dust particles are concentrated in certain regions. My research is focused on understanding the forces that are important for dust particle motion on the moon and asteroids and understanding the implications for space exploration.

There are three main areas of my research: 1. dust particle launching mechanisms, 2. dust particle motion, and 3. engineering applications. Previously, submicron-micron –sized dust particles were thought to be launched off the lunar surface due solely to electrostatic forces. However, we have found that interparticle-cohesion, which has been neglected by previous models, is actually larger than gravity for small particles. Since particle launching through electrostatic forces alone is not feasible given our current understanding of the plasma environment, we are exploring other particle launching mechanisms.

Since a feasible dust launching mechanism has not been identified, previous studies have evaluated particle motion by simply estimating the initial state of the particle. We are studying dust particles that oscillate above the surface in simulations to analytically identify the initial conditions that produce oscillation. Oscillation is of interest because it is the fastest mechanism of long-distance dust transport.

Finally, the distribution of dust particles on the moon and asteroids will influence the design of the mobility system of future surface exploration vehicles on the moon and asteroids. Additionally, the interparticle cohesion will significantly influence the design of sample collection systems.

7. Research implementation and results under the program

Title of your research plan: An Investigation of Dust Dynamics on Asteroid Surfaces

Description of the research activities: Since our previous work has shown that the currently known electric fields on the surface of the moon and asteroids are insufficient to separate dust particles from the surface, I investigated the ability of micrometeoroid bombardment to serve as a particle launching mechanism. While my main interest is asteroids, the moon is an important analog because we have many more observations of the moon than of asteroids.

Using analytical models from the literature, I created a code that models the ejecta plume particle size distribution and velocity distribution that results from a meteoroid impact. I also calculated the frequency of such of impacts. From this model, I calculated the mass of particles that should be separated from the surface of the moon due to micrometeoroid bombardment per unit time per unit area. Comparing this mass churning rate to that inferred from observations of dust particles above the lunar surface, we see that micrometeoroid bombardment alone is not sufficient to explain the lunar horizon glow observations. I also modeled and evaluated the ability of particles ejected from a micrometeoroid impact to produce an ejecta plume (called a secondary ejecta plume) when they reimpact. If secondary ejecta plumes are produced, they could increase the mass churning rate, potentially making micrometeoroid bombardment a feasible method of launching dust particles. However, we found that only centimeter-sized or larger impactors can cause a secondary ejecta plume at the velocities we are considering (1-12 m/s). Additionally, we see that even with the secondary ejecta particles included in our calculation of the mass churning rate, micrometeoroid bombardment does not satisfy the current interpretation of the lunar horizon glow observations. Thus, a feasible dust launching method that agrees with observations has not yet been identified.

Since a feasible particle launching mechanism has not yet been proposed, numerical models of dust particle motion use estimates of the initial state of dust particles, which may or may not be representative of the *in situ* initial states. Through these numerical models, it has been seen that some particles oscillate in altitude above the surface of the body, rather than exhibiting traditional parabolic motion. Our goal is to analytically identify which initial conditions will cause a particle to oscillate. However, this is difficult because the equations of motion of the system are second-order, nonlinear, nonconservative and coupled. I have developed an analytical expression for the energy of the system that, although energy is not conserved, could be useful in identifying the initial conditions of particles that oscillate. Additionally, through numerical experimentation, I have been able to identify some relationships between the oscillatory behavior of the system and the initial state (specifically, there appears to be a fairly strong correlation between the initial energy of the particle and the frequency of the particle's subsequent oscillations). I am currently considering modeling the system as a simpler system in order to understand its oscillations. I will continue work on this problem upon my return to the US.

Finally, it is desirable to understand the engineering implications of our new understanding of interparticle forces and dust particle motion. Originally, I considered the implications of the electrostatic environment on the dust collection apparatus of the Hayabusa spacecraft, which returned the first asteroid dust samples to Earth immediately before my arrival in Japan. Since the Hayabusa sample collection mechanism consisted of a tube impacting the surface, the photoelectron sheath inside the tube would collapse (since neither UV nor solar wind will be interacting with the surface inside the tube). Thus, unless the spacecraft base has a more negative electric potential than the collection tube, a dust grain inside the tube will not experience a vertical electrostatic force. Unless there is a very large potential inhomogeneity between the spacecraft and collection tube, particle collisions with the sides of the collection tube are likely to be more significant than electrostatic forces.

Since electrostatic forces do not appear to be significant for the Hayabusa sample collection device, I decided to explore other systems that could be modeled given my knowledge of the forces on dust particles. Researchers at the Kennedy Space Center have created a very effective dust shield. However, they have not tested the efficacy of the dust shield, which relies on electrostatic forces, in a plasma environment. I hope to develop a model of the dust shield operation in a plasma environment when I return to the US.

RESEARCH REPORT

1. Name: Ross Hatton （ID No.: SP10020）

2. Current affiliation: Carnegie Mellon University

3. Research fields and specialties:

Mathematical and Physical Sciences, Engineering Sciences

4. Host institution: National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba

5. Host researcher: ARISUMI Hitoshi

6. Description of your current research

My research at Carnegie Mellon University investigates the fundamental mechanics of locomotion, with a specific focus on snake robots and related systems. The core of my thesis is mathematically intensive, and examines how the choice of coordinates used to express problems in locomotion affects their analysis. I also have several side projects related to implementing snake-like motion on real robots.

7. Research implementation and results under the program

Title of your research plan: Wrapping Targets with a Casting Manipulator

Description of the research activities:

My research in Japan is in the area of “casting manipulation”, a branch of robotics that considers how a thrown object can be guided in flight by pulling on a rope or flexible wire connected to it. Because this wire can be much lighter than a robot arm of the same length, there is interest in using this principle to extend the reach of robots beyond what is currently feasible.

The specific project I am working on is the “Indiana Jones” problem – how to swing a whip or other casting manipulator so that it wraps around a target with a firm grasp. Together with Dr. Arisumi, I am taking a combined analysis/simulation/experiment approach. This draws on my background in applied mechanics and Dr. Arisumi’s experience with casting manipulation, along with a simulation framework developed at AIST.

My efforts this summer have focused on developing a physical model of the wrapping process. As the wrapping behavior is substantially different depending on the tension in the wire and whether it is slipping along the target, I have taken a hybrid modeling approach, using specific models for the slip, no-slip, and no-tension cases, with a transition model to switch between them.

Dr. Arisumi and I have also started experiments to validate my analysis, by repurposing a casting manipulator robot he developed for a previous research project. So far, our videos show a strong qualitative agreement with the simulations. In the near future, Dr. Arisumi plans to incorporate a motion tracking system into the experiments, so we can make quantitative comparisons.

8. Please add your comments (if any):

I have enjoyed this program very much and am very happy to have had the opportunity to come here. Both the research experience and the opportunity to see the country have been amazing.

RESEARCH REPORT

1. Name: David Hembry （ID No.: SP10021 ）

2. Current affiliation: University of California, Berkeley, USA

3. Research fields and specialties:

Biological Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Makoto Kato

6. Description of your current research

Coevolution between species is widely considered an important factor in the generation and maintenance of biodiversity on earth. Despite this, how and why coevolving species codiversify remains poorly understood. In my doctoral research I am studying a highly specialized mutualism between *Glochidion* trees (Phyllanthaceae) and *Epicephala* moths (Lepidoptera: Gracillariidae) on islands in Eastern Polynesia (Cook Islands and French Polynesia) as a model for understanding coevolutionary diversification. *Epicephala* moths are the sole known pollinators of *Glochidion* trees, but the trees lose a subset of their seeds to the moths' larvae. A major goal in this research is establishing the number of times these insects and plants have colonized Eastern Polynesia from the west Pacific and Asia. Preliminary molecular phylogenetic analyses suggest that both *Glochidion* and *Epicephala* have colonized Eastern Polynesia multiple times from the west, but that these colonizations are not congruent. This suggests that host associations in obligate mutualisms can be dynamic over evolutionary time, and that these host shifts may be an important factor in diversification.

In this research I have been closely collaborating with Dr. Makoto Kato and his current and former students since the beginning of my doctorate. My goals during the Summer Program were to run combined analyses on my DNA data from Polynesian species and that from southeast Asian species collected by Dr. Kato and his lab; to learn *Epicephala* dissection techniques from his former student Dr. Atsushi Kawakita; to amplify additional genes for sequencing from *Glochidion*; and to collect additional specimens of *Glochidion* and various moth genera that feed on it from Japan (Shikoku) and the vicinity of the Japanese field laboratory at Lambir Hills National Park in Malaysia.

7. Research implementation and results under the program

Title of your research plan:

Coevolution and codiversification of an obligate pollination mutualism in the Asia-Pacific region

Description of the research activities:

As a JSPS Summer Program Fellow, I combined my DNA sequence data set of Pacific island *Glochidion* and *Epicephala* species with 20+ additional outgroup species collected by Kato Lab members and ran phylogenetic analyses whose results suggest a different history of the colonization of the Pacific by *Glochidion* than suggested by previous results; subsequently, I amplified two new

genes (IGS region of ETS and chloroplast matK) for sequencing in the Kato Lab which should greatly help resolve this question upon return to my home institution.

I was able to conduct one week of outgroup specimen collection at the Japanese Laboratory at Lambir Hills National Park, Malaysia (with JSPS permission) and also sampled the insect fauna on *Glochidion* at Lambir and in Shikoku (Japan) to compare with that in Polynesia.

I learned dissection techniques for *Epicephala* moth genitalia from former student Atsushi Kawakita (now a professor at Kyoto University). Dissection of genitalia is essential to species identification in this genus. I then dissected male genitalia of all my Polynesian *Epicephala* samples to see if phylogenetic patterns suggested by DNA data are also supported by morphology. Additionally, I traveled to the Hokkaido University Museum to study the world's largest collection of *Epicephala* specimens, and of Asia-Pacific gracillariid moths generally. I was able to corroborate my identifications and examine the range of variation in Asian *Epicephala*. At Hokkaido University, I remet and discussed research extensively with Professor Emeritus Tosio Kumata, the world authority on Asian Gracillariidae.

I received extensive research guidance and discussion from Dr. Kato and Dr. Kawakita, and conducted extensive discussions of future research collaborations with Dr. Kawakita, Ryutaro Goto (Kato Lab, Kyoto University), Dr. Tomoko Okamoto (JT Biohistory Research Hall, Takatsuki), and Dr. Issei Ohshima (National Institute for Basic Biology, Okazaki). I was also able to meet Professor Shixiao Luo (South China Botanical Garden, Guangzhou, China), who is also studying the *Glochidion-Epicephala* mutualism, when he visited the Kato Lab in June.

Finally, I attended and presented my results as an oral presentation at the annual Society for Evolutionary Studies, Japan meeting in Tokyo.

8. Please add your comments (if any):

This program was an invaluable opportunity, both to the success of my doctorate and to my professional development as a scientist. I have been collaborating with Dr. Kato and his current and former students for five years, since the beginning of my doctorate; their lab is one of only two other labs in the world where research is being conducted on this system. I expect to co-author at least three papers with current or former Kato Lab members, two of which I advanced significantly as a result of Summer Program research activities. I received extensive feedback on my doctoral research and further research plans from host lab members. I improved my fluency in Japanese and met numerous evolutionary biologists and ecologists whom I did not already know. Finally, working in the same lab with other researchers studying the same system, and exposure to different perspectives from researchers at Kyoto University and other institutions in Japan, allowed me to understand my research and my career goals better. For these reasons I would like to express my appreciation to JSPS and NSF for their support.

9. Advisor's remarks (if any):

(Dr. Kato is away from campus this week teaching a field course, so I was unable to receive any comments)

RESEARCH REPORT

1. Name: Jeffrey A. Herron （ID No.: SP10022）

2. Current affiliation: University of Wisconsin – Madison, Department of Chemical and Biological Engineering

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Osaka University

5. Host researcher: Dr. Yoshitada Morikawa

6. Description of your current research

My research employs first-principles density functional theory to calculate the energetics of methanol electro-oxidation on the closed-packed facet of crystalline platinum and thereby determine the reaction mechanism. Understanding methanol electro-oxidation is of practical interest because methanol has been considered as a possible fuel for fuel cells.

In previous work, we have investigated methanol electro-oxidation on a number of transition metal catalysts, however, the representation of the reaction environment was crude – we considered only the reacting species and the catalyst in our model. At Osaka University, we include water layers surrounding the catalyst as well as a charged electrode in the computation model to increase the physical accuracy of the results.

The mobile surrounding water layers complicate the calculation of the energy, in a static model. Therefore, molecular dynamics simulations are performed to obtain a time-averaged energy of the system. Furthermore, using both the nudged-elastic-band and blue moon algorithms, we calculate the transition states for elementary steps involving proton abstraction from methanol and methanol derived intermediates.

7. Research implementation and results under the program

Title of your research plan:

Ab-initio molecular dynamics studies of methanol electro-oxidation on electrified Pt surfaces

Description of the research activities:

The calculations involved in this study are extremely computationally demanding, and convergence of the calculated energies with respect to simulation time will likely not be complete by the end of the summer. With that in mind, I have focused on learning new methods and navigating the simulation program (called STATE).

The project has expanded in scope from the original proposal. Originally, I wished to focus my efforts on only a single key step in the reaction mechanism. However, due to the nature of the calculations (including the ability to parallelize the calculation over numerous computers), the progress towards achieving that goal has been slow, yet steady (my progress has been restricted by computational power rather than personal effort). Therefore, I have had time to investigate other reaction intermediates beyond the small subset I originally proposed.

8. Please add your comments (if any):

I believe my research has been very successful in establishing a collaboration and learning the necessary skills/knowledge necessary to complete my research when returning to my home institution. Since the computation involved in my research at Osaka University has been performed at resources at my home institution and supercomputing facilities in the United States, I am already fully-equipped to continue my studies once returning home.

RESEARCH REPORT

1. Name: Zachary Holman （ID No.: SP10023）

2. Current affiliation: University of Minnesota

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Professor Tomohiro Nozaki

6. Description of your current research: The sun is arguably the most promising source of the abundant, clean energy that must power our future, with nearly 10,000 times the current global power consumption striking the earth in the form of sunlight. However, current solar panels which convert light into electricity are too expensive and too inefficient to favorably compete with fossil fuel energy sources. This has spurred calls for the development of breakthrough photovoltaic technologies which diverge from traditional silicon (Si) wafer-based devices.

Semiconductor nanocrystals (NCs) or quantum dots hold particular promise for solar cells for several reasons. Light absorption in NCs is a function of the NC size, so that multi-junction solar cells that absorb across the entire solar spectrum can be fabricated, in principle, using a single material. A new physical process known as multiple-exciton generation has been observed in NCs [1], and this process should reduce thermal losses in photovoltaics. Finally, colloidal NCs can be processed using many of the fast and inexpensive techniques used in the printing industry, allowing for significant solar cell manufacturing cost reductions.

Our research aims to synthesize high-quality semiconductor NCs, deposit thin layers or films of these NCs, and fabricate solar cells using the films. A plasma process has been developed at the University of Minnesota to synthesize Si NCs using silane (SiH_4) gas [2]. Several techniques have been developed to form thin films of Si NCs, and we have demonstrated working solar cells in which Si NCs are used in conjunction with a polymer [3]. Many questions worthy of investigation have surfaced during this research, one of which is being studied in the Nozaki group at Tokyo Institute of Technology. SiH_4 produces Si NCs with H-terminated surfaces, and while it is known that the surfaces of NCs often dominate their behavior, other surface chemistries have yet to be explored. Interestingly, using precursors besides SiH_4—and in doing so, producing NCs with alternative surfaces—is not just an option in Japan, but a near necessity. After a SiH_4 explosion at Osaka University in 1991 killed two students, the Japanese government passed laws for reactive gases that are so stringent that the equipment requirements are out of reach for most academic researchers [4]. Consequently, the Nozaki group synthesizes Si NCs from silicon tetrachloride ($SiCl_4$), and the properties of these NCs are under investigation.

[1] R.D. Schaller and V.I. Klimov, *Phys. Rev. Lett.* **92**, 186601 (2004).

[2] L. Mangolini, E. Thimsen, and U. Kortshagen, *Nano Lett.* **5**, 655 (2005).

[3] C.-Y. Liu, Z. Holman, and U. Kortshagen, *Nano Lett.* **9**, 449 (2009).

[4] T. Hirano, *J. Loss Prevent Proc.* **17**, 29 (2004).

7. Research implementation and results under the program

Title of your research plan: Plasma synthesis of silicon nanocrystals for solar cells

Description of the research activities: Silicon nanocrystals (Si NCs) were synthesized in a nonthermal plasma using silicon tetrachloride ($SiCl_4$) vapor and hydrogen (H_2) gas as precursors, and argon (Ar) as a background gas. The gases were passed through a 15 mm diameter quartz tube maintained at low pressure, and very-high-frequency (144 MHz) power applied to two ring electrodes wrapped around the tube sustained a plasma. In the plasma, $SiCl_4$ and H_2 were decomposed into reactive species which nucleated into nanometer-size particles. The NCs were collected on a mesh as powder or deposited onto substrates for analysis. A wide range of plasma pressures (1–20 Torr), plasma powers (5–100 W), and gas flow rates ($SiCl_4$: 0.5–20 sccm, H_2: 10–300 sccm, Ar: 0–500 sccm) were explored.

For each set of conditions, the NC crystallinity, surface chemistry, and optical properties were studied with Raman spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, and photoluminescence measurements. In select cases, the NC size and shape were examined using X-ray diffraction (XRD) and transmission electron microscopy (TEM). Ideally, conditions would be found that produce crystalline NCs of uniform size that are resistant to oxidation. Electron transport is superior in crystalline particles than in their unordered, amorphous brethren, and oxidation turns semiconducting Si into an insulator. It is also imperative that the mean NC size be easily adjustable, as their size-tunable properties are one reason NCs are exciting for solar cells.

We successfully synthesized Si NCs with diameters of approximately 3 nm, shown in the TEM image of Fig. 1a. The NCs are roughly spherical and have a narrow size distribution, and lattice fringes are visible. Raman spectroscopy confirmed that the NCs are highly crystalline, and XRD indicated that the crystal structure was diamond cubic, as expected. We found that the NC mean diameter can be varied from 2–5 nm via the residence time in the plasma, which was changed with either the pressure or total gas flow rate. Many samples exhibited strong photoluminescence, and the emission color changed with NC size (Fig. 1b). This indicates that the absorption is also tunable, which is important for photovoltaic devices. Unfortunately, NCs were found to oxidize instantaneously upon air exposure, and this problem plagued our work all summer. We hypothesize that Cl on the surfaces of the NCs reacts rapidly with moisture, and that steps will need to be taken to either remove the Cl or work in an air-free environment.

Surface Cl also seems to have some beneficial characteristics, however, as we were able to form relatively stable colloids with these NCs, and this has been a challenge with Si NCs synthesized from SiH_4. Acetonitrile (a polar solvent) was added to Si NC powder and sonicated, and the resulting “ink” was used to spin NC films—an important step in processing devices. We also employed a second, solution-free technique to deposit films, in which the NCs were accelerated by a gas jet and impacted directly onto substrates. This yielded uniform films, in concordance with findings in my home laboratory at the University of Minnesota. Future work must strive to minimize or eliminate oxidation, perhaps with the use of a glove box, and then revisit film formation and device fabrication. We suggest that efforts concentrate on Si NC colloids, as this is an opportunity that may be unique to NCs with Cl-terminated surfaces.

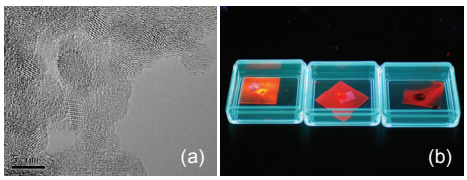


Figure 1. (a) High-resolution TEM image of 3 nm Si NCs and (b) Si NCs of various sizes glowing red and orange under ultraviolet illumination.

RESEARCH REPORT

1. Name: Raffi Khatchadourian （ID No.: SP10024）

2. Current affiliation:

Ohio State University

3. Research fields and specialties:

Engineering Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Hidehiko Masuhara

6. Description of your current research

My current research deals with issues related to evolving the source code of large and complex software systems. For my JSPS summer project, Mr. Masuhara and I have specifically focused on software evolution issues for programs written in Aspect-Oriented programming languages. Aspect-Oriented programming languages help software developers encapsulate source code that would normally be scattered and tangled throughout many software modules due to the nature of the software's requirements. Such languages facilitate so-called localized reasoning of programs as developers need only to look at a single location of the software system to understand code that affects many parts of the system. This kind of reasoning allows developers to easily change code that, for example, enforces systemwide policies in a single location. On the same note, developers can reason about the core functionality of their systems without concerning themselves with code that affects the entire system.

Although building software systems using an Aspect-Oriented programming language can be beneficial to developers in many ways, such systems have potential for new problems unique to these languages. A key construct that allows code to be situated in a single location but affect many system modules is a query-like expression called a *pointcut*. Pointcuts specify well-defined locations in the execution of the program where the code is to be executed. However, as the source code changes and as new functionality is added to the system, pointcuts may become invalidated. That is, they may fail to capture or inadvertently capture new places in the program's execution. Worse, these errors may go silently undetected in large and complex software systems. The result is that the software product may not function correctly, and the root of the problem may be difficult to discover.

Dr. Masuhara and I have created an approach that detects pointcuts that may have become invalidated as software changes. These possibly invalidated pointcuts are subsequently

presented to the developer. Along with the pointcut, we associate a degree of confidence, called the *change confidence,* that we have in the pointcut becoming invalidated given a particular change to the program. Pointcuts with a high change confidence value are presented in the programer's development environment with more emphasis than pointcuts with a lower change confidence value. This ensures that the developer is only alerted when there is a high probability of the pointcut being invalidated. The hope is that our approach will enable developers to discover problematic pointcuts *early* in the development process so that they may be fixed before causing the software to malfunction. We are in the process of evaluating our approach, as well as improving its performance.

7. Research implementation and results under the program

Title of your research plan:

Fraglight: Shedding Light on Broken Pointcuts using Structural Commonality

Description of the research activities:

Under the program, we have completed a prototype implementation of a tool that realizes our approach. It works as a so-called plug-in to a popular integrated developer's environment (programmers' workbench, software that helps developers write programs). We have tested our approach against several cases, as well as devised ways to improve its performance. We have also designed a thorough evaluation process to assess the usefulness of our tool in real-world situations. This entailed collecting historical data pertaining to how developers change Aspect-Oriented software from a variety of sources. Particularly, we collected and analyzed data that suggests which program changes lead to invalidated pointcuts in real-world software. Work in underway to apply our approach to this historical data to determine how helpful our tool would have been in these situations. These activities are critical in achieving wide acceptance of our tool, and ultimately helping developers evolve software written in Aspect-Oriented programming languages.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

As can be seen in the previous sections, Mr. Khatchadourian have successfully worked on a substantial part of his PhD research. It was great that discussions between him and myself during his stay brought many ideas, which we will be able to collaborate further.

RESEARCH REPORT

1. Name: Daniel Kiracofe （ID No.: SP10025 ）

2. Current affiliation:
School of Mechanical Engineering and Birck Nanotechnology Center,
Purdue University

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Kyoto University

5. Host researcher: Hirofumi Yamada

6. Description of your current research

The research for my thesis is focused around Atomic Force Microscopy (AFM). The AFM is a technique for obtaining images of very small structures. In fact, it is able to take pictures of individual atoms and molecules. In addition to taking pictures of samples, researchers can also use it to determine material properties such as harder or soft (i.e. how the sample "feels" in addition to what it looks like). For biological samples, AFM is particularly attractive to researchers because it can take pictures of samples while they are in their native environments (e.g. in water or liquid). My research activities involve better understanding and interpretation of current AFM techniques and development of improved techniques, especially for AFM in liquids.

7. Research implementation and results under the program

Title of your research plan:

My original proposal was titled "Using Non-linear Dynamics to Improve Compositional Contrast in High-Resolution Atomic Force Microscopy in Liquids ". However, due circumstances beyond our control, this project could not be completed. Instead, I completed a different research project, titled, "Optimization of photothermal excitation efficiency: effect of cross section"

Description of the research activities:

Photothermal excitation is a means of actuating microscale structures (such as vibrating cantilever beams for atomic force microscopy). However, photothermal efficiency is low, which means a large amount of laser power is required for a given mechanical response. The high powered laser may cause local heating effects, or damage sensitive samples. We have shown that by simply changing from a probe with a rectangular cross section to one with a trapezoidal cross section, the photothermal efficiency can be increased by more than a factor of ten. That is, we can produce the same mechanical vibration with one-tenth the laser power. This effect is demonstrated experimentally for a variety of situations (e.g. in air and in water). We have used computer simulations to explain the results. This result will allow researchers to better understand and use the photothermal excitation method in a larger variety of experiments.

8. Please add your comments (if any):

Although the original research project could not be completed, the new research project was very successful. We plan to submit this work to Review of Scientific Instruments shortly after my departure from Japan.

RESEARCH REPORT

1. Name: Ryan William Kurkul （ID No.: SP10026 ）

2. Current affiliation: University of Michigan

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Nagoya University

5. Host researcher: Professor Akihiro Sasoh

6. Description of your current research

The research that I conducted was on laser propulsion. Specifically, using laser propulsion as a means to clean up space debris in near Earth orbit. The type of laser propulsion that we investigated was laser ablation propulsion. In laser ablation propulsion, a pulsed laser is fired at a piece of material. The laser energy causes melting and vaporization of the material. At high power levels such as the ones that we are operating at, the vaporization of the ablative material causes a plasma plume to be generated. As this high pressure plume expands outward, it presses against the ablative material surface and thus generates thrust.

Space debris in low Earth orbit is an increasingly dangerous problem. Currently, there are an estimated 600,000 objects with a diameter larger than 1 cm in orbit. Collisions between these objects and satellites can result in catastrophic damage. Another concern is a state called Kessler Syndrome in which a critical density of space debris is reached, and collisions between these debris cause a runaway reaction that generates debris faster than it naturally decays. Obviously, action must be taken to actively reduce the amount of space debris, and laser ablation propulsion is one option. In eventual practical applications, a laser would be placed on an orbiting satellite and would track nearby space debris. By ablating the debris using the laser, the debris' orbital trajectory could be changed in such a way as to cause it to enter and burn up in Earth's atmosphere.

7. Research implementation and results under the program

Title of your research plan:

High Frequency Laser Ablation Propulsion

Description of the research activities:

The purpose of my research at Nagoya University over the summer was to characterize the thrust performance of a wide variety of common space borne materials ablated using a high frequency (10 KHz), YLF solid state laser. The experimental setup was relatively simple. A small piece of the target material (typically a 50 mm x 50 mm square) was hung from a free-swinging pendulum. The laser was fired at the target material and, if ablation occurred, the resulting thrust would cause the pendulum to deflect and begin to oscillate. The pendulum was connected to an Differential Transformer (DT), which outputted the target's linear position as a voltage signal. Though the DT only measures linear displacement, and the pendulum is in circular motion, the angular displacement of the pendulum is so small (on the order of 1º) that the two are essentially equal. A calibration curve for the pendulum setup was obtained using an impulse hammer. By striking the pendulum and measuring the maximum displacement, and measuring impulse applied, you can build a linear relationship between the input thrust and the output DT voltage. The optical setup of the experiment was also simple, utilizing only two mirrors. No lenses were used to focus the beam in order to better simulate the likely conditions of a future mission, during which targets would be at a wide variety of different distances necessitating a wide variety of different lens focal lengths. Because the adaptive optics necessary for such a system would be extremely complex, we thought it better to run the tests using the raw laser beam. Thrust was measured over a range of 1000-5000 laser pulses for each different material. Pulse numbers larger than 5000 were not possible for our setup as you only want ablation to occur during the first quarter (the "upswing") of the pendulum's period. Ablation pulses after that will serve only to dampen the motion of the pendulum. Originally we planned to carry out the tests inside a vacuum chamber, but complications left the vacuum chamber unusable for the majority of my stay. Therefore, these experiments were conducted in atmosphere.

The materials that we ran tests on were acrylic polymer, Teflon, Lexan, granite, and polyoxymethylene (POM). We were unable to achieve ablation in the Teflon, Lexan, granite and POM, though we were able to achieve melting with the granite. Ablation occurred in the case of the acrylic at pulse numbers above 1000. The resulting thrust data we obtained from the acrylic tests proved to be interesting in several ways. First, it had a clear maximum number of pulses after which the DT voltage displacement would no longer increase. This could be explained by the fact that laser pulses after one quarter of the period would only serve to dampen the pendulum motion. The other interesting result was the generation of so called "negative thrust". While the laser was turned on, the displacement of the pendulum was measured to be small and positive, or away from the laser. Once the laser was turned off, there was a large spike in the displacement (much larger than the initial positive displacement) in the negative direction toward the laser. Since the laser was turned off at this point, there has to be some other mechanism causing this motion in the pendulum. We are not sure exactly what this mechanism is at this point, but it is possibly caused by a local pressure change near the ablation target due to convection heating. This phenomenon will be investigated further in the future in order to better understand what is going on. The test will also be conducted under vacuum so that the thrust results will not be distorted by these atmospheric effects. I was happy to lay the groundwork for what will no doubt be a very fruitful research project in the future.

RESEARCH REPORT

1. Name: Paul Gregory Larson （ID No.: SP10027）

2. Current affiliation: The Ohio State university

3. Research fields and specialties:

Biological Sciences

4. Host institution: Hokkaido University, Hakodate

5. Host researcher: Satoshi Wada

6. Description of your current research

My research focuses on the evolution of external brooding behavior in sea anemones. The backbone of my project is a phylogenetic analysis of the genus *Epiactis*, closely related genera, and other externally brooding anemones. The species *Cnidopus japonicus* is an externally brooding sea anemone that is thought to be closely related to *Epiactis*, and preliminary data is consistent with this hypothesis. Since brooding offspring precludes larval dispersal (the main dispersal mode for "sessile" animals), it can affect the population structure of the species. Population structure and heterozygosity have already been investigated in the ecologically similar *Epiactis prolifera* with results showing extremely high levels of inbreeding. It is possible that the main difference between the two species, reproductive cycle, will be manifested in the population structure of *C. japonicus*. *E. prolifera* reproduces continuously, while *C. japonicus* only does so in the fall. This increased degree of reproductive coordination could facilitate outcrossing for *C. japonicus*. Whether or not *C. japonicus* outcrosses or self-fertilizes at all is still unknown. I am collecting samples of *C. japonicus* from eight localities for population genetic analysis, and brooding individuals and their offspring to determine reproductive mode (selfing vs. outcrossing).

7. Research implementation and results under the program

Title of your research plan:

Genetic diversity, population structure, and reproductive mode in brooding anemones (Cnidaria: Anthozoa).

Description of the research activities:

Research activities were limited to field observation and the collection of whole animals and tissue samples. Samples were collected from 8 localities; predominantly my study species, but at least three additional species were collected in small numbers when encountered. Due to the difficulty of transporting raw DNA overseas, no DNA extraction was done in Japan. Tissues have been sent to my home institution for processing and data collection. Samples for karyotyping (chromosomal study) have been collected, prepared, and preserved for analysis at my home institution.

8. Please add your comments (if any):

I would like to thank JSPS for offering the program, and my host researcher, Dr. Wada for his exceedingly generous hospitality, support, and assistance.

9. Advisor's remarks (if any):

I am really grateful to Paul for providing us a window of opportunity to learn our related study subjects, biology of sea anemone and English communication.

RESEARCH REPORT

1. Name: Amanda M. Leister （ID No.: SP10028）

2. Current affiliation: Purdue University

3. Research fields and specialties:

Social Sciences, Agricultural Sciences

4. Host institution: Nagoya City University

5. Host researcher: Dr. Yuta Hoshino, and Dr. Ken Itakura

6. Description of your current research

My current research uses a combination of Econometric and Computable General Equilibrium (CGE) analysis to evaluate the potential effects of the proposed Special Safeguard Mechanism (SSM), which is a controversial feature of the current Draft Modalities for Agriculture in the WTO negotiations under the Doha Development Agenda. The SSM under discussion (WTO 2008a) is broadly based on the special agricultural safeguard (GATT 1994, p43), and would allow developing country members of the WTO to levy additional safeguard tariffs on imports under certain conditions in the market. The SSM includes two triggers, one based on the price of imports and one on the volume of imports. The proposed SSM is complex, controversial, and expected to be a critical point of discussion when WTO negotiations formally resume. My research investigates the specific implications of the SSM to inform governments and policy makers of the effects that the policy may have on the global economy. Specifically, my work investigates the history of safeguards within the WTO and the specific design of the SSM, econometrically estimates the frequency and duration of potential SSM invocation, and quantifies the potential effects of the SSM on the global wheat market by using a CGE Modeling Framework.

7. Research implementation and results under the program

Title of your research plan: Potential Implications of the Special Safeguard Mechanism in the WTO Negotiations under the Doha Development Agenda

Description of the research activities: This research assess the global implications of the proposed price- and quantity-based SSMs for a key agricultural staple, wheat, taking into account not just its direct impacts on import prices but also the resulting impacts on world prices when the measure is used by many developing countries at the same time. This research quantifies the welfare implications of implementing the mean price- and quantity-based SSM duties as estimated by Hertel, Martin and Leister (2010).

Results indicate that both the price- and quantity-based safeguards decrease global welfare. Agricultural producers in developing countries are vulnerable to shocks both domestically, particularly from weather-related shocks to output, and from shocks to international markets. However, it must be remembered that consumers in developing countries are also particularly vulnerable to shocks to food prices, given that the poorest people spend as much as three quarters of their incomes on food. Policy measures that raise the price of food by imposing an import duty may help farmers whose incomes have fallen due to a harvest shortfall, but will do so at the expense of net buyers of food, including many farmers, as they will be hurt by the increase in the price of food. If farmers are isolated from world markets by poor infrastructure and communications, an even worse possibility emerges in which protection raises the cost of food to poor consumers linked to world markets, while providing little or no benefit to producers in more isolated locations. This highlights the need for careful analysis of the welfare implications of special safeguards taking into account the potential differentiation between imported and domestic goods. It is important to consider the implications of the measure for global markets since the SSM would apply to all developing countries, which now account for two-thirds of the value of world agricultural production. Countries are allowed to use just one of the price- and quantity-based measures in any given year. Therefore, this work assesses the price- and quantity-based SSM separately.

The welfare implications of the price- and quantity-based SSM duties differ for developed and developing countries and regions. Overall, the price-based SSM tends to favor developed country regions at the expense of welfare losses experienced by developing countries and regions. This results from the fact that the price-based SSM discriminates against low value exporters, which are typically developing countries. The opposite is true of the quantity-based SSM; developed countries and regions would generally experience significant welfare losses, while six of nine developing country regions would experience a welfare gain. The overall effect of implementing either the price- or quantity-based SSM is to decrease global welfare and the quantity-based SSM is significantly more damaging when compared to the price-based SSM.

8. Please add your comments (if any): My experience as an NSF-EAPSI Fellow and JSPS Summer Program Participant has been invaluable. I have received outstanding support from NCU, my formal host Dr. Yuta Hoshino and my daily host Dr. Ken Itakura. I thoroughly enjoyed my stay in Japan and I had all the resources I needed to work effectively on my research. I am extremely grateful to NSF and JSPS for providing this outstanding opportunity and would like to express my utmost appreciation to Dr. Itakura for going above and beyond what was required to guide and facilitate my research experience.

9. Advisor's remarks (if any): It has been our great pleasure to host Ms. Leister at the Faculty of Economics, Nagoya City University for the NSF-EAPSI and JSPS Summer Program. As Ms. Leister has been making progress toward her academic research objective, she has also actively participated in educational events; giving the guest lectures at undergraduate classes, and presenting her research at the faculty seminar. Students and the staff members are grateful to Ms. Leister for her cheerful friendship, and we wish her the bright future.

RESEARCH REPORT

1. Name: Kingson Man (ID No.: SP10029)

2. Current affiliation: University of Southern California

3. Research fields and specialties:
Biological Sciences

4. Host institution: National Institute for Physiological Sciences

5. Host researcher: Ryusuke KAKIGI

6. Description of your current research

My current research focuses on the interaction between the brain and the body. I am interested in what occurs when we have a feeling in the body, and what makes that feeling conscious. For my graduate work I am investigating the effects of general anesthetics on the brain, and how they lead to a loss of consciousness. I would like to answer the following question: why is it that sensory stimulation, even very painful stimulation, is no longer felt by the "sleeping" patient who is under general anesthesia?

To answer this question I am using a range of techniques, including fMRI, EEG, and MEG brain scanning. These methods of brain scanning can safely open a window into the living human brain, and each method has particular advantages and disadvantages. At USC I have used fMRI and EEG and at NIPS I am able to gain experience with MEG. fMRI can estimate brain activity from blood flow, and allows precise location information throughout the brain albeit on a slow timescale. MEG detects the ultrafast changes in magnetic waves on the surface of the skull, but cannot precisely determine where in the brain was the activity that generated those changes. By designing experiments to suit each method's strengths and weaknesses and then combining the information, one can pinpoint where and when brain activity occurs during a phenomenon of interest - for example, the application of a painful stimulus to a test subject.

By understanding how the brain processes pain stimuli and how different states of consciousness contribute to that processing, we might learn how to consciously control the experience of pain.

7. Research implementation and results under the program

Title of your research plan:
Pain attenuation during Zazen meditation: a MEG study

Description of the research activities:

This study was designed to take full advantage of the location afforded by the NSF-JSPS summer research program. We were interested in the effect of Zazen mindfulness meditation on pain processing, and how meditation may attenuate the experience of pain. We recruited a Zen Buddhist monk with over 15 years of experience as an experimental subject, as well as several control subjects with no prior meditation experience.

We used an MEG scanner to detect neural activity during pain stimulation. Pain stimuli were electrical currents delivered to the hand using intra-epidermal needle electrodes, which selectively stimulate the pain-sensing a-delta nerve fibers. Our preliminary results show strikingly different neural responses to pain during the presence vs. the absence of meditation. Interestingly, while both the control subjects and the monk reported feeling less pain during meditation, their neural responses were markedly different. While meditating, controls showed a reduced response around 100 ms after stimulation in the primary sensory areas, however the monk showed reduced responses later (300 ms) and higher up the processing stream (in the frontal and anterior cingulate cortices).

8. Please add your comments (if any):

At the outset we had anticipated some difficulty in recruiting a Zen monk to be our subject. But after joining an open meditation session (and suffering through the attendant leg pains in the lotus position!), we were very excited to find a monk who was indeed interested. He proved to be inquisitive about our work and was an extremely motivated and cooperative subject. Following the experiment we gave the monk a brief tour of the facility and explained the initial findings from his scan. Our interactions with the monk were carried out with a sense of mutual inquiry and respect, and might serve as a model for scientific engagement with the public at large.

9. Advisor's remarks (if any):

I have reported the effect of meditation on pain in a Yoga Master in 2007. He said he did not feel pain at all during meditation, and his fMRI findings while receiving pain between non-meditation and meditation were very different. Mr. Man was impressed by this paper and he determined to visit my department to confirm it and add new findings. He did the similar study in a monk and made very interesting findings. I would like to congratulate his fruitful study and am very delighted to work with Mr. Man who was a very clever and honest person for these two months.

RESEARCH REPORT

1. Name: Emily Chan Marquez （ID No.: SP10030 ）

2. Current affiliation: Boston University, Boston, MA USA

3. Research fields and specialties:

Biological Sciences

4. Host institution: Tohoku University

5. Host researcher: Dr. Makoto Osada

6. Description of your current research

The aim for this project was to complete the sequence of a partial estrogen receptor (ER) cDNA in the Japanese scallop, *Patinopecten yessoensis.* The partial ER is similar to the molluscan ER2. The existing partial scallop ER cDNA sequence, obtained by previous students in the Osada laboratory, was 823 nucleotides long, translating into a 274 amino acid long predicted protein that includes most of the DNA-binding domain and the ligand-binding domain, both conserved domains that are present in estrogen receptors.

In order to extend the cDNA sequence, I used a technique called RACE (Rapid Amplification of cDNA Ends) to clone PCR products and send them off for sequencing. RACE utilizes one gene-specific primer, based on an existing nucleotide sequence, and one generic primer that binds to motifs that exist on the distal end of the gene of interest. I was already familiar with the methodology involved, but had the opportunity to learn new protocols using products other than the ones in use in my current laboratory.

7. Research implementation and results under the program

Title of your research plan: Cloning of estrogen receptor (ER) in the Japanese scallop, *Patinopectin yessoensis,* and expression profiles of ER

Description of the research activities:

I trained an undergraduate student, Ms. Yurika Otoki, who is applying for the Master's course in Dr. Osada's laboratory. I taught Ms. Otoki the techniques for molecular cloning, as she will continue her research on cloning the estrogen receptors in a different species of bivalve.

In the work to extend the scallop ER cDNA sequence, I used the Invitrogen Generacer RACE kit (purchased with JSPS research grant) and primers of my own design based from the existing partial cDNA sequence. I also learned new protocols for RNA extraction and RACE for the kits that the laboratory currently has in use.

Due to difficulties in extending the scallop ER sequence, cloning scallop ER has been an ongoing project in this laboratory. After unsuccessful attempts using PCR products obtained from ovarian and testicular tissue, I obtained a 3' RACE PCR product using cDNA obtained from gill tissue, adding approximately 180 nucleotides. The extended partial scallop ER including the 3' sequence that I obtained, is 1003 nucleotides long, translating to 333 amino acids. This partial ER cDNA sequence includes the entire ligand-binding domain and stop codon, but not the poly A tail.

In my last week here, I am working on cloning more PCR products to extend the scallop ER in the 5' and 3' directions. I designed a new primer from the extended 3' end of the scallop ER.

Lastly, I worked on a JSPS postdoctoral fellowship grant, which will be submitted for review in September.

8. Please add your comments (if any):

I particularly enjoyed working with Ms. Otoki, and highly recommend other JSPS students mentor an undergraduate student if possible during their fellowship.

9. Advisor's remarks (if any):

Ms. Emily Marquez attempted to extend the scallop ER sequence, which was a difficult and ongoing project in my laboratory so far. She successfully extended it to 3' end and mentored well the undergraduate student who wishes to be a molecular endocrinologist. She greatly stimulated Japanese students of my laboratory in the experiments, seminar and daily activities exchanging scientific knowledge and culture. I believe that she will be a good molecular endocrinologist and a mentor for students.

RESEARCH REPORT

1. Name: Bailey D. McKay （ID No.: SP10031）

2. Current affiliation: University of Minnesota

3. Research fields and specialties:

Biological Sciences

4. Host institution: National Museum of Nature and Science

5. Host researcher: Dr. Isao Nishiumi

6. Description of your current research

A central goal of modern science is to explain biological diversity: where it comes from and how it evolves. My current research uses a multilocus, coalescent-based approach to survey the evolutionary histories of four co-distributed bird species: Brown-eared Bulbul (*Microscelis amaurotis*), Varied Tit (*Poecile varius*), Narcissus Flycatcher (*Ficedula narcissina*), and Japanese White-eye (*Zosterops japonicus*). I am interested in when these species colonized the islands of East Asia and subsequently diversified: was it during the Pliocene or during the Pleistocene? Was their colonization associated with landbridges that periodically connected Japan and other East Asian islands to the mainland? I also want to know how these species colonized the East Asian islands: did they colonize from south to north or from north to south? Are the histories of these co-distributed species concordant? A secondary objective involves basic systematics. Compared to North America and Europe, East Asia is understudied from an avian systematic perspective. Many have argued that the avifauna is “overlumped” compared to other regions, meaning there are actually more species in East Asia than current species checklists would indicate. Thus another major goal of this research is to combine molecular and morphological data to assess whether each of the four target species actually consist of multiple species. This work is extremely important in light of the current extinction crisis—the proper allocation of conservation resources depends critically on knowing how many species occupy a region. This study has important bearings on understanding the major geologic periods that where important in the evolution of present-day biological diversity. In a conservation context, this type of study is critical for defining areas of biological endemism and providing a historical context for the conservation and management of species.

7. Research implementation and results under the program

So far results are very preliminary. We know from preliminary assessments of mtDNA that all of four of our target species have deep (>3%) intra-specific divergences. This indicates that there is something biologically interesting going on with all of our target species. It also suggests that each target species might be a complex of more than one species. To know this for sure, we will need to collect more DNA as well as analyze morphological data. Using samples obtained this summer, I will continue to collect nuclear sequence data this fall in my home lab. Once we have all of our data, we will begin to generate stronger results later this year. This summer, I finished collecting morphological measurement data. I measured over 400 specimens (see below), but we have not yet analyzed these data. I will also do that this fall. This summer was extremely productive and we collected a lot of data that will serve as the foundation for many future papers.

Title of your research plan: Comparative statistical phylogeography of Japanese birds

Description of the research activities:

The first goal of my summer research was to conduct fieldwork in the Ryukyu Islands. I spent one week with my host, Dr. Nishiumi, in Kume Island before the program started. We collected many samples that will be useful in our research. The second goal was to organize samples that Dr. Nishiumi had already obtained. I organized and aliquoted approximately 650 samples that we will use in our research. The next goal was to collect preliminary sequence data. I sequenced over 1,000 base pairs from 130 individuals of Brown-eared Bulbul. I also tested 20 different nuclear primers on all four of my study species. Finally, I needed to collect morphological data from my study species. In total, I collected measurement data and took photographs of over 400 specimens. This included specimens from my host museum, the National Museum of Nature and Science, as well as a special trip to the Yamashina Institute of Ornithology. In all, I think my host and I had an extremely productive summer and we accomplished a tremendous amount.

8. Please add your comments (if any):

I would like to say that I had an incredible experience. My host lab was a very productive working environment. We got a lot of work done, and I am so happy about what we accomplished. This was all made possible through the efforts of my host researcher, Dr. Isao Nishiumi. He did an outstanding job. He worked very hard to make sure I had everything I needed. If I ask for something, he would drop whatever he was doing and take care of my request immediately. I know he is a very busy man, and I am very appreciative of the time he gave me. Dr. Nishiumi made it easy for me to conduct high-level research. His students, particularly Sayaka and Yasuko were also extremely helpful and gave freely of their time. I had a really great experience, and I expect this summer to result in a very productive future collaboration.

9. Advisor's remarks (if any):

Bailey is a very honest, highly communicative and active young researcher. His visit to Japan stimulated my students and me very much and we really enjoyed research with him. We exchange much experience and knowledge. Although we stand on different species concepts, Biological and Phylogenetic Species Concepts, his seminar was a very good opportunity, not only for me but also for many Japanese ornithologists in the Kanto area, to understand an alternative opinion more deeply and to warm up somewhat to it through his detailed and courteous explanations, which we had only previously been exposed to through books and papers. I believe his visit will become a starting point to continue cooperative research on the state and origin of the biodiversity of Asian birds.

RESEARCH REPORT

1. Name: Arthur Millius (ID No.: SP10032)

2. Current affiliation: University of California – San Francisco

3. Research fields and specialties:

Biological Sciences

4. Host institution: Tohoku University Graduate School of Life Sciences

5. Host researcher: Naoki Watanabe MD. PhD.

6. Description of your current research

The goal of my work is to understand the biophysical mechanisms that control polarized cell movement. Many cells move in response to external cues, and this directed movement occurs during development, axon guidance, wound healing, tumor progression, and the immune response. Cells must interpret external signals through signal transduction networks and engage actin polymerization machinery to generate mechanical force for membrane protrusion at the leading edge of the cell. Our work focuses specifically on the interface between the cell's signaling guidance system and actin nucleation machinery. In particular, the multiprotein WAVE (also known as SCAR or WASF) complex initiates actin filament nucleation through the Arp2/3 complex, but only when stimulated by the proper combination of upstream signaling inputs, including the GTPase Rac and the phospholipid PIP_3. Deletion of the WAVE complex is required for movement and morphogenesis of cells in C. elegans, Drosophila, and mice, but, surprisingly, also abrogates the activity of Rac. These observations reveal the critical nature of the WAVE complex and related proteins as nodes both controlling the actin cytoskeleton and feeding back on the signaling network. Previously, we have elucidated some mechanisms by which the WAVE complex contributes to cell polarization and we have begun to analyze the WAVE complex biochemically. My summer project focused on analyzing the behavior of the WAVE complex and Arp2/3 complex in living cells at single molecule resolution.

7. Research implementation and results under the program

Title of your research plan: Single molecule analysis of major cytoskeletal proteins

Description of the research activities:

Cell polarization and protrusion highly correlate with the activity of two major cytoskeletal regulators in cells - the WAVE complex and the Arp2/3 complex. We analyzed the behavior of single Arp2/3 and WAVE complex molecules in cells. Understanding biophysical behaviors of these signaling molecules revealed new insights into how emergent protein properties underscore directed cell migration.

For instance, we compared the lifetime and speed during retrograde flow of the WAVE complex to the Arp2/3 complex. Retrograde flow occurs when a cell builds a protrusion and undergoes rapid actin polymerization at the cell's periphery. The Arp2/3 and WAVE complexes orchestrate the building of actin monomers into a meshwork of polymers. This meshwork is pushed toward the center of the cell in a phenomenon called retrograde flow. Interestingly, the lifetime of the WAVE complex in this flow is significantly shorter than the Arp2/3 complex and actin, which suggests that the WAVE complex is associated with the network in a fundamentally different manner. In making these measurements, we stumbled upon a surprising finding, which only could have occurred because of the JSPS summer program. I examined cells from the Watanabe lab using a technique more commonly used in the Weiner lab – TIRF microscopy. This technique enabled me to visualize molecules with higher temporal dynamics and spatial resolution than previously observed in the Watanabe lab. The assumption in the cytoskeleton field was that most actin assembly molecules spend the majority of their time inactive in the cytosol and transiently bounce on and off the cell membrane where they occasionally are activated and incorporated in the actin meshwork. In contrast, I observed that both the Arp2/3 and WAVE complex spend significant time on the membrane laterally diffusing *before* activation and incorporation into the actin network. This revises our understanding of how cytoskeletal molecules are activated during protrusion and challenges the notion that actin nucleation springs from a common cytosolic pool. We speculate that actin nucleation-promoting factors like the WAVE complex actively recruit the Arp2/3 complex to the membrane by binding to more stably associated molecules like Rac-GTP or anionic phospholipids before nucleation. We are currently designing in vitro experiments to directly test this possibility.

8. Please add your comments (if any): In my research proposal I had four goals: XTC cell and image analysis training, visualization of WAVE complex single molecules in XTC cells, biochemistry experiments, and visits with other Japanese (non-host) researchers. I was able to accomplish all my objectives and more with the exception of the proposed biochemistry experiments, which were put on hold in favor of following up the exciting results in cells. I gave five talks at four different research institutions across Japan and had many enjoyable and scientifically productive conversations with my Japanese colleagues. Importantly, this unique collaboration enabled me to discover with my host the core of an exciting and novel finding. I was pleasantly immersed in Japanese language, culture and food and even learned to fish with my lab mates! Thank you JSPS and NSF for a richly rewarding summer!

9. Advisor's remarks (if any): I think highly of this program now. It was fortunate for me to have a student like Arthur who is highly motivated and already has a good experience in research. He is learning our single-molecule imaging quickly and getting very interesting results. This is similar to what I experienced during my posdoc in US and in my recent interdisciplinary collaboration supported by the HFSP grant. I hope that more young researchers become aware of this program and use it for their career development.

Naoki Watanabe

RESEARCH REPORT

1. Name: Jessica L. Montag （ID No.: SP10033 ）

2. Current affiliation: University of Wisconsin-Madison

3. Research fields and specialties:
Social Sciences

4. Host institution: Hiroshima University

5. Host researcher: Professor Hiromu Sakai

6. Description of your current research

The aims of my research are to examine sentence production and comprehension and the effects that these processes have on each other. This research differs from much of the other psycholinguistic research for two reasons. First, comprehension and production processes historically been studied independent of each other, though we expect there to be associations between the two processes. Specifically, a main hypothesis underlying the proposed research is that important characteristics of the comprehension process can be explained in terms of the language production process, which determines many properties of the utterances to be comprehended. By looking at these processes in parallel and examining the production and comprehension of similar structures we hope to gain a better understanding of both processes. Second, psycholinguistic research has typically focused on English. This is a problem for the field because each language creates confounds among potential factors such as word order, lexical properties and language typology so it may be unclear as to whether findings in English can be extended to other languages or to general linguistic processes. The goal of this research is to develop theories that extend beyond the idiosyncrasies of English and can account for production and comprehensions processes independent of the particular language being tested.

My research is a combination of comprehension and production studies, with the goal of developing an account of what sort of constraints on production lead speakers to make certain choices over others. I then show that this leads to reliable statistical distributions in the linguistic environment and that comprehension patterns are driven by individual's experience with these statistics in their environment. Cross-linguistic studies can provide unique insight because they allow us to look at cognitive constraints and enable us to control for language specific confounds like word order and typology. This is crucial to understanding the cognitive mechanisms behind language processes. Further, because our theory stresses the role of learning and experience, cross-linguistic domains provide an opportunity to examine how experience with different sorts of patterns may affect language behaviors. Cross-linguistic studies provide us with the opportunity to show that production and comprehension processes are driven by one's experience with their linguistic environment and identify what capabilities of the linguistic system, if any, can be attributed to innate human linguistic abilities.

7. Research implementation and results under the program

Title of your research plan:

Production and Comprehension of Complex Sentences in Japanese

Description of the research activities:

My main goal this summer was to collect data in a psycholinguistic experiment. This particular study was about human sentence production, and the factors that drive speakers to make certain choices over others when they are producing a sentence. Knowledge of what factors make a sentence more easy or difficult to produce and knowledge of the factors that speakers seem to weigh when producing a sentence can help us understand the organization and nature of the human language production architecture. I had speakers complete a picture description task that required them to produce different sentence types.

I coded both what sorts of sentences speakers produced, to gauge what factors speakers consider when making production choices as well as the time-course of these productions (e.g., time to start speaking, duration of pauses, duration of noun phrase) to gain insight into the planning and production processes. I have previously collected this data in English and found it to be very revealing of cognitive processes during language production and hoped that repeating this study in Japanese would further shed light on language-specific or typology specific features of the planning process and processes and mechanisms that might exist across languages. I completed data collection for this study and have begin the arduous coding process.

In addition to data collection, I have learned a number of eye-tracking data collection and data analysis techniques from colleagues in Japan. I am very interested in using this methodology in the future and have gained valuable skills this summer that will undoubtedly help me when I implement this methodology when I return to the University of Wisconsin-Madison. Further, I have plans to collaborate on an eye-tracking study with my host professor, Professor Sakai, and his lab. I will carry out data collection of English participants in the US while he and his lab will carry out data collection of Japanese participants in Japan. Eye-tracking studies tend to confound language-related gaze patterns with low-level scene perception gaze patterns so this cross-linguistic study attempts to tease apart the effects of both these processes.

Finally, I have made a number of valuable professional contacts in Japan. Though they may not have a direct influence on my career, it is invaluable to have other researchers know my name, know my academic perspective and perhaps be aware of the work I am doing so they will be more likely to search out my publications, cite my publications and be aware of the progress of my research as my career beings to take form. Of course, now that we have had to opportunity to meet once, we will be able to easily share research ideas and findings if we were ever to meet at a conference in the future.

RESEARCH REPORT

1. Name: Marion Moore (ID No.: SP10034)

2. Current affiliation: University of California, Davis

3. Research fields and specialties:
Mathematical and Physical Sciences

4. Host institution: Tokyo University of Agriculture and Technology

5. Host researcher: Hiroshi Goda

6. Description of your current research:

The objective of 3-dimensional geometric topology is to classify 3-manifolds and understand each homeomorphism type. By decomposing 3-manifolds into simple pieces along surfaces it is possible to analyze both the geometry and topology of 3-manifolds, as well as connections between the two. Classical examples of such decompositions are generalized Heegaard splittings, and Dehn surgery, each of which give important information. A generalized Heegaard splitting decomposes a 3-manifold into two (or more) compression bodies, while a Dehn surgery corresponds to a decomposition of a closed 3-manifold into a solid torus and a knot exterior.

Every closed 3-manifold can be realized by Dehn surgery on a link in the 3-sphere. For this reason, the study of Dehn surgery is fundamental to the classification of 3-manifolds. The study of exceptional Dehn surgeries and their relationship to Heegaard splittings is an active field.

My thesis establishes a new tool for the analysis of link complements, alpha-sloped generalized Heegaard splittings for 3-manifolds, a natural extension of classical generalized Heegaard splittings. My research plan aims to find relationships between both classical and alpha-sloped generalized Heegaard splittings of knot exteriors and of Dehn surgeries on the same knot exterior.

In an alpha-sloped generalized Heegaard splitting the decomposing surfaces have boundary components that have slope alpha on the boundary of M. Assigning a complexity to these decompositions thin position of M is the alpha-sloped decomposition of M with the lowest complexity over all slopes. This kind of decomposition gives an natural picture of M and allows the structure of the manifold to dictate the most natural slope(s) on the boundary. It also gives a means of comparison between decompositions of knot exteriors and Dehn surgeries.

7. Research implementation and results under the program

Title of your research plan: alpha-sloped Generalized Heegaard Splittings

Description of the research activities: Progress was made on several projects.

In Circle Valued Morse Theory for Knots and Links Goda introduced the concept of the *handle number of a link,* which is the minimum number of handles needed to make a sutured Heegaard splitting of the sutured manifold for a Seifert surface of the link, over all Seifert surfaces. Goda asked whether this number can be realized via an incompressible Seifert surface. Progress was made on answering this question in the affirmative for so called small knots.

Progress was also made in codifying a new class of knots, the generalized Berge knots of genus 3. Using the Seifert surgery network of Dreuelle, Miyazaki and Motegi I am working to prove that some of these knots have Seifert fibered surgeries that do not result from a genus 2 primitive/primitive presentation, nor a genus 2 primitive/Seifert presentation. This class of knots also shows promise for shedding light on the Berge conjecture, an important open conjecture in topology

8. Please add your comments (if any):

I would like to thank all of the mathematicians who I met at Tokyo University of Agriculture and Technology for the interesting and insightful conversations, as well as their hospitality. I would like to particularly thank Goda-sensei for his helpful insights on new directions for my research without which the above progress would not have been possible. I am also grateful for the opportunities he provided for me to visit other universities and to interact with top mathematicians in the field throughout the country.

9. Advisor's remarks (if any):

Dr. Moore gave talks not only Tokyo Univ. of Agri. & Tech. but also The University of Tokyo, Nihon Univ. and Nara Women's Univ. I attended the seminar at The University of Tokyo. It was well prepared and very good. In the research aspect, we discussed several times at my univ., and I could have fruitful times with her. The research is still in progress and will last after her return to USA. I am very glad to have been able to have her as our guest.

RESEARCH REPORT

1. Name: Alexander Mueller （ID No.: SP10035）

2. Current affiliation:

State University of New York College of Environmental Science and Forestry

3. Research fields and specialties:

Chemistry, Biological Sciences

4. Host institution: University of Hokkaido

5. Host researcher: Professor Seiichi Taguchi

6. Description of your current research

In Syracuse, our group studies the bacterial production of polyhydroxyalkanoates (PHAs) which are an environmentally friendly alternative to petroleum based plastics in that they are both carbon neutral and completely biodegradable. My work consists of genetically manipulating a PHA producing bacterial strain to make it grow and produce polymer more efficiently on glycerol, a waste product from biodiesel production from waste oils. On a day to day basis, my work consists of culturing bacteria, isolating and manipulating DNA, and monitoring various factors with both liquid and gas chromatography.

7. Research implementation and results under the program

Title of your research plan:

Improving the monomer-supplying function of FabH for polyhydroxyalkanoate production through site-specific mutagenesis

Description of the research activities:

Day to day work in Japan has been very similar to work back home, the biggest difference being longer hours, not too bad though. My project here has a different aim than the one back home as well. Here I was working on making the production of PHAs in E. coli, a bacterium that does not naturally produce polymer, more efficient. To do this I produced multiple mutant forms of a key enzyme.

8. Please add your comments (if any):

I really enjoyed this experience, my confidence in myself has been greatly increased From this summer.

RESEARCH REPORT

1. Name: Alija Bajro Mujic ID No.: SP10036

2. Current affiliation: Oregon State University
Department of Botany and Plant Pathology, Corvallis, Oregon, United States of America

3. Research fields and specialties:
Biological Sciences

4. Host institution: The National Museum of Nature and Science, Department of Botany, Tsukuba, Ibaraki-ken, Japan

5. Host researcher: Dr. Kentaro Hosaka

6. Description of your current research My research is developing a greater understanding of the unique ectomycorrhizal (EM) relationship shared by the genera *Rhizopogon* and *Pseudotsuga*. *Rhizopogon* (*Boletales, Basidiomycota*) is a large genus of EM fungi which form obligate mutualistic symbioses with trees in the family *Pinaceae* and form truffle-like fruitbodies underground. Within the genus *Rhizopogon* the subgenus *Villosuli* possesses an apparently monophyletic association with trees in the genus *Pseudotsuga*. Japan's native species of *Pseudotsuga* is *Pseudotsuga japonica* (Togasawara) and it is currently listed as "vulnerable" by the Red list of Threatened Plants of Japan. The *Rhizopogon* species associated with *P. japonica* are unknown. *Pseudotsuga menziesii* (Douglas Fir) is a native *Pseudotsuga* species of Western North America and provides many ecosystem services and interactions which link it with the stability and resilience of forests across it's range. A better knowledge of the evolutionary biology and phylogeography of the *Pseudotsuga-Rhizopogon* symbiosis will be useful in forest ecosystem conservation. The obligate nature of the *Pseudotsuga-Rhizopogon* symbiosis, its ecological significance and its monophyletic distribution within the genus *Rhizopogon* are all factors that formulate a model system for the study of the evolutionary biology of EM symbioses.

I have worked with Japanese mycologists in order to collect field specimens of *P. japonica* and its *Rhizopogon* symbionts. Phylogenetic analyses will be conducted upon DNA sequence data retrieved from these specimens in order to test the following research objectives:

Objective 1: Test the monophyly of the *Psuedotsuga-Rhizopogon* symbiosis within Rhizopogon.

Objective 2: Test the systematic and evolutionary hypotheses of *Pseudotsuga*.

Objective 3: Establish a comparative phylogeography of the *Rhizopogon-Pseudotsuga* host relationship.

7. Research implementation and results under the program

Title of your research plan: Systematics and Phylogeography of the *Rhizopogon-Pseudotsuga* Symbiosis

Description of the research activities:

Field Work: While in Japan I conducted field work in multiple *Pseudotsuga japonica* forests where I collected plant specimens, soil samples and searched for *Rhizopogon* fruitbodies and ectomycorrhizal (EM) root tips. *Pseudotsuga japonica* exists within fragmented populations confined to high elevations within Nara and Kochi Prefectures. Two sites in Kochi prefecture and one site in Nara prefecture were selected for sampling. Unfortunately, due to landslides, stands of *P. japonica* at one site in Kochi were inaccessible. Soil was collected using a soil coring tool and stored at 4

degrees Celcius until processing was possible. Plant specimens collected were pressed and prepared for drying within 12 hours of collection and plant tissue samples were immediately preserved in silica gel for future DNA extraction. Sampling for *Rhizopogon* fruitbodies and EM root tips was conducted by gentle raking in and around coarse woody debris and other microhabitats favorable for the formation of these structures. Roots were collected in 10 – 40 mm segments along with small amounts of soil and stored at 4 degrees Celcius until further processing was possible. Within 12 hours of collection, small tissue samples from all recovered fruitbodies were preserved in 20% DMSO buffer for DNA extraction and the fruitbodies were then dried for future study.

Lab Work: Work in the laboratory has focused upon processing root and soil samples and performing DNA extractions. All root and soil samples were processed within 5 weeks of the return to the laboratory. Roots were first cleaned of adhering soil in purified water and examination of roots was performed under a dissecting microscope. All EM root tips identified during examination were photographed and individually preserved in 20% DMSO buffer for DNA extraction. Over 500 EM root tips were characterized and preserved. Soil samples were sifted using a sterilized soil sieve and total soil DNA extractions were performed upon the resulting aggregate. These total soil DNA's will be subjected to molecular analyses to characterize the fungal community in the soil and probe for the genetic signatures of *Rhizopogon* species. These sifted soil samples are now being used to conduct bioassay experiments in which *Pseudotsuga* seedlings are potted into dilutions of this soil in order to induce formation of new root tips from the dormant fungal spores present in the soil. Using these techniques I am able to perform an extremely thorough search for the presence *Rhizopogon* species.

The morphologies of *Rhizopogon* fruitbodies and mycorrhizae are highly cryptic and as such molecular analysis of DNA from fruitbodies and EM root tips is essential for identification. Approximately 2 dozen truffle-like fruitbodies were recovered and of these, seven were tentatively field identified as *Rhizopogon*. EM Root tips contain tissue from both the tree host as well as the fungal symbiont. Molecular analyses of DNA derived from root tips will be essential to verify the host associations of the Rhizopogon species collected through their comparison to *Rhizopogon* fruitbodies and tree tissue DNAs. DNA extractions have been performed upon all suspected *Rhizopogon* fruitbodies and preliminary sequence analysis has confirmed the identity of these fruitbodies as *Rhizopogon*. Preserved root tips are awaiting DNA extraction in the United States.

All plant and fungal specimens relevant to my research are currently being prepared for deposit at the herbarium of the Japanese National Museum of Nature and Science (TNS) in Tsukuba City as well as the herbarium of Oregon State University

8. Please add your comments (if any): My experience performing research in Japan has been unbelievably fruitful. I have founded what promise to be several long-term collaborations and friendships. I have also learned valuable field collection techniques and acquired new laboratory procedures. The strength of these skills is amplified due to the adaptability I have gained by acquiring them within an unfamiliar environment. Additionally, my time living and working in another culture has been one of the most rewarding and memorable experiences of my adult life.

9. Advisor's remarks (if any): Advisor's comments are included on advisor's questionnaire.

RESEARCH REPORT

1. Name: Joules Nahas （ID No.: SP10037）

2. Current affiliation: University of California at Santa Barbara

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Kyoto University

5. Host researcher: Professor Yoshio Tsutsumi

6. Description of your current research

Nonlinear dispersive equations are a class of partial differential equations that model a variety of physical phenomena such as waves in a fluid, waves in a plasma, traffic flow, etc. My research involves studying the behavior of solutions to these equations. In particular, I am interested in how quickly solutions decay in space, in relation to how many derivatives the solutions have (how regular the solutions are). It seems necessary that in order for the decay of solutions to nonlinear dispersive equations to persist, the solutions must also have some corresponding amount of regularity. In the case that a solution $u(x,t)$ to a nonlinear dispersive equation has an integer number of spatial derivatives in the Lebesgue space L^2 (over the variable x) these decay/regularity properties are well known. It the case when $u(x,t)$ only posses a fraction of a derivative in the space L^2, these properties have not been completely established, which is where my research interests lie.

7. Research implementation and results under the program

Title of your research plan:

Decay properties of solutions to nonlinear dispersive equations

Description of the research activities:

I can prove that if a solution of the mKdV equations has spatial decay at two different times, then it must poses a corresponding amount of regularity, provided we know the solution has a quarter of a derivative in L^2 to begin with. The strategy for the proof should also work as an outline to remove the quarter of a derivative in L^2 requirement, and to obtain the corresponding result for most gKdV equations.

The strategy is to obtain *a priori* estimates on the nonlinearity by treating the nonlinearity as a perturbation of a linear equation. These estimates imply that for small times, the nonlinearity will be comparable in size to the solution. A difficulty is that the *a priori* estimates require that the solution have more derivatives in L^2 than the one quarter initially assumed. A way to *regularize* the solution, which means approximating the solution with functions which have more derivatives, is required. A simple regularization scheme yields the stated result for the mKdV. The *a priori* estimates still work for most of the other gKdV equations. By developing better regularization methods, the stronger result for the mKdV and the corresponding result for the gKdV should follow.

8. Please add your comments (if any): I would like to thank my hosts at Kyoto University, and also Tohoku University for their hospitality. Visiting Japan was a good opportunity for me to communicate my work to the PDEs community and in turn learn about the excellent work that these research groups are doing.

9. Advisor's remarks (if any):

Dr. Nahas' visit to Kyoto University was beneficial to us. Because graduate students personally disscused mathematics and cultures of Japan and USA in English with him. This is an invaluable experience to them.

RESEARCH REPORT

1. Name: Chris Nasrallah
（ID No.: SP10038）

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:
Biological Sciences

4. Host institution: The Graduate University for Advanced Studies (Sokendai)

5. Host researcher: Dr. Hideki Innan

6. Description of your current research

RNA plays a central role in biology, acting as an information carrier (mRNA), translator (tRNA and rRNA), as well as regulatory molecule (microRNA). The various functions of RNA are largely mediated through its ability to form a three-dimensional structure. This structure is largely determined by the ability of RNA to form dinucleotide bonds known as Watson-Crick pairs. The key insight is that while the RNA sequence itself may not be conserved over evolutionary time, the structure must maintained in order to preserve the molecular function. Models of RNA evolution have largely attempted to account for this structure by focusing on a single pair of sites. This approach is limited however, in that it fails to consider the remainder of the RNA sequence in which the pair is found; in reality pairs of sites are never found in isolation, but always in the context of the rest of the sequence. My current research aims to understand how this context affects the evolution of RNA.

This can be done by simulating the evolution of RNA using a more complete model that accounts for the entire sequence and structure of the molecule. Because the RNA must maintain its structure to perform its function, I can consider the energy of the folded molecule as proportional to the fitness of the sequence. By simulating an entire population of such sequences using classical population genetic approaches, I can make inferences about the dynamics of the substitution process. Specifically I can examine the expected time until a compensatory mutation is observed and the linkage disequilibrium created during the substitution process. This will also assess the adequacy of the simpler models of RNA evolution that fail to consider sequence context. The goal of my current research is to therefore design and implement software to simulate this evolution and perform the appropriate population genetic analyses. Specifically I am interested in the effect of context on the expected time to fixation of compensatory substitutions, and the creation of linkage disequilibrium during the compensatory substitution process.

7. Research implementation and results under the program

Title of your research plan:

Understanding the evolutionary dynamics of compensatory substitution in RNA through simulation

Description of the research activities:

The simulation and analysis software has been fully designed, and significant progress has been made in the implementation thereof. As with any project contingent upon writing software it is an exercise in delayed gratification, with few results until the end. Thus I am unable to offer any preliminary results at this time. But because of the nature of the project, it is easily continued at my home institution and I am confident that it will be completed in the coming weeks. Because it is important to understand how the evolution of RNA might or might not differ when sequence context is considered, the results of these analyses will be important regardless of their outcome. Thus I am confident that my time in Japan has been well-spent.

In addition to the work accomplished on my project, this research experience has been invaluable to me for scientific outreach purposes. For the past year I have worked with an NSF program called GK-12, in which graduate students become involved in scientific education in primary school. At my request, my host research arranged for me to visit and observe a middle school science classroom in order to compare the learning experiences of American and Japanese students. This was a very useful experience to gain understanding of science education in another culture. My time in Japan has also been extremely useful in observing how scientists in Japan interact with the public at large, providing me with ideas for how American scientists might also do a better job of encouraging interest in science among the general public.

8. Please add your comments (if any):

In addition to my scientific experiences, this was a rewarding experience for me culturally. As a jazz musician with a strong interest in music composition I found inspiration in my time in Japan. I gained access to a piano and composed a new piece of music for a jazz group. The composition is based on the melody of a well-known Japanese folk song known as *Sakura* and is called *Arukas* (an anagram of *Sakura*). My composition preserves the original melody, but drastically alters the song in phrase structure and introduces a novel set of chord changes over which to improvise. I look forward to performing this piece with a jazz group upon returning to the US.

RESEARCH REPORT

1. Name: Aric George Newton （ID No.: SP10039）

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:

Chemistry

4. Host institution: Hokkaido University

5. Host researcher: Professor Tamotsu Kozaki

6. Description of your current research

Atomistic simulations are a powerful research methods that can be used in geochemistry to gain insight into complex systems. The ability of molecular simulations to isolate specific molecular interactions at the atomic scale permits researchers to explore phenomena that cannot be isolated through traditional experimental techniques. Ion diffusion at the basal surface of smectite clay minerals is just such a phenomena. Understanding diffusion at the basal surface in compacted clay barriers is an important aspect of risk assessment for hazardous waste containment.

Experiments by my host researcher, Prof. Tamotsu Kozaki, have demonstrated that the energy barrier to diffusion in compacted clays with a dry density ~1.0 kg/m^3 can be less than the energy barrier to diffusion in free water. The current research used molecular simulations (for model, see Figure 1) to determine the energy barrier to diffusion at the basal surface by modeling diffusion in this model system at five different temperatures. The slope of a plot of diffusion versus temperature determines the energy barrier to diffusion (Figure 2).

The energy barrier to diffusion at the clay basal surface was found to be less than the energy barrier to diffusion in free water (14.2 kJ mol^{-1} vs. 18.4 kJ mol^{-1}). This is in agreement with the experimental values determined by Dufey & Laudelot (13 kJ mol^{-1}; 1975) and Kozaki, et al. (~14 kJ mol^{-1}; 2005). These previous finding were attributed to diffusion at the basal surface. However, this interpretation could not be confirmed as this diffusion pathway cannot be experimentally isolated. The results of these atomistic simulations have demonstrated the validity of this methodology to determine the energy barrier to diffusion in a compacted clay layer. Future simulations using this methodology are being planned to determine the energy barriers to diffusion for additional cations and anions as well as along different diffusive pathways (i.e. the interlayer and clay edges).

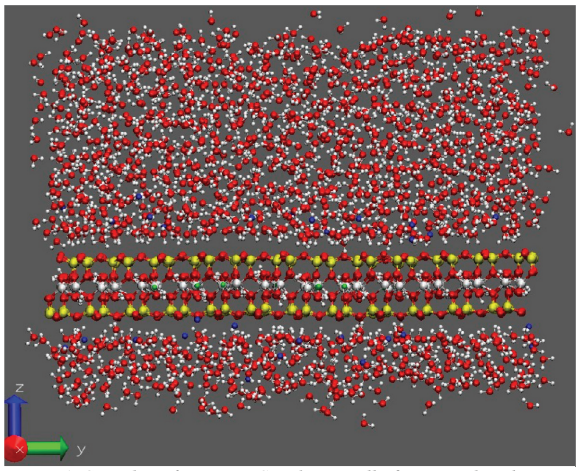


Figure 1: Snapshot of NVT-MD Simulation cell of NaMMT basal surface at t=0 with Na (blue), O (red), H (white, small spheres), Si (yellow), Al (white, large spheres), Mg (green) atoms.

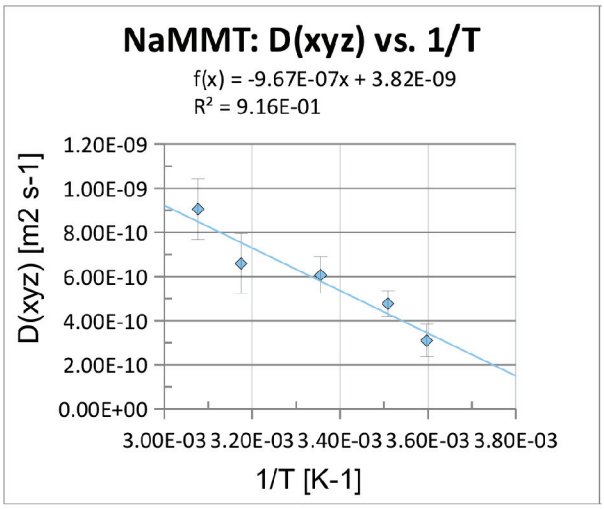


Figure 2: Na^+ ion Diffusion coefficient v. temperature^{-1}

References: 1) Dufey, J. E. and H. G. Laudelout (1975). *J. of Coll. and Int. Sci.* **52**(2):340.

2) Kozaki, T., et al. (2005). *Engin. Geology* **81**(3): 246-254.

7. Research implementation and results under the program

Title of your research plan: Atomistic Simulations of Ion Diffusion in Clay Barriers

Diffusive Path Energy Barriers

Description of the research activities: The research activities completed during the JSPS Summer Program were a series of atomistic computer simulations of ion diffusion at the clay-water interface. The diffusion coefficient at five different temperatures was determined from these atomistic simulations of the clay-water interface. The diffusion coefficients at these different temperatures are related to one another through the activation energy of diffusion. A plot of the diffusion coefficient as a function of temperature gives the activation energy of diffusion. The simulations demonstrated that the energy barrier to diffusion at the clay-water interface is less than the energy barrier to diffusion in bulk water (E_a= 14.2 kJ/mol at the clay-water interface v. 18.4 kJ/mol in bulk water). The results of these simulations have helped to confirm the interpretation of previous experimental data and to validate this molecular modeling approach for further study of ion diffusion in compacted clay barriers.

RESEARCH REPORT

1. Name: Jonathan Nguyen
（ID No.: SP10040）

2. Current affiliation: University of California, Davis

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Tohoku University

5. Host researcher: Professor Junji Saida

6. Description of your current research

Bulk metallic glass (BMG) composites composed of Cu-Zr-Al with multi-walled carbon nanotubes (CNTs) have become the subject of recent interest due to their potential high ductility and low Young's modulus. A limiting factor for widespread use of CNTs is their inherent high Van der Waals forces typically causing agglomeration of CNTs into bundles. Using a wet process of various surfactants in aqueous solutions has been shown to individually disperse CNTs, thereby functionalizing the CNTs to be able to bond to the metal powder surface. An understanding of the mechanisms and underlying microstructural interactions associated with various BMG-surfactant-CNT combinations is vital to the processing and development of BMG-CNT composites via Spark Plasma Sintering (SPS) with enhanced mechanical behavior.

Cu-based amorphous alloy powders have a tendency to crystallize in water solution. A goal is to determine the minimum time the powders have to be in solution to obtain cohesion of CNT onto metallic powder surface. Depending on the alloy composition, CNT cohesion occurs at different times and has been shown to dissociate with the metallic powder if dwell time is too long as seen in Figure 1.

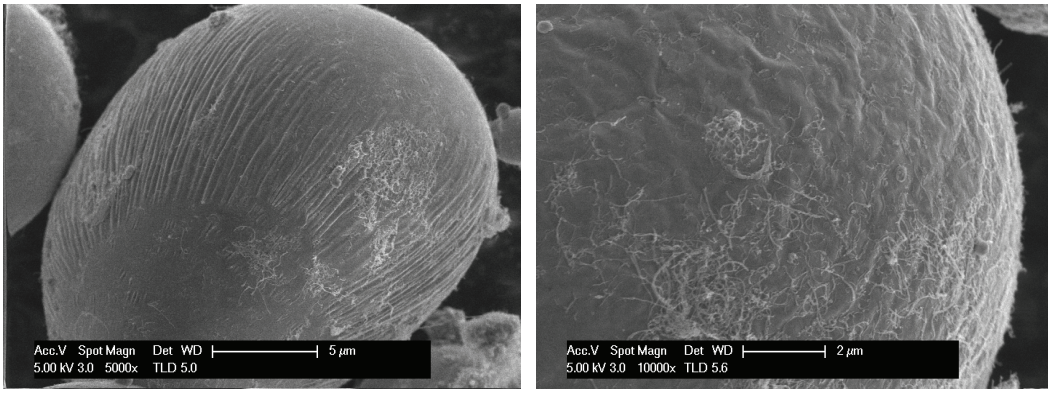


Figure 1 – (Left) Cu-Zr-Al-CNT with dwell time in surfactant solution: 1 hr
(Right) Cu-Zr-CNT with dwell time in surfactant solution: 4 hr

7. Research implementation and results under the program

Title of your research plan: Effect of CNT on ductility and glass forming ability of Zr-Cu-Al-Ag BMG composites.

Description of the research activities:

My research at Tohoku University comprised of using arc melting, gas atomization, spark plasma sintering, and Cu-mold casting of many bulk metallic glass alloys including Zr-Cu-Al-Ag, Cu-Zr-Al, Cu-Zr, Ti-Cu-Ni-Zr-Sn, and Fe-P-B-Si with varying amounts of CNT addition. Typical consolidation of BMG-CNT composites involves the following steps: 1) Producing prealloyed ingots using vacuum arc melting of high purity elemental powders of the desired nominal composition in a Zr-gettered Ar purified environment, 2) Prealloyed ingots are gas atomized using high pressure Ar gas directed at molten ingots to form powder with a size range of 25-150 μm, 3) Fine powder is mixed with CNT zwitterionic wet solution to form composite powder, 4) Composite powders are then consolidated into cylinders using spark plasma sintering (SPS), 5) Cylinders are quickly melted in a quartz tube by induction under a high purity Ar atmosphere, and 6) Melt is quickly casted into a Cu-mold to produce BMG-CNT composite rods.

Evaluation of microstructure was accomplished using standard analysis techniques including: X-ray diffraction to confirm an amorphous structure at each processing step, differential scanning calorimetry to determine the nature of glass transition temperature, melting temperature, endothermic/exothermic reactions to better understand how processing conditions effect the overall structure of the BMG, and SEM to observe the morphology.

Apparent improvements in mechanical behavior was also achieved with an average increase in Vickers hardness values with an of ~4% and ~8% with composites containing 0.1 wt% and 0.5 wt%, respectively. The relatively small improvements in Vickers hardness is mostly due to low density, with the highest being ~93% theoretical. Further processing such as warm extrusion is expected to improve these values dramatically. Although there was insufficient time for compression testing of casted rods, samples were cut and ground to be ready for testing as soon as I arrive back in the US. A relatively new method is tensile test samples that were cast in the shape of a dog bone that will be ready for testing upon my return to the US as well.

Overall the research performed thus far has laid the groundwork for further collaboration as well as enough data for at least one journal publication.

RESEARCH REPORT

1. Name: Anders A. Nottrott （ID No.: SP10041）

2. Current affiliation: University of California, San Diego, Department of Mechanical and Aerospace Engineering

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Tokyo Institute of Technology, Ookayama Campus, Department of International Development Engineering

5. Host researcher: Dr. Manabu Kanda

6. Description of your current research

The development of urban areas alters the natural environment and leads to the formation of urban heat islands (UHI). The UHI effect is characterized by elevated air and surface temperatures in urban environments relative to nearby rural areas. UHIs increase energy consumption in cities and create unfavorable environmental conditions that have detrimental effects on the health of the population. There are three main environmental processes that contribute to the formation of UHIs: (1) Reduction in the amount of latent cooling of urban air because of decreased vegetation relative to rural areas. (2) Increased surface heating in urban areas causes increased urban air temperatures. (3) Anthropogenic heat production (heat generated by building HVAC systems, vehicles, etc.) contributes to increased urban air temperatures. UHI mitigation, which can be accomplished through conscientious urban planning and design, is an attractive strategy to achieve energy savings in the buildings sector and improve the living environment in cities.

Yet varying a single parameter within the urban environment can have complex feedback effects that impact the entire urban heat balance. Thus urban boundary layer (BL) models are needed to accurately quantify the heat and moisture transport in urban environments. Existing models cannot accurately simulate turbulent heat transfer very close to urban surfaces, because the number of calculations required fully resolve those regions exceeds the computational capabilities of even the most advanced computing systems. However, the near wall convective heat transfer is a critical component of the urban energy balance and is directly linked to UC air temperature and building cooling load. Simplified yet accurate convection models, called wall models (WM), must be applied in order to account for the near wall convective heat flux.

Current WMs do not provide the necessary accuracy required for advanced urban BL simulations because they are derived from average heat flux parameters and have no knowledge of turbulent structures in the near wall BL that drive convective heat transfer over urban surfaces. This research seeks to improve existing WM correlations using a novel approach that incorporates direct measurements of turbulence within the near wall thermal BL, in the UC and above the UC to develop accurate correlations for convective heat transfer at building walls. Broad applicability of the results is facilitated by the unique nature of the Comprehensive Outdoor Scale MOdel (COSMO) for urban climate studies where the experiments are conducted.

7. Research implementation and results under the program

Title of your research plan:

Turbulence measurements of thermal boundary layers in urban environments

Description of the research activities:

During the two month period of the JSPS summer research program three experimental campaigns were carried out in COSMO over a one month period in July, 2010. COSMO is a 1/5 scale model of an urban city specifically designed for the study urban atmospheric and energy transport processes, and it is the only facility of its kind in the world. At COSMO experiments can be conducted in a simplified yet realistic urban environment that is exposed to real atmospheric conditions. Measurements were carried out on opposite walls of two neighboring building units in order to capture two types of flow conditions. The purpose of the first measurement campaign was to setup the experiment and obtain a sample dataset that was used to ensure the correct operation of all equipment and test the viability of the experimental setup. During the second and third campaigns data were collected from both building walls for a period of several hours. These long datasets were used in the final analysis to study the near wall, thermal BL characteristics under different conditions.

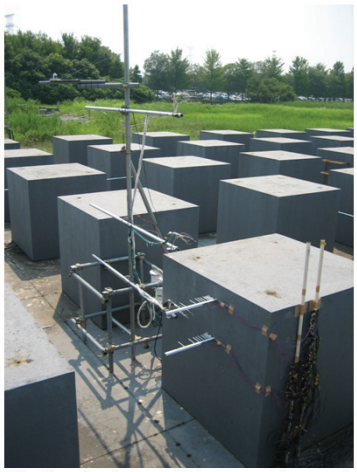


Fig 1 - A photo of the experimental setup at the COSMO facility.

The experimental setup (see Fig 1) consisted of two fine-wire thermocouple rakes fixed at different heights on the building wall, three sonic anemometers mounted in and above the UC and one thermopile pyranometer mounted above the buildings. Additional thermocouples were attached to the building and measured wall surface temperature at two heights and roof surface temperature. The thermocouple rakes were used to measure the temperature profile and turbulent fluctuations of temperature in the wall BL as functions of distance from the wall. One sonic anemometer was mounted between the thermocouple rakes and measured the velocity near the building wall. Two sonic anemometers were mounted above the buildings and were used to measure the predominant wind velocity and local atmospheric stability during the experiment. The pyranometer measured global horizontal irradiance above the buildings because radiation from the sun is the primary heat input to the system. Turbulence data from the thermocouple rakes and the sonic anemometers were sampled at 50 Hz. Irradiance data from the pyranometer were sampled at 1 Hz and averaged and stored once per minute.

Analysis of the data yielded interesting results and also helped to identify shortcomings of the experimental setup that will be improved in future experiments. In particular this study helped to (1) develop estimates for the thickness of the thermal BL on vertical building walls in COSMO; (2) clarify the extent of different regimes within the BL; (3) study the influence of atmospheric surface layer and UC wind velocity on boundary layer development; (4) identify the necessary spatial resolution of turbulence measurements in the BL required to fully resolve the inner layer.

This experiment produced a unique dataset and the first turbulence measurements of the thermal BL on a vertical building wall under atmospheric conditions in a realistic urban environment. Since an analytical solution for this flow is not available and no similar experiments exist, wind tunnel experiments conducted under highly controlled conditions provide the basis for comparison of the results from this experiment. Measurement of the mean air temperature profile near the wall suggested that the thermal boundary layer thickness on the building wall is approximately 5 cm (Fig 2a). Although this value is small relative to results obtained in wind tunnel experiments, it is not unrealistic since turbulence in the free stream is expected to suppress the boundary layer growth. Unfortunately direct estimates of wall convective heat flux could not be made from the data collected in this study due to the low spatial resolution of measurements in the inner region (viscous layer) of the BL. However, it was determined that better resolution is needed particularly within the first 1 mm from the wall, and that at least 5 thermocouples should be placed less than 0.5 mm from the wall in order to accurately estimate the slope of the temperature profile close to the wall. Interesting results were observed in the profiles of the standard deviation of the temperature fluctuation (Fig 2b). Although the intensity of turbulence in the free stream was quite large, data from this experiment indicated that the general structure of the boundary layer is similar to that observed in wind tunnel experiments, which is an indication that the experimental method is valid.

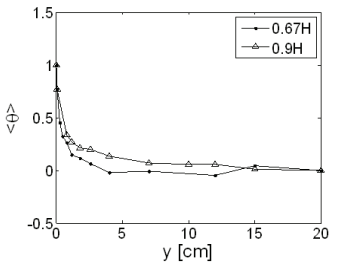


Fig 2a – Dimensionless temperature as a function of distance from the wall measured at two heights on the building wall. The temperature is roughly constant for $y > 5$ cm.

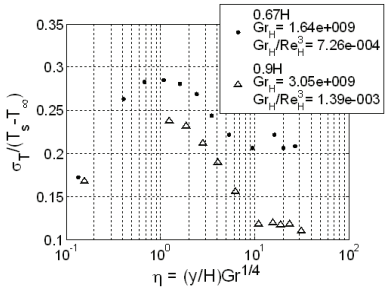


Fig 2b – Intensity of turbulent fluctuation of temperature at different points in the boundary layer measured at two heights. The wall surface temperature is greater at *0.9H* than at *0.67H*.

While the initial results of the data analysis are promising, future study will seek to establish a relationship between surface layer wind velocity, canyon wind velocity and the near wall thermal BL structure. This is important to develop useful correlations that can be applied to urban heat transfer problems in the context of large eddy simulation models. On the basis of this experiment it is recommended that future experiments should make use of a highly specialized thermocouple rake that has many measurements in the viscous region of the BL (i.e. the region that is less than 0.5 mm from the wall). Such equipment would allow for direct estimates of convective heat flux at the wall.

RESEARCH REPORT

1. Name: Kevin M. Oberg （ID No.: SP10042）

2. Current affiliation: Colorado State University

3. Research fields and specialties:

Chemistry

4. Host institution: Kyoto University

5. Host researcher: Professor Keiji Maruoka

6. Description of your current research

Reaction development is of vital interest to organic chemistry as these reactions are the tools used to construct molecules of synthetic and medicinal importance. Catalytic methods are attractive because they are atom economical, reduce waste generation, and can be rendered asymmetric to generate large quantities of enantioenriched material from small amounts of enantioenriched material. The reaction between two substances that reside in two distinct, immiscible phases is almost non-existant; however, the use of organic salts, phase-transfer catalytst, can transfer reactants between phases and subsequently, catalyze their reaction. In the past few decades, the use of enantioenriched, well-defined, catalyst have been developed to catalyze these phase-transfer reactions in high enantioexcess. Professor Keiji Maruoka has developed a class of phase-transfer catalyst (Fig 1) that has proven effective at catalyzing a number of reactions. We employed these catalysts in the synthesis of 1,4-benzoxazine-3-one derivatives. This scaffold has been shown to be a renin inhibitor by Pfizer (Fig 1) and therefore is of biological interest.

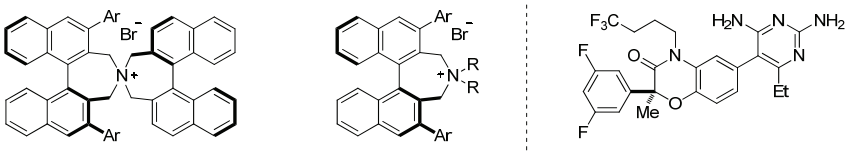
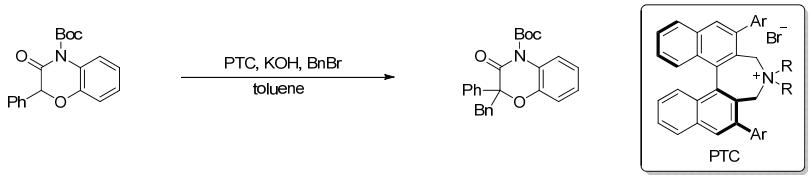


Figure 1. Phase-Transfer Catalyst developed by Maruoka group and Pfizer renin inhibitor

7. Research implementation and results under the program

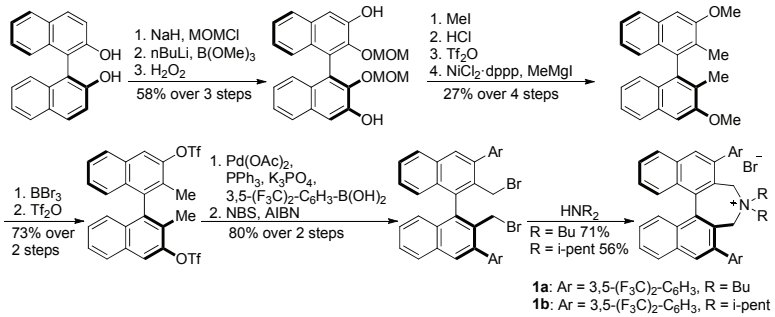
Title of your research plan: Asymmetric Alkylation of 1,4-Benzoxazine-3-one via Phase-Transfer Catalysis



Description of the research activities:

Initial efforts were placed on the synthesis of the phase-transfer catalyst (Scheme 1). This 12-step protocol resulted in the synthesis of two catalyst, one of which (**1b**) is novel.

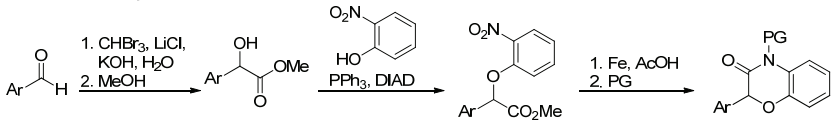
Scheme 1. Phase-Transfer Catalyst Synthesis



1a: Ar = 3,5-$(F_3C)_2$-C_6H_3, R = Bu
1b: Ar = 3,5-$(F_3C)_2$-C_6H_3, R = i-pent

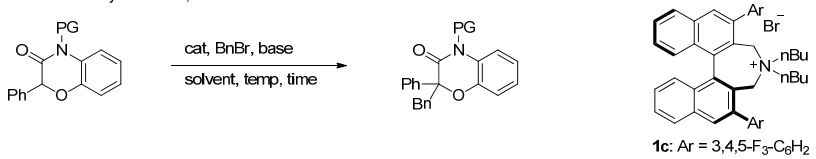
The synthesis of the starting material was also undertaken (Scheme 2).

Scheme 2. Starting material synthesis



Initial results from Hidenori Kimura demonstrated that with potassium hydroxide as the base, the reaction benefits from the use toluene and lower temperatures. Variations in reaction conditions were explored (Scheme 3). An initial problem in the reaction was hydrolysis of the starting material from base. Variations in base and solvent result in lower amounts of hydrolyzed product, but yields also decrease (entries 1-6). Alkylation of the intermediate before reduction and cyclization was also attempted, but yields and enantioselectivities are poor. Changing the protecting group from t-butoxycarbonyl (Boc) to benzyl (Bn) eliminates the problem of hydrolysis, but yields and enantioselectivities are low (entries 7, 8) and the use of a benzoyl protecting group results in no product. Finally, different catalysts and reaction temperatures were examined (entries 9-14). The use of catalyst **1b** at low temperature generates high yields of target material with little to no hydrolysis and maintains the same level of enantioselectivity as **1c** (entry 14). Conducting the reaction at -40 °C results in low yield and no benefit in enantioselectivity (entry 13).

Scheme 3. Alkylation of 1,4-Benzoxazine-3-one



1c: Ar = 3,4,5-F_3-C_6H_2

entry	cat	PG	BnBr (eq)	base	solvent	temp (°C)	time (h)	yield (%)	ee (%)
1[a]	**1c**	Boc	5	KOH (1.5 eq)	PhMe	0	24	87	83
2	**1c**	Boc	1.2	KOH (1.5 eq)	PhMe	0	24	43	79
3	**1c**	Boc	1.2	NaOH (1.5 eq)	PhMe	0	24	28	78
4	**1c**	Boc	1.2	K_3PO_4 (1.5 eq)	PhMe	0	24	21	81
5	**1c**	Boc	1.2	Cs_2CO_3 (5 eq)	PhMe	0	24	16	82
6	**1a**	Boc	1.2	Cs_2CO_3 (5 eq)	TBME	0	24	20	78
7	**1c**	Bn	1.2	KOH (1.5 eq)	PhMe	0	24	8	25
8	**1c**	Bn	1.2	CsOH (2 eq)	PhMe	0	24	5	21
9	**1c**	Boc	1.2	KOH (1.5 eq)	PhMe	-20	24	6	86
10	**1a**	Boc	1.2	KOH (1.5 eq)	PhMe	-20	24	20	86
11	**1c**	Boc	5	KOH (3 eq)	PhMe	-20	24	43	86
12	**1b**	Boc	5	KOH (2 eq)	PhMe	-20	48	85	79
13	**1b**	Boc	5	KOH (2 eq)	PhMe	-40	48	18	88
14	**1b**	Boc	2.5	KOH (2 eq)	PhMe	-20	48	81	89

[a] result from Kimura

8. Please add your comments (if any): This reaction needs to be conducted between -20 °C and -40 °C to find the optimal reaction temperature that results in high yields and potentially higher enantioselectivities. With these optimal conditions in hand, variations in substrate and alkylating agents can be explored to generate a variety of 1,4-benzoxazine-3-ones.

RESEARCH REPORT

1. Name: Augustine O'Keefe （ID No.: SP10043）

2. Current affiliation: Tulane University

3. Research fields and specialties:
Mathematical and Physical Sciences

4. Host institution: Osaka University

5. Host researcher: Hibi, Takayuki

6. Description of your current research

The roots (or zeroes) of a system of polynomials is a classical field of study in mathematics. When considering polynomials in an arbitrary number of variables, this becomes a computationally expensive problem to solve. Alternatively, one may look at the set of polynomials of interest and describe their relations and other algebraic invariants. One can consider a special set of binomials, called a *toric ideal*, and focus on invariants arising from the *Minimal Free Resolution* of the ideal. It is advantageous to look at toric ideals because of their elegant connection to combinatorial objects such as polytopes and discrete graphs.

In particular, I am currently interested in toric ideals arising from discrete simple connected graphs. The generators of such an ideal can be characterized by even closed paths in the associated graph. The goal of my research is to calculate the *multigraded Betti numbers, projective dimension* and other such algebraic invariants arising from the Minimal Free Resolution of the toric ideal, and then characterize them in terms of the combinatorial structure of the graph.

7. Research implementation and results under the program

Title of your research plan:

The Castelnuovo-Mumford regularity and Betti numbers of Toric rings

Description of the research activities:

Given a list of simple connected graphs on up to 8 vertices by a graduate student of my host researcher, I used a computational algebra program, Macaulay2, to compute the corresponding toric ideals and their Minimal Free Resolutions. The focus of the project soon changed from characterizing the *Castelnuovo-Mumford regularity* of the ideal to calculating the *depth* of the toric ring. By looking at the projective dimension of the Minimal Free Resolution of the ideal, one can apply the Auslander-Buchsbaum theorem to directly compute the depth. Upon running examples in Macaulay2, I found an infinite family of graphs that all seemed to have the same depth. I then worked with the aforementioned graduate student and a post-doctoral fellow on proving this and other related results. We are now in the process of writing a paper on the results obtained this summer.

8. Please add your comments (if any):

The paper mentioned above should be submitted to a journal sometime in September. Although the focus of the research changed, I could not be happier with the outcome of this summer research experience. I thoroughly enjoyed working with my Japanese colleagues and am sure that collaboration will continue in the future.

RESEARCH REPORT

1. Name: Jeffrey Orth （ID No.: SP10044）

2. Current affiliation: University of California, San Diego

3. Research fields and specialties:
Biological Sciences

4. Host institution: Institute for Advanced Biosciences, Keio University

5. Host researcher: Dr. Masaru Tomita

6. Description of your current research

Systems biology is a new multidisciplinary field that seeks to understand the connections and interactions between these components and to understand how biological systems work on many different scales. The field of systems biology encompasses both experimental methods to gather data and confirm predictions, and computational methods to analyze data and perform simulations. Biochemical network reconstructions provide a common denominator in systems biology. These reconstructions contain the most up-to-date information on molecular components and their interactions available for an organism, and thus serve as both content databases and as bases for computational models. Genome-sequencing together with biochemical and physiological literature has enabled the development of genome-scale metabolic network reconstructions for many different organisms including the bacteria *Escherichia coli*, *Saccharomyces cerevisiae* (yeast), and *Homo sapiens*. Most applications of network reconstructions depend on the ability to convert these reconstructions to predictive mathematical models, typically constraint-based models. Constraint-based modeling is especially useful for analyzing genome-scale metabolic networks because unlike most other types of biological modeling, it does not require extensive and precise kinetic parameters.

Despite the relatively large amount known about the model organism *E. coli*, there is still much to learn. The functions of nearly half of the 4453 genes in the *E. coli* K-12 MG1655 genome have not been experimentally confirmed, and many do not even have predicted functions. Many of these unknown genes are thought to code for enzymes, proteins that catalyze chemical reactions. By comparing experimental results to model based predictions, it is possible to identify where knowledge is missing. Several methods have been developed recently, and I am applying these to discover new genes and reactions in *E. coli*.

7. Research implementation and results under the program

Title of your research plan:

Systems Biology and Metabolomics to Identify Uncharacterized *E. coli* Genes

Description of the research activities:

Working at the Institute for Advanced Biosciences, Keio University in Tsuruoka, Japan, I have been using the metabolomics infrastructure of Dr. Martin Robert's lab to identify the functions of as yet uncharacterized *E. coli* genes. In particular, I have analyzed a set of genes predicted by systems biology methods to encode metabolic enzymes. A total of eight genes were investigated in detail during this project. The procedure used is conceptually straightforward, and was used to rapidly identify the reaction carried out by an enzyme *in vitro* (i.e. in a test tube rather than in living *E. coli*). The first step in this procedure was to express and purify the uncharacterized protein from the gene of interest. A library of clones of every *E. coli* open reading frame (ORF), called the ASKA Collection, was used for this purpose. *E. coli* strains containing the target genes were grown overnight, and the expression of the genes was induced. The next day, the proteins were extracted and purified by adhesion to metal beads. In the second step of the project, *in vitro* reaction mixtures containing all of the possible metabolites that may be consumed in an enzymatic reaction were prepared. This was done using a mixture of the predicted substrates and various general cofactors such as NADH, NADPH, ATP, GTP, biotin, coenzyme A, and others. The purified proteins were then be added to the reaction proper mixtures, allowing the reaction to take place. Many sets of these reactions were performed throughout the project. In the third step of the procedure, the concentrations of the different compounds in the mixtures were measured using liquid chromatography mass spectrometry (LCMS), a method that can measure the concentration of many different charged organic compounds. Control reaction mixtures (without enzyme) were also prepared and measured by LCMS. These different sets of measurements were analyzed using the MathDAMP software package. The metabolites that are consumed in the enzymatic reaction should decrease in abundance, while the metabolites that are produced should increase.

In most of the reaction mixtures measured, the samples with enzyme contained similar compound concentrations to the control samples, indicating that the predicted reaction did not occur *in vitro*. However, by altering reaction conditions such as temperature, enzyme and metabolite concentrations, and concentrations of various inorganic ions, it was possible to find the proper conditions for enzyme activity. Reactions that appeared to work were repeated for confirmation. By the end of the project, new enzymatic reactions were experimentally verified for five *E. coli* genes. Several additional experiments are now being planned to further verify these results. This project has thus increased our knowledge of the metabolic capabilities of *E. coli*.

8. Please add your comments (if any):

By using the extensive mass spectrometry capabilities of the Institute for Advanced Biosciences as well as the expertise of Dr. Martin Robert, I was able to experimentally verify the functions of several *E. coli* genes during this relatively short project. This project has increased my repertoire of experimental biochemistry skills and has lead me to make many new contacts in Japan that should help me in my career.

RESEARCH REPORT

1. Name: Daniel M. Pajerowski (ID No.: SP10045)

2. Current affiliation: University of Florida

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Keio University

5. Host researcher: Dr. Yasuaki Einaga

6. Description of your current research

Recently, heterostructured films of $Rb_{0.7}Ni_{4.0}[Cr(CN)_6]_{2.9}\bullet nH_2O$ (**Ni-Cr**) and $Rb_{0.7}Co_{4.0}[Fe(CN)_6]_{2.9}\bullet nH_2O$ (**Co-Fe**) Prussian blue analogues were shown to display a long-range magnetic photoeffect at temperatures much higher (~ 70 K) than single component **Co-Fe** (~ 20 K), Figure 1 (a). For these heterostructures, **Co-Fe** was chosen for its photoeffect and **Ni-Cr** was chosen for its high T_C, pressure dependence, and similar lattice constant. During photoirradiation, **Co-Fe** changes lattice constant, even above its magnetic ordering temperature, and thus applies a pressure to the **Ni-Cr** lattice, modifying the Ni anisotropy. At the heterostructure interfaces there exist mixed regions of $\mathbf{Ni_{1-x}\text{-}Co_x\text{-}Fe}$ and $\mathbf{Co\text{-}Fe_y\text{-}Cr_{1-y}}$, Figure 1 (b), which can be approximated in bulk powder form for more detailed analysis. The degree to which foreign atoms disrupt the photomagnetism of **Co-Fe** (and the heterostructure) is the subject of the proposed study.

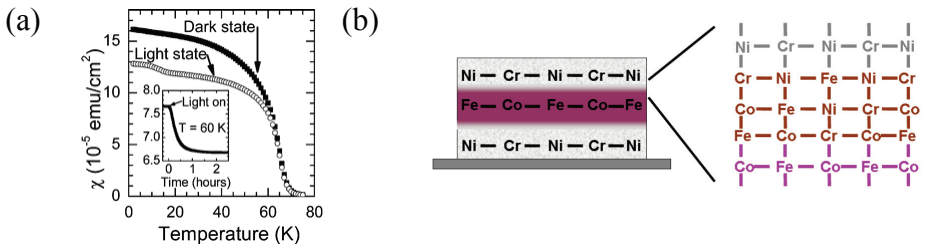


Figure 1. (a) Photomagnetic Heterostructure. Field-cooled magnetic susceptibility χ(T) in 100 G, oriented parallel to the surface of the film: (■) dark state; (○) photoinduced state. Inset: time dependence of χ(T = 60 K). (b) Heterostructure Schema. Heterostructures are made of interacting Ni Cr and Co Fe layers, and at layer interfaces, there may exist mixed regions containing $\boldsymbol{Ni_{1-x}\text{-}Co_x\text{-}Fe}$ *and* $\boldsymbol{Co\text{-}Fe_y\text{-}Cr_{1-y}}$.

7. Research implementation and results under the program

Title of your research plan:

Nanostructured Photomagnetic Prussian Blue Analogues

Description of the research activities:

- Sample Synthesis

To synthesize $\mathbf{Ni_{1-x}\text{-}Co_x\text{-}Fe}$, standard preparations for **Co-Fe** were modified to have the desired proportion of nickel precursor in place of cobalt. Similarly for $\mathbf{Co\text{-}Fe_y\text{-}Cr_{1-y}}$, the **Co-Fe** synthesis was modified to include the desired proportion of $K_3Cr(CN)_6$ in place of $K_3Fe(CN)_6$. The result was 11 powder-like compounds, having **x** = 0, 0.2, 0.4, 0.6, 0.8, 1.0 and **y** = 0, 0.2, 0.4, 0.6, 0.8, 1.0.

- Measurement

The material properties of these powders were quantified using a variety of techniques, including mass spectrometry for chemical formula, Mössbauer spectroscopy for iron oxidation states, temperature dependent infrared spectroscopy to extract the amount of bistable material, X-ray diffraction to determine the lattice constants, and magnetic susceptibility to understand the magnetic order and to determine the gyromagnetic ratios.

- Results

The aforementioned measurements confirmed the hypothesis that the intimate mixing of alien ions into the photomagnetic **Co-Fe** lattice disrupts the desirable photomagnetic behavior. Restated, the introduction of nickel or chromium ions into the lattice stabilized the magnetization and inhibited the ability to tune magnetization with external stimuli. One unexpected result for this series of compounds was that $\mathbf{Ni_{1-x}\text{-}Co_x\text{-}Fe}$ materials tended to force the lattice into a fully magnetic state, while $\mathbf{Co\text{-}Fe_y\text{-}Cr_{1-y}}$ materials had the effect to force the lattice into a fully non-magnetic state. This effect can be seen in the Mössbauer and temperature dependent infrared data. The evolution of the Mössbauer spectrum as a function of atom substitution shows that the room temperature iron atoms are magnetic for $\mathbf{Ni_{1-x}\text{-}Co_x\text{-}Fe}$ and become non-magnetic with $\mathbf{Co\text{-}Fe_y\text{-}Cr_{1-y}}$, Figure 2 (a). In addition, the temperature dependent infrared data (Figure 2 (b)) shows that the iron atoms lose their ability to switch with atom substitution, thus confirming that nickel substation stabilizes magnetic iron and chromium substitution stabilizes non-magnetic iron. This result explains why when synthesizing heterostructures, a sufficient thickness of the layers was required to observe the largest effect, to avoid disturbing the **Co-Fe**.

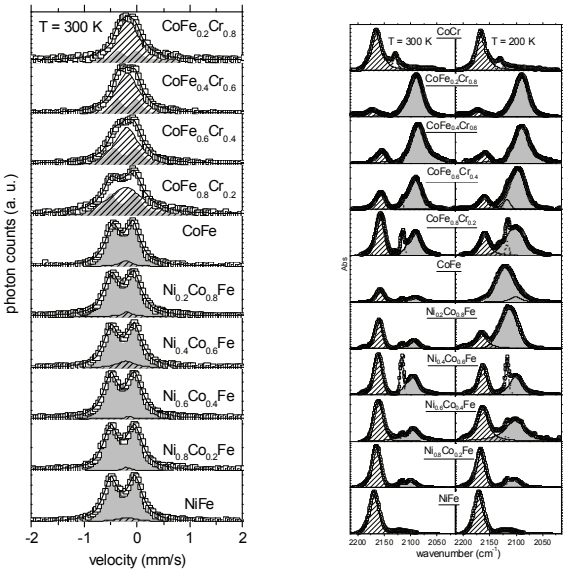


Figure 2. (a) Mössbauer Spectroscopy. Absorption spectra of ^{57}Fe Mössbauer at T = 300 K are shown (□) with a fit (—) that includes an Fe^{3+} doublet (gray) and an Fe^{2+} singlet (stripes). (b) Infrared Spectroscopy. Absorption spectra of FT-IR at T = 300 K (a) and T = 200 K (b) are shown (□) with a fit (—) that includes an Fe^{3+} peak (stripes), an Fe^{2+} peak (gray), and precursor peaks (dotted).

8. Please add your comments (if any):

I learned a lot over the summer and enjoyed working with the Japanese students; everyone from the Professor to the undergraduates were very hospitable to me. One great aspect of the research experience was that I was free to explore other projects that interested me, such as electrochemistry and electron paramagnetic resonance.

9. Advisor's remarks (if any):

During his stay in our laboratory this summer, Daniel worked hard and was helpful to the students. I was so impressed that I want to work with him in the future. I have recommended that he uses a JSPS program in the future to visit and collaborate with my lab.

RESEARCH REPORT

1. Name: Edmund F. Palermo (ID No.: SP10046)

2. Current affiliation: University of Michigan, Ann Arbor, USA

3. Research fields and specialties:
Chemistry

4. Host institution: Nagoya University

5. Host researcher: Professor Masami Kamigaito

6. Description of your current research

Due to the rapidly increasing prevalence of bacteria resistant to traditional antibiotics, and the declining number of new antibiotic drug approvals, there is an urgent need for novel antimicrobials. Host defense peptides (HDPs) represent a class of biomacromolecules of considerable scientific and commercial interest due to their ability to kill bacteria cells without harming host cells. It is generally believed that the biological function of these materials can be generalized to various macromolecular platforms, including synthetic polymers. The features common to HDPs are their small molecular size, net cationic charge, and a fine balance of hydrophilic and hydrophobic residues. By functionalizing the side chains of low molecular weight polymers with hydrophobic and cationic moieties, intended to mimic the common residues in HDPs, synthetic polymers with antimicrobial activity have recently been obtained. After extensive optimization of parameters such as molecular weight, the ratio of hydrophobic to cationic groups, and the identity of the side chain groups, a select few examples were identified which displayed potent antimicrobial while inducing little or no damage to human red blood cells, an activity profile rather evocative of HDPs. Still, the underlying design rationale for such materials retains alarming gaps in knowledge, which have hindered further development. To fill these voids, systematic investigations of polymer structures with precisely defined features will be requisite in the future.

Biological macromolecules such as peptides exhibit precisely defined chemical structures, which enable them to play sophisticated roles in biochemical and biophysical processes. A central challenge in the field of synthetic polymer chemistry has been to control the chemical structures of polymers in a precisely defined fashion which rivals naturally-occurring biomacromolecules. The advent of controlled/living radical polymerization has shown great promise toward exerting control over molecular weight distribution in a wide range of traditionally unruly vinyl polymerizations. In recent years, free radical polymerizations with simultaneous control of molecular weight distribution *and* stereoregularity in vinyl polymers have been developed as well. The free radical polymerization mechanism has been classically considered the most difficult to control, although it also accommodates the widest range of functionalized monomers and is relatively tolerant of impurities. By combining the modern methods of controlled/living free radical polymerization chemistry with methods to govern the stereoregularity, more precisely defined vinyl polymers have become accessible. While these results are deeply interesting from the point of view of basic polymer science, there are certainly a plethora of practical applications suitable for such well-controlled polymeric materials.

7. Research implementation and results under the program

Title of your research plan:

Stereoregular Antimicrobial Polymers

Description of the research activities:

This summer, we synthesized polymers intended to mimic host defense peptides by the cutting-edge methods recently developed in the Kamigaito lab.

The main feature of these polymers which we endeavored to control was the stereochemical regularity of the polymer backbone, known as the "tacticity." The effect of tacticity on the antimicrobial activity or toxicity to human cell expressed by synthetic polymers has not be addressed to date, although it would be expected to play a significant role; polymethacrylates with isotactic configurations (the same stereochemical arrangement along the backbone) are far more flexible that syndiotactic (alternating two different stereochemical arrangements) homologues.

Predominantly isotactic polymers were obtained by reversible addition fragmentation transfer (RAFT) polymerization of triphenylmethylmethacrylate (TrMA) with cyanopropyl ethyl trithiocarbonate (CPETC) as the chain transfer agent. TrMA propagates via a helical gauche conformation in which steric repulsion of the bulky triphenylmethyl side chains gives rise to polymer chains enriched with isotactic diads. Polymerization conditions were adjusted to obtain molecular weights in the range of HDPs (2-4 kDa) and to maintain narrow polydispersity indices. Subsequently, the prevailingly isotactic poly(TrMA) was hydrolyzed in acidic DMSO to afford isotactic poly(methacrylic acid), which was in turn converted, by carbodiimide coupling chemistry, into an isotactic copolymer displaying cationic and hydrophobic side chains, suitable for antimicrobial activity evaluation. For comparison, analogous copolymers were prepared with the same chemical structure, molecular weight, end groups, and polydispersity but without control of the stereoregularity. This was achieved by directly copolymerizing Boc-aminoethylmethacrylate with methylmethacrylate using the same CPETC RAFT agent and polymerization conditions.

After returning to our lab at Michigan, these novel functionalized polymers will be assayed for their antimicrobial activity as well as their toxicity to human cells. By that method, the role of stereoregularity in the biological activity of synthetic polymers will be revealed.

RESEARCH REPORT

1. Name: Megan Paustian （ID No.: SP10047）

2. Current affiliation: University of Maryland, College Park

3. Research fields and specialties:

Biological Sciences

4. Host institution: University of Tokyo, Bunkyo Campus

5. Host researcher: Dr. Rei Ueshima

6. Description of your current research

I performed two methodologically-complementary, simultaneous studies of philomycid niche dimensions and genetics: 1) an independent project to elucidate the ecological circumstances of *Meghimatium bilineatum* invasion in Japan and 2) preliminary research to allow me to form hypotheses for a post-doctoral project on the ecological origins of the philomycid slugs.

For the Independent Project, I sought to determine which human associations may have enabled *M. bilineatum* to establish and spread in historic times by contrasting these niche dimensions with those of *M. fruhstorferi*, a native species. I hypothesized that, as a probable invasive, *M. bilineatum* is found more often in human-disturbed habitat and is a consumer of cultivated plants. I found that *M. bilineatum* is almost entirely restricted to greenspace within urban areas on the mainland, while *M. fruhstorferi* occupies high-altitude forests on the mainland. *M. bilineatum* appears to feed mainly on algae rather than cultivated plants.

In combination with field data collected in the U.S. and China, the Preliminary Research project will provide critical baseline data (niche dimensions, tree resolution) to investigate the ecological and phylogeographic origins of philomycid species diversity. In Japan, populations of *M. bilineatum*, *M. fruhstorferi*, and the Okinawan *Meghimatium* sp. do not overlap, and initial analyses suggest that the species are ecologically distinct.

7. Research implementation and results under the program

Title of your research plan:

Determining the niche dimensions associated with invasion and speciation of the slug genus *Meghimatium* (Pulmonata: Philomycidae) in Japan

Description of the research activities:

I surveyed slugs in natural and disturbed habitats across much of Japan (Honshu and Okinawa) in order to capture the range of environmental conditions occupied by each species (Fig. 1) and to determine which niche dimensions (micro- and macrohabitat characteristics and food preferences) distinguish species. I conducted surveys in urban parks, public gardens, and national parks, seeking active slugs on trees, rocks, and logs during wet periods, or turning over dead logs to find sheltered slugs if conditions were dry. Substrate type and behavior (such as feeding) were noted. I recorded each slug's GPS coordinates, and the GIS program DIVA was used to match coordinates to corresponding habitat characteristics (human disturbance factors - land cover type, human density; landscape factors - altitude, precipitation, temperature, seasonality) derived from WorldClim and additional datasets. I collected specimens to contribute to a molecular tree of the Philomycidae and to confirm species identification.

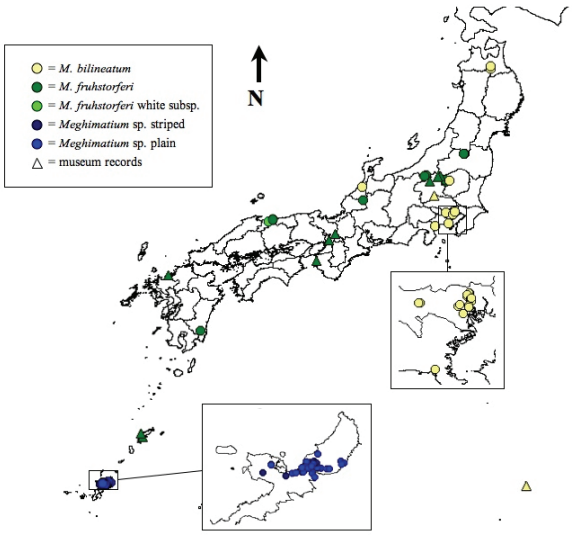


Fig. 1 A total of 427 *Meghimatium* slugs were surveyed at 21localities and 80 sub-localities across Japan. 13 museum records were included in analyses.

Through previous research, Rei Ueshima determined that more than three genetically-distinct *Meghimatium* species occur in Japan, with more likely. I selected four groups of observed slugs (*M. bilineatum*, *M. fruhstorferi*, and the Okinawan *Meghimatium* sp. with "striped" and "plain" morphs) to compare ecologically. One-way ANOVAs showed significant differences among the four slug groups for all factors investigated. Following is a brief summary of notable planned means comparisons (two-tailed t-tests) and Pianka's index of niche overlap, O (where a higher value indicates higher ecological similarity).

Independent Project - As expected of a probable "weedy" invasive species, *M. bilineatum* is smaller than *M. fruhstorferi* (1.71+/-0.08 cm^2 vs. 9.50+/-1.51 cm^2 estimated body area in populations including both adults and juveniles; $df = 25$, $t = -4.206$, $P < 0.000$), and found in locations with much higher human populations (6280 +/-100 vs. 480 +/-160 people per km^2; $df = 69$, $t = 30.081$, $P < 0.000$). Habitat type use is distinct (O = 0.263), with 84% of *M. bilineatum* occupying cultivated or urbanized land while 62% of *M. fruhstorferi* were found in intact forests. However, *M. bilineatum* feeds primarily on algae covering tree and rock surfaces rather than macrophytes; in the habitats observed, it is likely to be a human commensal rather than a pest.

Preliminary Research - *M. bilineatum* and *M. fruhstorferi* are ecologically distinct. *M. fruhstorferi* occupies higher elevations (737 +/-74 m vs. 39 +/- 6 m; $df = 38$, $t = -9.329$, $P < 0.000$) and cooler habitats (10.9 +/-0.7ºC vs. 15.3 +/- 0.1ºC average per year; $df = 40$, $t = 6.679$, $P < 0.000$) with more precipitation (2100 +/-89 mm vs. 1450 +/-15 mm average per year; $df = 38$, $t = -7.353$, $P < 0.000$). The Okinawan slugs were once identified as *M. fruhstoferi*, although subsequent genetic data show them to be distinct. *M. fruhstorferi* shares few habitat types (O = 0.281) with and occupies cooler (10.9 +/-0.7ºC vs. 21.8 +/- 0.0ºC average per year; $df = 38$, $t = -16.811$, $P < 0.000$) and higher (737 +/-74 m vs. 103 +/- 4 m; $df = 38$, $t = 8.691$, $P < 0.000$) sites than *Meghimatium* sp. Precipitation (2100 +/-89 mm vs. 2250 +/-2 mm average per year; $df = 38$, $t = -1.652$, $P = 0.107$) and human population levels are similar (480 +/-160 vs. 365 +/-0 people per km^2; $df = 38$, $t = 0.702$, $P = 0.487$). Although partly geographically separated, the two Okinawan *Meghimatium* sp. morphs are very similar in size (5.4 +/- 0.5 vs. 6.0 +/- 0.3 mm body area; $df = 80$, $t = -0.905$, $P = 0.368$) and ecological habits (shelter O = 0.958, habitat O = 0.936; both consume mostly algae with some fungus). This accords with existing genetic data that show them to be the same species. Following the program, I will perform factorial analysis of ecological characteristics in SAS to better distinguish ecological niches among *Meghimatium* and other philomycid species.

We are in the process of analyzing my collected specimens of *M. fruhstorferi* to determine if any populations comprise new species. After EAPSI, my North American and Asian Philomycidae data will be integrated. I will establish which niche dimensions are correlated with evolutionary distance and in which parts of the philomycid tree, and thus, I will be able to hypothesize how ancient environments contributed to philomycid speciation.

Additional Research - I attempted to survey other invasive slugs to improve their range data, but I only found *Lehmannia valentiana* in Tokyo city and a vaginulid species on Okinawa. I located surprisingly few invasive slugs in Japan. However, the giant African landsnail (*Achatina fulica*) was highly abundant in many locations on Okinawa.

RESEARCH REPORT

1. Name: Miroslav Penchev （ID No.: SP10048）

2. Current affiliation: University of California, Riverside

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Tohoku University

5. Host researcher: Professor Tadahiro Ohmi

6. Description of your current research

The ever increasing world energy demand and the rising environmental concerns over use of fossil fuels, call for the urgent development of clean, renewable, and inexpensive energy technology. Solar cell technology is the most promising candidate, capable of capturing the abundant energy from the sun while being environmental friendly. One drawback of solar cell technology is its high cost of production. There are two strategies that are utilized in the developing of cost efficient solar cell devices; one is by increasing the power conversion efficiency, the other is by lowering the cost of production. Silicon based solar cell is among the most promising candidates, however the high cost of manufacturing of single crystalline silicon remains the main obstacle for the widespread use of this technology. Amorphous silicon (α-Si) thin film solar cell requires much lower production cost, since it uses layers of α-Si only a few micrometers thick, less than 1% of the raw material used in standard single crystalline silicon cells. In addition to α-Si, micro-crystalline silicon (μc-Si) thin films can be incorporated in the fabrication of high efficiency tandem solar cells. μc-Si thin films are fabricated in the same manner as α-Si, however a higher dilution rate of H_2 during deposition gives it distinctive optoelectronic properties, by combining the two materials in a solar cell, higher efficiency is achieved by capturing more of the wide solar radiation spectrum. Based on modeling data this solar cell configuration can yield conversion efficiency of up to 30%. Unfortunately experimentally such high efficiencies in α-Si/ μc-Si cells have not been achieved, mainly due to material defects which arise from the use of current processing equipment and processing techniques. Therefore, the objective of this research project is the development of a new fabrication process for high quality α-Si/μc-Si thin films deposition and fabrication of high efficiency multi-junction thin film silicon solar cells.

7. Research implementation and results under the program

Title of your research plan:

Fabrication of tandem microcrystalline/amorphous silicon thin film solar cells

Description of the research activities:

The deposition of high quality microcrystalline silicon thin films was carried by a newly developed damage-free rotation magnet sputtering system (ROT-MS). This novel instrument employs a rotating helical magnet to generate a number of moving plasma loops on the target surface; this allows for very high utilization of target material and thus lowers fabrication cost, and also results in deposition of very uniform thin films. Furthermore, the strong magnetic field at the target surface generates high density and low electron temperature plasma, which facilitates the deposition of high-quality films free of ion bombardment induced damage.

The research activities in this project involved establishing a set of optimal deposition conditions for fabrication of microcrystalline silicon thin films, optimization of process parameters for rotation magnet sputtering system,

characterization and assessment of the optoelectronic properties of the μc-Si thin films fabricated by ROT-MS.

The process conditions for deposition of microcrystalline silicon thin films which were investigated were: H_2 additive ratio, gas species ratio (Xe/H_2, Ar/H_2), working chamber pressure, substrate temperature, RF power, and target DC voltage (normalized ion flux). While material and optoelectronic characterization consisted of film thickness measurements, optical absorption measurements, X-ray diffraction (XRD) spectroscopy, dark and photo conductivity, and photo sensitivity measurements. Based on the results of these studies deposition conditions were optimized to produce μc-Si thin films with highest light absorption at minimum film thickness.

In addition to intrinsic μc-Si thin films, deposition parameters for fabrication of p-type and n-type μc-Si thin films were also investigated. Doping of the μc-Si films to n or p-type was achieved by the introduction phosphine (PH_3) and diborane (B_2H_6) gas respectively, during the thin film deposition. Deposition parameters which were studied were: H_2 additive ratio, PH_3 and B_2H_6 additive ratio, working pressure, and target DC Voltage. Resistivity measurements on the n and p-type thin films were performed following deposition to determine doping efficiency and optimum deposition conditions.

8. Please add your comments (if any) Although this research project was not completed within the duration of this summer program, since it is a long term project, however some major progress was made in past two months which will pave the way for the successful fabrication of high efficiency solar cells based on amorphous and microcrystalline thin films.

I am deeply grateful to JSPS and NSF for granting me the opportunity to participate in EAPSI program. It has been truly an enriching experience on both personal and professional level. Conducting research in Dr. Ohmi's state-of-art clean room facility, I have gained a tremendous amount of knowledge and experience in the deposition and characterization Si thin films. I have also established professional relationships with researchers from Dr. Ohmi's lab, which I hope will lead to more future collaborations and strengthen the relationship between the my home institution University of California, Riverside and Tohoku University and Dr. Ohmi's research lab.

9. Advisor's remarks (if any): Mr. Miroslav Penchev, who is Ph. D. candidate student of University of California, Riverside (UCR), has stayed for 2 months and promoted enthusiastically experiments to create new microcrystalline silicon thin film solar cells by using newly developed Rotation Magnet Sputtering Equipment free from damages. He has optimized the formation conditions and the thickness of the intrinsic microcrystalline silicon thin films to very effectively absorb the sunlight. After that, he has obtained the optimum formation conditions of n^+ microcrystalline silicon films (Phosphorus doped film) and p^+ microcrystalline silicon film (Boron doped film) by minimizing the electrical resistivity of the microcrystalline silicon films.

He is going to fabricate new microcrystalline silicon thin film solar cell (n^+ i p^+) having a thickness of 6μm by combining the obtained optimized formation conditions just at present. Mr. Miroslav Penchev has had very fruitful experience and practice through these research experiments in the most excellent super clean facility, I believe.

The collaboration between Tohoku Univ. Ohmi Lab. and UCR on the silicon thin film solar cells having very high conversion efficiency is enhanced due to the very great effort of Mr. Miroslav Penchev.

RESEARCH REPORT

1. Name: David Penneys （ID No.: SP10049）

2. Current affiliation:

University of California, Berkeley

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: The University of Tokyo

5. Host researcher: Professor Yasuyuki Kawahigashi

6. Description of your current research

I currently study subfactors and planar algebras, a branch of modern analysis which incorporates aspects of quantum topology. In the 1930s, in his study of quantum mechanics, von Neumann developed the theory of what are now referred to as von Neumann algebras, the most non-commutative of which are called factors. To be precise, a factor is a von Neumann algebra with trivial center (the order of operators matters!). A subfactor is a unital inclusion of factors.

The study of II_1-subfactors (infinite dimensional factors which have traces) was initiated by Jones in 1983. In 1999, he invented planar algebras which allow quantum topology techniques to be applied to the combinatorial description of the “standard invariant” of a finite index subfactor due to Ocneanu and Popa. My current research revolves around the study and classification of invariants of subfactors and planar algebras. I am involved (with many others) in the current program to classify all subfactors with index less than 5 (and hopefully up to index less than t^2=3+(5)^(1/2), where t is the golden ratio). In addition, I am investigating multishaded planar algebras, which are “standard invariants” of finite lattices of II_1-factors. Finally, I am interested in studying subfactors of infinite index, as very little is known about such inclusions.

7. Research implementation and results under the program

Title of your research plan:

Titles of three projects I worked on this summer are:

1. Multishaded planar algebras from quadrilaterals of factors
2. Properties of subfactors from the symmetric enveloping algebra
3. Infinite index II_1-subfactors

Description of the research activities:

1. In joint work with Noah Snyder, we were able to prove that a finite index, finite lattice of II_1-factors gives a multishaded planar algebra, and one can recover the lattice from the planar algebra. Work on these planar algebras, including looking for generators and relations of the GHI-quadrilateral of Grossman and Izumi which includes the exotic Haagerup subfactor, continues as a joint effort with Grossman and Snyder.
2. Along with EAPSI fellow Owen Sizemore, also studying at the University of Tokyo under Professor Kawahigashi, and visiting scholar Thomas Sinclair, we investigated defining properties of subfactors via Popa's symmetric enveloping algebra. Current examples of such properties include amenability and property (T). As this project continues, we hope to define the Haagerup property for subfactors in terms of the symmetric enveloping algebra and show that the free composition Fuss-Catalan subfactors of Bisch and Jones have this property.
3. In joint work with Makoto Yamashita, graduate student at the University of Tokyo, and Steven Deprez, graduate student at KU Leuven, we study infinite index inclusions of II_1-factors. After studying a “folklore” example (which does not appear in the literature, yet is probably known to experts), we are now in a position to study some nontrivial questions arising when the “standard invariant” consists of finite dimensional algebras. This project started while all three of us (and host researcher Professor Kawahigashi) were attending the Operator algebras satellite conference to ICM in Chennai, India during one week of the JSPS program.

RESEARCH REPORT

1. Name: Yevgeniy Plavskin （ID No.: SP10050）

2. Current affiliation: Watson School of Biological Sciences, Cold Spring Harbor Laboratory

3. Research fields and specialties:

Biological Sciences

4. Host institution: National Institute for Basic Biology

5. Host researcher: Mitsuyasu Hasebe

6. Description of your current research

One of the most important discoveries to come out of recent developmental studies is that organisms separated by many hundreds of millions of years of evolution seem to use the same genetic toolkit during the course of their development. This raises the question of how a handful of genes can produce the morphological diversity we see in nature. The answers to this question hold the promise of elucidating not only the evolutionary history of the major groups of multicellular organisms, but also the general principles of how evolution works to create new morphologies from earlier genetic blueprints.

Leaf development in plants presents a unique opportunity to study the mechanism by which genetic pathways are co-opted for the development of novel morphologies. In plants as diverse as gingko and rice, leaves have distinct upper and lower (or adaxial and abaxial) surfaces. Many of the pathways involved in specifying and maintaining adaxial/abaxial polarity are redundant with each other, and have evolutionarily conserved roles in other processes, including embryonic patterning, vascular development, and meristem (plant stem cell) maintenance. Interestingly, many of these pathways are conserved in plants – such as mosses – that diverged from the common ancestor of flowering plants before it evolved true leaves, true meristems, and vasculature. The function of leaf polarity pathways in the development of mosses, as of yet, is unknown, and may yield the key to understanding their true ancestral function. It is tempting to speculate that these genes may be involved in processes reminiscent of their known roles in flowering plant development: for example, stem cell maintenance, or in the development of flattened organs from a radial body axis.

We have chosen to work on one of the conserved pathways involved in leaf polarity, the miR390-dependent trans-acting short interfering RNA (ta-siRNA) pathway. To elucidate the ancestral role of this pathway before its co-option for leaf development, we are exploring its function in the model moss *Physcomitrella patens*, which offers the advantages of a sequenced genome and the capability of making targeted transgenics.

The miR390-dependent ta-siRNA pathway starts with a microRNA, miR390, which associates with an ARGONAUTE protein to cleave a non-coding transcript. This transcript is then converted into a double-stranded RNA and diced into 21-nucleotide-long small RNAs called ta-siRNAs. These go on to silence their target genes. In *Arabidopsis*, maize, and moss, the target genes include Auxin Response Factor (ARF) genes.

Taking advantage of the ability to create targeted transgenics in *P. patens*, we are exploring the miR390-dependent tasiRNA biogenesis pathway throughout moss development. We are doing this by creating loss-of-function mutants in genes requ-ired for ta-siRNA biogenesis, and by monitoring the targets of tasiRNAs throughout moss development using reporter lines and loss- and gain-of-function mutations.

7. Research implementation and results under the program

Title of your research plan: Exploring the evolution of leaf development using the moss *Physcomitrella patens*

Description of the research activities:

Over the course of the summer, I worked with the Hasebe lab to create a number of transgenic moss plants needed to dissect the role of the miR390-dependent ta-siRNA pathway in moss. I performed transformations to create moss deleted for all three miR390 precursor genes, which consequently lack activity of miR390 and the miR390-dependent ta-siRNAs. In order to explore the function of the ta-siRNA targets throughout moss development, I also transformed moss to create strains deleted for two of the four ARF genes targeted by the ta-siRNAs, specifically *PpARF11* and its close paralogue *PpARF12*. I also performed transformations to generate strains in which *PpARF12* target is tagged with a fluorescent protein to monitor its expression. These transgenic lines will soon be ready for verification and subsequent phenotypic analysis.

Under the guidance of members of the Hasebe lab, I have also analyzed the developmental phenotypes of moss strains with perturbed ta-siRNA or ARF target gene function that were generated previously either by me at Cold Spring Harbor Laboratory or by the Hasebe lab. First, we analyzed the developmental functions of *PpARF11* and *PpARF12* in moss. Auxin is an important plant hormone that functions in various aspects of development in all land plants. In moss development, auxin signaling is known to induce formation of filaments known as caulonema. Thus, it may be expected that knockouts of these ARF genes – which mediate the response to auxin – will have a decreased number of caulonema, while increased caulonema formation might be observed in strains overexpressing either ARF gene. In fact, the opposite phenotypes were observed. An important point to consider, however, is that under normal conditions, caulonema begin to form only after about one week of plant growth. Taken with our data, this suggests a developmental switch in the plant's response to auxin, potentially controlled by the miR390-dependent ta-siRNA pathway. There are many examples of miRNAs controlling developmental transitions in animal development, and the miR390-dependent ta-siRNA pathway is thought to control the transition from juvenile to adult leaf growth in *Arabidopsis*.

We also observed a strain reporting the expression pattern of one of the three moss miR390 loci. The tip cell of moss filaments acts as the stem cell, and we confirmed our previous findings that miR390 is expressed in some tip cells but not others, suggesting a transient tip cell expression. In addition, miR390 seems to be expressed in filament cells that are initiating a branch, suggesting a potential connection to cell division or reestablishment of stem cell identity. Supporting the first possibility, lines overexpressing *PpARF11* and *PpARF9* showed cell division defects –especially an incorrect lane of cell division –during filamentous growth.

My research from this summer suggests a link between the miR390-dependent ta-siRNA pathway and both developmental transitions and cell division in moss. We plan to explore both these directions further to elucidate the ancestral role of this unique small RNA pathway and gain a better understanding of its contribution to the diversification of land plant development throughout evolution.

8. Please add your comments (if any):

In addition to allowing me to learn a great deal about moss biology, this summer program has also let me observe first-hand what science is like in Japan and to interact with Japanese scientists on an everyday level. This was incredibly valuable for two main reasons. First, science is an international undertaking, and learning to effectively communicate with scientists in other countries – as well as setting up contacts and collaborations with them – is incredibly advantageous. Second, by talking to the researchers in my host lab, I was able to learn a lot about how things like government funding and science education function in Japan. Understanding the differences between the Japanese and American systems, and the situations when one works better, is absolutely key if we want to reform and improve our nations' science policies in the future.

RESEARCH REPORT

1. Name: Laura K. Reynolds （ID No.: SP10052）

2. Current affiliation: University of Virginia, Charlottesville, VA 22903 USA

3. Research fields and specialties:
Biological Sciences

4. Host institution: Akkeshi Marine Station
Field Science Center for Northern Biosphere
Hokkaido University

5. Host researcher: Dr. Masahiro Nakaoka

6. Description of your current research

Seagrasses are submerged, flowering plants that are foundation species that provide many ecosystem services including sediment and nutrient filtration, sediment stabilization, and provision of nursery and resident habitat for many ecologically and economically important invertebrate, shellfish, finfish, and marine mammal species (Hemminga and Duarte, 2000). Waycott et al (2009) estimate that the nutrient cycling provided by seagrass meadows around the world is worth $1.9 trillion dollars. Costanza et al. (1997) claim that 40% of the global renewable ecosystem services (worth over US$33 trillion per year) are provided by shallow waters, and they estimate that seagrass ecosystems deliver a value that is at least twice as high as the next most valuable habitat.

Ecosystem functions such as stability and production are often positively correlated with measures of biodiversity (Hooper et al 2005). Biodiversity, however, is a hierarchical concept that can be measured on the order of ecological guilds all the way down to species and even to genes within species. There is growing evidence that diversity at all of these levels can have impacts on ecosystem function and that in monospecific communities such as crop field and seagrass meadows, genetic diversity is associated with increased ecosystem functions (See Reusch and Hughes 2006).

Several recent studies have suggested that genetically diverse populations of seagrass are more resistant and resilient to ecosystem disturbances and may be more productive and act as a better habitat (Hughes and Stachowicz, 2004; Reusch, 2005). It has also been suggested that more diverse assemblages are more fit in that they reproduce sexually and clonally more effectively (Williams, 2001; Hammerli and Reusch 2003). The applicability of these studies to the natural world, however, has been questioned since they use a very low, narrow range of diversities, since they only observed very small ($1m^2$) plots (See Arnaud-Haond et al 2010). The goal of my JSPS Summer Program research is to explore the role of genetic diversity in the ecosystem functioning and stability of large natural seagrass meadows.

7. Research implementation and results under the program

Title of your research plan: The role of genetic diversity in seagrass meadow function and stability

Description of the research activities:

At 6 sites in Akkeshi-Ko estuary and Akkeshi Bay, seagrass productivity and invertebrate density was measured in 3 replicated 1m x 1m plots. Samples for genetic diversity were also collected and preserved for analysis in the US this fall. A multiple regression approach will be used to determine if plot level measurements are correlated with whole meadow measurements and if areas with higher diversity provide more ecosystem services.

Using a map created with GIS by researchers at Akkeshi Marine Lab, 12 sites were selected that range in seagreass meadow age from 2 years to 43 years. It is assumed that the meadows that are older and more stable over time. At each of these sites, samples for genetic diversity were collected and preserved for analysis in the US this fall. Once diversity has been measured, a multiple regression analysis will be used to determine if location and conditions (ie water depth and salinity) or age of the meadow is more closely correlated with genetic diversity.

The results of these analyses will help us understand the importance of genetic diversity to seagrass meadow stability and functioning. It will help to guide good conservation practice.

RESEARCH REPORT

1. Name: Thomas Reynolds （ID No.: SP10053）

2. Current affiliation: University of California - Berkeley

3. Research fields and specialties:
Engineering Sciences

4. Host institution: Kyushu University

5. Host researcher: Professor Noritaka SAITO

6. Description of your current research

While at the University of California – Berkeley, my work has explored the microstructure-processing-property relationship for ceramic/metal interfaces joined using PTLP bonding. Recently we have shown that using Partial-Transient-liquid-phase (PTLP) bonding is an elegant method of joining materials at reduced temperatures to protect fragile microstructures. PTLP bonding was inspired by the transient-liquid-phase- (TLP) bonding techniques used to join nickel-based superalloys. In TLP bonding, an interlayer containing a melting-point depressant (MPD) is placed between the nickel-alloy components. At the bonding temperature, the MPD in the molten interlayer begins to diffuse into the adjoining nickel-alloy. As the amount of MPD in the interlayer is depleted, the liquid-layer thickness decreases until the liquid has solidified entirely. The MPD continues to redistribute through the now-solid body until the assembly's composition is homogenous. As a result of the homogenization process, the final bonded assembly has very similar thermal and mechanical properties to those of the original nickel-alloys.

PLTP bonding of ceramics relies on a thin, multilayer interlayer consisting of a core metal coated with a thinner cladding metal. The cladding acts as the MPD, causing a liquid layer to form between the core and the ceramic at the bonding temperature. The liquid ideally wets the interface, flowing into and filling interfacial voids and gaps. The MPD diffuses into the solid core, causing the liquid layer to decrease in thickness, and eventually solidify. The resultant ceramic/metal/ceramic assembly has a strong, solid bond with a remelt temperature greater than the original joining temperature. This makes PLTP bonding a useful technique in the manufacture of high-temperature devices (similar to diffusion bonding), while the presence of a liquid phase leads to shorter processing times and less rigorous surface preparation (similar to brazing).

The fracture strength of a bonded assembly is dependent on a number of parameters; the interfacial adhesion, the residual thermal stresses, the formation of reaction products, and the morphology of interfacial voids all play a role in determining the fracture stress of a bonded assembly. Of these, only the residual stresses are determined by the bulk compositions of the parts being joined. The remaining parameters are controlled by the composition at the interface itself. In order to fully exploit the high-temperature capabilities of ceramics, a rapid and reliable bonding technique that produces bonded assemblies with both a high use temperature and a high fracture strength is needed. PTLP bonding

addresses these issues. In my current work using Ni/Nb interlayers, PTLP bonded Al_2O_3-Al_2O_3 assemblies have been shown to be strong, reliable, and have high temperature capabilities. The reason for this is not fully understood due to the difficulty in deconvoluting the contributions of the thermally-induced residual stresses from those of the interfacial adhesion and morphology to the final fracture strength. In order to better understand these interactions, my research objective has been to develop a modified PTLP bonding technique for Al_2O_3-Al_2O_3 assemblies that allows the interface and interlayer chemistries to be tailored independently. With this technique I am examining the individual contributions of the interface and interlayer to the fracture strength of a bonded ceramic assembly. The results of this study should help in the development of other TLP bonding systems to join various types of ceramics for a range of applications.

7. Research implementation and results under the program

Title of your research plan:

Controlling Interfacial Composition to Optimize Fracture Strength in Partial-Transient-Liquid-Phase Bonded Ceramics

Description of the research activities:

During my stay in Japan my research has focused on developing a better understanding of what compositional changes occur during the PTLP process. This was done in two ways: chemical analysis of existing bonded assemblies using electron-probe micro-analysis (EPMA), and through wetting experiments where the contact angle of different molten metal alloys on ceramic substrates was measured. Before arriving, I fabricated a number of PTLP-bonded Al_2O_3-Al_2O_3 assemblies using different interlayer chemistries. Each assembly was designed so that, prior to bonding, the composition at the interface was independent of the composition of the interlayer core. It was hoped that this fabrication technique would allow the wetting properties at the interface and the thermal expansion of the interlayer to be controlled independently. In Japan, these bonds were machined and a portion of each was made into EPMA suitable samples. EPMA line scans were performed across the interface of each sample. This was to better understand the diffusion processes that occurred during bonding, and to determine the final composition profile of the interlayer. This information will also be used to help estimate the thermal expansion coefficient of the interlayer. The remaining bonded assemblies were further machined for mechanical testing that will be performed at a later date. To help design future PTLP interlayers, wetting experiments of different metal alloys on ceramic substrates were performed. These experiments gave insight into which MPD-based alloys will yield low contact angles, and what role atmosphere plays in the ability of the alloys to wet a ceramic surface. With this information, future PTLP interlayers can be designed to maximize the interfacial strength, and thus improving the robustness of the overall bonds.

RESEARCH REPORT

1. Name: Ender (Shana) Ricart （ID No.: SP10054）

2. Current affiliation: University of Chicago, Department of Anthropology

3. Research fields and specialties:

Social Sciences

4. Host institution: Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology

5. Host researcher: Dr. Ryutaro Takahashi

6. Description of your current research: My doctoral research at the University of Chicago focuses on the scientific practice of gerontology in Japan. In the future I hope to carry out cross-cultural comparative studies of gerontology in Japan and the United States and aging more broadly. These two countries are similar economically, have a large aging population with high life expectancy, and conduct scientific, medical and social research on aging. Yet, Japan and the United States have vastly different histories, political structures and cultures leading to diverging approaches to aging and the aged. Through ethnographic research I hope to uncover cultural conceptualizations of the mechanisms of aging, aging process, personhood, and nature that might shape gerontological research design and analysis as well as Japan's particular emphasis and response to an 'Aging Society'. This summer I conducted ethnographic research at the Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology (*toukyourouzinsougoukenkyusho*,東京老人総合研究所), colloquially referred to as"Rouken"(老研). Geriatric research at Rouken is divided into research on biology and medical science and research on social and human science. This latter division is a multi-disciplinary team comprised of psychologists, nurses, medical doctors, political scientists, and social welfare researchers. Taking into account my linguistic and time constraints I focused my research this summer on how a trained qualitative researcher such as an anthropologist might contribute to multi-disciplinary gerontological research teams by providing more in-depth understanding of socio-cultural specificities of aging to improve gerontological research method and social policy design, and 2) more readily enable cross-cultural comparisons by accounting for local differences.

7. Research implementation and results under the program

Title of your research plan: Future Aged Society: How Anthropology Can Contribute to Multi-disciplinary Gerontological Research Teams

Description of the research activities: As an anthropologist the core of my research involved participant–observation and structured or unstructured interviews. Participant observation entails both active engagement with others and events but simultaneously paying close attention to what is being said and done and how and why. I kept a field notebook at hand and would later regularly type up detailed descriptions of day's events. Given my level of language skill and the institutional nature of this field-site, I was most readily able to observe Rouken researchers' data collection and data analysis processes as well as read their English publications. I observed: medical examinations of the elderly, home visit to bed-ridden oldest-old, research being carried out on early intervention in Sarcopenia (loss of muscle mass due to aging), preliminary data collection on the preventative effects of exercise on dementia, a conference on palliative care in Tokyo and discussions relating to research or care of the elderly. I was additionally given guided tours of a nursing home and day care center for the active and mentally or physically impaired elderly, of neighborhoods in Tokyo renown for the numbers of elderly residence, of Rouken's facilities and hospital. I was able to participate in the nursing home and day-care centers yearly festival as

well as take preliminary tests for dementia and Alzheimer's with 100 other Japanese elderly. This summer I additionally conducted 11 in-depth interviews with gerontologists at Rouken and an interview with an Oberlin University gerontology professor emeritus. These interviews lasted for nearly 2 hours each and were carried out in English and Japanese. Transcription on average took about 5 hours for every hour of audiotape. I was also able to make many important research contacts with scholars, professors, and researchers related to aging studies, philosophy of science, and anthropology that reside or work in Japan.

Research Results: An anthropologist trained in ethnographic research method and analysis can most readily assist in Rouken's research division of Social and Human Science. However, it is not a simple matter of insertion or addition. In order to understand how and where the anthropologist might contribute requires a discussion of Rouken's economic structuring, which both limits and enables geriatric research projects and designs. Rouken receives about 70% of its research funding from the Tokyo Metropolitan Government and roughly the remainder 30% from the National Government (such as Ministry of Health, Labour and Welfare (kouseisyou 厚生省) or , Japanese Ministry of Education, Culture, Sports, Science and Technology (monbukagakushou 文部科学省 or simply MEXT)), Corporations, Universities, or local municipalities such as the neighboring Itabashi- ku (板橋区). Given Rouken's dependency upon outside funding, specific research interests are tempered by the desires of the grant-givers and the obligations they incur. Of course this is not an unfamiliar situation, many social scientists and institutional researchers find themselves in similar circumstances but when it comes to inter-disciplinary research teams, fund acquisition furthermore impact research design and method. Funding agencies, governmental or corporate, valuate quantitative method and analysis over qualitative. Insofar as gerontology strives to improve the well-being of the elderly, elderly-care, their caregivers and society, gerontological research must extend beyond the confines of a scholarly and specialty publications and knowledge cultures. Gerontological research data must either: hold significant statistical weight to motivate governmental action and merit social policy innovation and change, or the research method they design must be more broadly applicable for the production of mass calculations at a national or international level. In both situations the final form is most readily quantitative, be it the quantitative data of Rouken or the data resulting from the mass reproduction of Rouken's research design. Given this quantitative bias, researchers in multi-disciplinary teams who are primarily trained in qualitative methods and analysis may encounter a separation of personal research interests from institutional, team oriented projects.

Despite this, researchers at Rouken readily utilize qualitative research and analysis in the creation of quantitative data and data collection methodology. Interviews inform or supplement surveys and mass-data collection by highlighting key indicators of mental and physical conditions that are being targeted for gerontological research. In the analysis structured and semi-structured interviews, patterns or themes are abstracted and then restructured into surveys and questionnaires. Within these early phases of research an anthropologist trained in ethnographic method and analysis could most readily contribute. An anthropologist trained in recognizing and analyzing cultural conceptualizations could assist in the construction of interview questions, the analysis of interviews for meaning, significance, and patterns and thereby the later construction of more accurate survey and questionnaires.

8. Please add your comments (if any): This has been a wonderful opportunity. I really enjoyed being part of a research team and community. I could not think of a better way to be introduced to Japanese culture. I did not feel like an outsider. Through EAPSI summer program I have made many important contacts with researchers and professor and I have also made some life-long friends.

RESEARCH REPORT

1. Name: Alexander K. Rubin (ID No.: SP10055)

2. Current affiliation: Colorado State University (just finished MS.)

3. Research fields and specialties:

Physical Sciences

4. Host institution: University of Hokkaido

5. Host researcher: Dr. Futoshi Nakamura

6. Description of your current research

The sediment detention and hydrologic alteration caused by dams and gravel mining creates a variety of impacts on downstream geomorphic forms and processes. Downstream impacts are often costly and include threats to infrastructure, water quality deterioration, and ecologic impacts to fisheries and other communities. Our research investigated the influence of human activities on channel incision- a widespread and ongoing problem in Japan that severely impacts both ecosystems and infrastructure. To investigate causes of channel incision we studied the influence of 1) sediment detention by dams, 2) hydrologic alteration by dams, and 3) gravel mining directly from the channel. The magnitude of flow and sediment alteration by dams was assessed from an extensive database of reservoirs throughout Japan that was previously compiled by Dr. Futoshi Nakamura. The software IHA (Indicators of Hydrologic Alteration) was used to assess dam-induced hydrologic change by comparing inflowing and outflowing discharge records. Sediment detention in reservoirs was calculated from annual sedimentation data collected by reservoir managers. Data regarding gravel mining and the magnitude of incision was collected by the Ministry of Infrastructure and Transport. My research combines the two datasets to investigate the influence of sediment detention, hydrologic alteration, and gravel mining on the occurrence and magnitude of channel incision.

7. Research implementation and results under the program

Title of your research plan:

Controls on Downstream Impacts of Dams

Description of the research activities:

My research in Japan was twofold: 1) To study and to visit rivers and river engineering projects to better understand the philosophy and implementation of river management activities in Japan. Since the study of river geomorphology requires an integrated knowledge of climate, biological, and physical processes of entire watersheds, I visited several sites (Tomakomai, Usu, Tokachi, Toyohira, Kushiro, Gifu, and Tsukuba) to visit ongoing research areas/facilities- specifically locations experiencing channel incision. 2) I translated, organized, and integrated two large databases from different sources and different rivers- compiling and quantifying data on flow alteration, sediment detention, gravel mining, and channel incision. Data analyses are still ongoing.

RESEARCH REPORT

1. Name: Christopher J. Schilling （ID No.: SP10056 ）

2. Current affiliation: Univ. of Illinois at Chicago (U.S.)

3. Research fields and specialties:

Social Sciences

4. Host institution: Nagoya University

5. Host researcher: Jun Kawaguchi

6. Description of your current research

To successfully access needed information in memory, it is important to push aside irrelevant, similar information, which can cause difficulty and errors in retrieval. This phenomenon is called retrieval-induced forgetting (RIF), and serves an important role in our ability to keep relevant information up-to-date. However, retrieval success is dependent on other factors such as the encoding and retrieval contexts. The current study examined these factors in relation to RIF. In doing so, the experiment tested an inhibitory account of RIF, which suggests that irrelevant information is suppressed in order to make relevant information more active. In addition, we tested the boundaries of RIF by observing whether the phenomenon is dependent on contextual cues, or if contextual cues were not used so strongly at the time of test.

7. Research implementation and results under the program

Title of your research plan: Forgetting does not follow us: Recall improves after an environmental context change

Description of the research activities:

Thirty-six Japanese university students studied a series of category-exemplar pairs in Japanese (e.g. 鳥 – ハヤブサ, Bird – Falcon). There were eight categories and six items in each category, totaling to 48 studied items. Next, participants performed a generation task and came up with new items from only four of the studied categories. Here, participants were given the category and a single Japanese character that did not match any previously studied items (e.g. 鳥 – ス, Bird – S). Participants were asked to generate several new items in each of the four categories that started with the first character given (e.g.「スズラン」, Sparrow). These responses were written down.

At this point, half of the participants were moved to a different room to implement a context change. In this condition, a new experiment of the opposite sex finished the last phase with the participant. The other half of participants remained in the same room for the entire experiment.

Finally, participants were tested on all 48 studied items from the first part of the experiment. Similar to the generation task, participants were shown the category and the first character of a studied word. Participants responded aloud while a nearby researcher recorded their responses.

We measured the recall of competitors (items in a generated category) compared to baseline items (items not in a generated category).

An analysis of variance revealed no main effects of context-change condition nor item type, but we did observe a significant interaction of item type and context change condition, $F(1,30) = 5.72$, $p < .05$. Planned comparisons revealed that participants recalled more competitors in the context-change group than the no context change group $t(30) =$, but recall for baseline items did not differ between groups.

Results of the experiment replicated previous retrieval-induced forgetting effects in the no-context change group, $t(15) = -2.85$, $p < .05$, which is to say, participants forgot more studied items in categories from which they generated new words than in categories from which they did not generate new words. Such forgetting was not observed for participants in the context change group, although the current studied suffered from low power. With additional participants, it appears likely that significant effects would emerge.

Astonishingly and contrary to prior context-change work in memory, participants who went through a context-change recalled more studied items compared to participants who did not go through a context change. Usually, a context change diminishes the recall of studied items, because contextual cues are no longer available to aid in recall. However, these effects are typically observed using unrelated stimuli, whereas the current study uses categorically-related stimuli. Based on this, we conclude that participants are not using context cues as strongly during encoding of semantically-related materials. Furthermore, while contextual cues are not used to recall items at test in this case, a change in context appears to release inhibition of previously studied items. This suggests that encoding of semantic relations is grounded in the specific context that items are learned and/or practiced in.

8. Please add your comments (if any):

Having been able to conduct this experiment with the help of Prof. Kawaguchi and several of his graduate students, I have many ideas about what I would like to pursue for my prelim proposal and doctoral thesis. I appreciate the opportunity that JSPS, Nagoya University, and the Kawaguchi Memory Lab has granted me in this program.

RESEARCH REPORT

1. Name: Daizaburo Shizuka （ID No.: SP10057）

2. Current affiliation: University of California, Santa Cruz

3. Research fields and specialties:

Biological Sciences

4. Host institution: Rikkyo University

5. Host researcher: Dr. Keisuke Ueda

6. Description of your current research

My research broadly encompasses the evolution of social strategies and behavior in birds. In particular, I am interested in the relationship between cognition and evolution of behavior.

One of my major projects involves the evolutionary dynamics between brood parasites (birds that lay eggs in the nests of other birds) and their hosts who receive those eggs. This peculiar reproductive strategy has been an interesting subject for evolutionary biologists not only because of its outlandishness, but also because it is subject to behaviors that have clear fitness costs and benefits for both parasites and hosts.

In particular, I am interested in the evolution of anti-parasitism strategies in hosts of brood parasites. That is, how do hosts mitigate the costs of parasitism through behaviors such as nest defense, egg rejection and chick discrimination? For example, in a prior study, I showed that American Coots, who often play host to parasitic eggs of conspecifics, are able to identify and reject these parasitic chicks. My research on host strategies in conspecific brood parasitism (parasitism within species) of American Coots is very complimentary to the research on some Australian brood parasite host species conducted by students in my host lab of Dr. Keisuke Ueda at Rikkyo university. They have found that two species of gerygones are able to recognize and reject parasitic Little Bronze Cuckoo chicks. Strikingly, coots and gerygones are the only known species that practice this type of host defense. These species, though they are evolutionarily distant and face different ecological challenges, have both evolved an extremely rare host strategy—recognition and rejection of parasitic chicks. Using this commonality as a starting point, our aim was to discuss and investigate the cognitive bases of these types of anti-parasitism strategies, as well as other links between recognition and the evolution of major behavioral strategies.

7. Research implementation and results under the program

Title of your research plan:

Host defense against brood parasitism: Two missing pieces of an evolutionary puzzle.

Description of the research activities:

Based on discussions and meetings that took place this summer, we have begun work towards two publications in international journals. My planned research project did not involve data collection during the summer (the breeding season for the gerygone system is in the Japanese winter), but rather on building a comparative framework that ties together our two focal study systems. We were also confronted by the logistical constraint that one of the lab members who were principally involved in the project had recently graduated, and another was in the middle of

recruitment for a job. Despite these challenges, I was able to meet with the key members a number of times, and together with another grad student currently in the lab, we have come up with at least two potential manuscripts, which we will begin drafting soon. One paper, on the natural history and evolution of brood parasitism in the Little Cuckoo (the brood parasite of gerygones in Australia), will help uncover potential ecological factors that tie together the findings of my American coot study and their gerygone studies. Another paper will be a broad comparative study of hatching patterns of various brood parasites in relation to their hosts, which will help uncover other potential species pairs that may be similar to our systems. We are further considering potential funding sources (either in Japan or US) that could help us conduct more field studies that compliment these working papers.

Another major goal for this summer was to present my findings widely to the Japanese scientific community to foster networking opportunities and solicit perspectives on the topic from researchers here. In this, I was quite successful. I conducted three presentations of my research – including one presentation of some very new projects I'm working on that I have not presented elsewhere. As a result, I gained the opportunity to discuss my work at length with researchers at the National Museum and University of Tokyo, as well as various alumni of the Ueda Lab, who are scattered around different institutions across Japan. My research was then featured in a public seminar on avian natural history at the National Museum's Institute for Nature Studies. I also conducted a lecture to masters students of Life Sciences at Rikkyo University, which was also very productive.

An unexpected and particularly productive discovery for me this summer has been the appreciation for the unique natural history of brood parasitism in Japan, and the long history of research on brood parasitism in Japan. This country is quite unique in being home to four distinct species of brood parasitic cuckoos (compared to one species in Europe, where much of the research has been conducted), and this leads to a unique multi-species interaction that influences the course of coevolution between brood parasites and hosts. Furthermore, Japan has an exceptional written record of natural history, dating back at least to 8th century. This has helped Japanese researchers track changes (or stability) of brood parasite-host associations over more than a millennium. At the same time, the island biogeography of Japan facilitates a mosaic of interactions between parasite and host species, ripe for the study of "coevolutionary hotspots". Several field trips with different members of the lab have also helped identify potential field sites for these studies. This has led to discussions about the potential for me to join or help start some research on brood parasite-host dynamics in Japan.

All in all, my summer research experience through JSPS is likely to lead to two publications, which significantly increases the scope of my work as well as that of the Ueda lab. I am also optimistic that the connections established here will lead to funding for a collaborative research project on comparative natural history of brood parasite systems. These are systems that have much more to be explored, and I see much opportunity for future collaborations stemming from the connections established during my time here.

8. Please add your comments (if any):

This summer has been a unique experience that has dramatically increased my future research possibilities, as well as a new network of colleagues with whom I will remain connected for the rest of my career. Being a Japanese national working in the U.S., this has been an invaluable opportunity to establish a presence in the Japanese scientific community. Without this program, I am not sure I would've have ever had the opportunity to become involved with Japanese scientists to this extent.

RESEARCH REPORT

1. Name: James Owen Sizemore （ID No.: SP10058）

2. Current affiliation: University of California – Los Angeles

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: University of Tokyo

5. Host researcher: Yasuyuki Kawahigashi

6. Description of your current research

The systematic study of what are now called von Neumann algebras was initiated by John von Neumann in the mid 1930's. From a mathematical perspective, his motivation was group representation theory and ergodic theory, while from a physical perspective his motivation was closely tied in with Heisenberg's work.

Guided by experimental results from spectroscopy, Heisenberg realized the importance of matrices for, what was at the time, the newly emerging quantum mechanics. Von Neumann realized that, in order to accurately model a quantum system, infinitely many degrees of freedom were needed, and thus he attempted to generalize the ideas of Heisenberg from matrices to operators on an infinite dimensional Hilbert space. The resulting objects, von Neumann algebras, have seen intense study since the 1930's and have given rise to applications in such diverse areas as: knot theory, statistical mechanics, quantum field theory, free probability, noncommutative geometry, representation theory, ergodic theory, and descriptive set theory.

Much of the work in the field of operator algebras from the 1930's to the late 1970's culminated in two main results. First, a complete classification in the amenable case. Second, the realization that the classification of all von Neumann algebras largely boils down to classification of type II_1-factors and their automorphisms.

In the last decade there has been many breakthroughs in the classification of these factors, solving problems that date back to the beginning of the subject. These new techniques, known as Popa's deformation/rigidity theory, center around transferring ideas from representation theory of infinite discrete groups to von Neumann algebras.

A second thread in the study of von Neumann algebras is the study of inclusion of two finite factors, known as Jones' theory of subfactors. For many important cases, the amenable ones, such inclusions are completely classified by their tower of higher relative commutants, known as the standard invariant, the of study of which was pioneered by Sorin Popa and Adrian Ocneanu. However, apart from a few results the classification in the non-amenable case remains wide open and, in fact, is currently a relatively inactive area of research.

7. Research implementation and results under the program

Title of your research plan:

Operator Algebras and Ergodic Theory.

Description of the research activities:

Working with fellow EAPSI member David Penneys, we used tools and ideas from deformation/rigidity theory to classify infinite depth subfactors. As stated above the classification of non-amenable subfactors remains largely wide open. Largely, this is due to the fact that many of the strong combinatorial techniques of subfactors no longer work in this setting. However, the non-amenable setting is exactly the situation under which deformation/rigidity techniques have produced such striking results. Thus we worked to apply deformation/rigidity ideas to the classification of non-amenable subfactors. This line of research is quite open and thus is an avenue for future collaboration.

The central tool in our study of non-amenable subfactors was the symmetric enveloping algebra of Popa. This is an algebra which encodes the fusion data and tower of higher relative commutants associated with a given subfactor. Fortunately, the structure of the symmetric enveloping algebra is such that it allows deformation/rigidity techniques to be applied to study the original subfactor. We were able to define the Haggerup property for subfactors and use the symmetric enveloping algebra to show that certain examples of subfactors, which should have the Haagerup property, in fact do.

Further research in this direction, which we hope to continue in our collaboration, involves further investigating the connection between the fusion algebra associated to a subfactor and the symmetric enveloping algebra. This could lead to the continued interplay between representation theory of groups, property (T) and Haagerup property, and probabilistic properties of groups, random walks and Poisson boundaries.

A second thread of research this summer under the supervision of Professor Kawahigashi was the continuation of the study of rigidity properties for von Neumann algebras coming from ergodic actions of wreath product groups. Using recent work of Ioana, Popa, and Vaes I made significant progress toward W*-superrigidty, which is the strongest possible rigidity phenomenon, for Bernoulli actions of certain wreath product groups. While this is not the first such superrigidity theorem, it has the significance that involves groups that do not have a normal subgroups with the relative property (T). The removal of the relative property (T) assumption will be of crucial importance in the resolution of an important conjecture of Popa, Ioana, Chifan, and Peterson. Namely that the Bernoulli actions of a group is W*-superrigid if and only if the group is non-amenable and has vanishing first l_2-betti number.

RESEARCH REPORT

1. Name: William B. Sutton （ID No.: SP10059）

2. Current affiliation: Research Associate, Alabama A&M University

3. Research fields and specialties:
Biological Sciences

4. Host institution: Tottori University

5. Host researcher: Dr. Nobuo Tsurusaki and Dr. Sumio Okada

6. Description of your current research

My research during the summer 2010 EAPSI program examined habitat selection among different life stages of Japanese Giant Salamanders (*Andrias japonicus*). *Andrias japonicus* is one of the largest living amphibians, which can reach a total length of 150 cm. Although this amphibian is of high cultural importance in Japan, most of the published literature has focused on genetic relationships of adult salamanders and very little data exists regarding the natural history differences among different life stages of this salamander.

We used radiotelemetry to examine habitat use differences among three life stages (i.e., adult, juvenile, and larvae) of *Andrias japonicus*. Our research was centered in two study sites in Tottori (Tsuchia River) and Hiroshima (Ikuritani River) prefectures. Both rivers are small to medium in size and support populations of *Andrias japonicus*. Although many rivers in Japan support populations of adult *Andrias japonicus*, it is difficult to find successfully breeding populations and subsequently larval and juvenile salamanders.

Each stream was searched during the day and night via visual surveys and by turning over rocks to capture salamanders. We measured snout-vent length (cm), total length (cm), head width (cm), and tail height (cm) and marked each individual with a unique injectable passive integrated transponder (PIT) tag. Radiotransmitters were attached to the tail of each individual by passing a small piece of monofilament fishing line through the tail and securing each end of the fishing line with small plastic disks and aluminum clamps. We located salamanders daily using a three-element Yagi antenna and a receiver unit. As salamanders were located, we recorded location data and completed a maximum of three habitat plots for each individual. Habitat plots were delineated by placing a 0.75 m^2 habitat grid around the location. At each habitat plot, we recorded stream substrate data (e.g., percent cover of sand, gravel, cobble, rocks, and vegetation), stream physical data (e.g., stream depth (cm), stream width (cm), distance to nearest bank (cm), and stream velocity (m/s)), and water chemistry data (e.g., water temperature (°C), dissolved oxygen (ppm), and pH)). To evaluate whether habitat selection was different from random stream sites, we completed the same habitat analysis at randomly located sites within 50 m of each salamander location.

7. Research implementation and results under the program

During this research we were able to successfully monitor 25 total salamanders (i.e., 5 larvae, 9 juveniles, and 11 adults) at the Ikuridani River site (19 salamanders) and the Tsuchia River site (6 salamanders) located in Hiroshima and Tottori prefectures, respectively. In total, we were able to obtain approximately 300 individual locations and were able to complete 106 habitat plots (53 used plots and 53 random locations) for all monitored salamanders.

Adult salamanders tended to use microsites that possessed large rocks (> 100 cm), deep water (> 30 cm), and very little flow, whereas larval and juvenile *A. japonicus* tended to occupy microsites with relatively small rocks (~40 cm), shallow water (10-20 cm), and lower stream velocity (10-20 m/s). In addition, larvae and juvenile *A. japonicus* tended to be located nearest the stream bank where water levels were lower in comparison to adult and random stream locations.

Title of your research plan:

Microhabitat Use and Substrate Choice of Larval Japanese Giant Salamanders (*Andrias japonicus*)

Description of the research activities:

A majority of my efforts were spent in the field surveying for adult, juvenile, and larval *A. japonicus*. Once transmitters were attached to study individuals, I radiotracked each individual daily and completed habitat analyses for these individuals. During periods of heavy rain or unsuitable stream conditions (i.e., floods), which were both very prevalent during most of June and July during the rainy season, I assisted with another field project examining the spatial ecology and macrohabitat selection of the Forest Green Frog (*Rhacophorus arboreus*) at Mt. Hyonesen in Tottori Prefecture.

8. Please add your comments (if any):

I would like to thank the JSPS along with the National Science Foundation for providing this excellent opportunity. Through this program I was able to complete exciting research and also make contacts with potential longterm collaborators. I will remember this experience for the rest of my life and hope that someday I will be able to return to continue research in the future.

RESEARCH REPORT

1. Name: Scott D. Swensen （ID No.: SP10060）

2. Current affiliation: Stanford University

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Disaster Prevention Research Institute, Kyoto University

5. Host researcher: Professor Masayoshi Nakashima

6. Description of your current research

Several contemporary studies forecast disastrous outcomes should a strong earthquake strike near a large urban area in the U.S. The U.S. Geological Survey recently released a report which predicts 1,800 deaths, over $200 billion in economic losses, and the displacement of more than 200,000 people should a magnitude 7.8 earthquake scenario event occur on California's southern San Andreas Fault. Comparably devastating consequences are predicted for earthquake scenarios occurring near San Francisco. Much of the monetary loss and the disruption to residential occupancy is expected to occur due to damage to light-frame, low-rise residential structures. These buildings are generally only one to four stories in height, with structural systems composed of wood or cold-formed steel framing covered with some form of rigid sheathing. Though such structures have been shown to provide adequate life safety during moderate and severe ground shaking, the resulting monetary loss and down time can be substantial.

In an effort to provide a more robust and sustainable residential housing infrastructure, a new method of designing low-rise residential structures is sought. Over the past two decades, increased emphasis has been placed on providing significant structural ductility and reducing lateral building strength. This shift has been reflected in building codes and construction practices. This emphasis stems from a belief that providing less lateral strength and more ductility will lead to systems where inelastic damage is produced early on in an earthquake event (i.e. provide early warning), yet significant deformations are able to occur prior to structural collapse. While this design methodology may make sense for large steel or concrete structures, low-rise light-framed buildings tend to experience significant damage at small structural deformations. The economic incentive to providing less lateral strength to such systems is also very low. Additionally, the low weight and relatively high lateral stiffness of such systems amplifies inelastic deformations. Because of these structural properties, a new design methodology that incorporates considerations for both life safety and life cycle performance must be established.

It is believed that sufficient structural strength and stiffness to minimize damage caused by large earthquakes can be achieved by incorporating architectural building components such as partition walls and structural cladding to behave integral to the building's lateral load resisting system. My current research is focused on developing original strength-enhanced design concepts for light-frame construction that incorporate architectural and structural building components. These efforts, combined with the development and validation of numerical models will result in the establishment of light-frame residential construction practices that meet life safety requirements while minimizing damage when subjected to extreme ground motions.

7. Research implementation and results under the program

Title of your research plan:

The Characterization of Non-Structural Component Performance for Application to Performance-Based Earthquake Engineering

Description of the research activities:

In order to effectively determine the lateral strength and stiffness contribution of nonstructural architectural building components to building systems, numerical simulations are to be employed. During the program, the focus of my research efforts has been on the model development of partition walls with different geometries, fastener configurations, sheathing types, and stud locations. Since the onset of different damage thresholds is to be investigated, it was necessary to develop more complicated finite element models as opposed to phenomenological wall models. These numerical models and simulations have been carried out using the ABAQUS finite element software package. Data from experiments carried out at Kyoto University and at E-Defense, a facility directed by my host professor, are being used to assess the accuracy of the models in simulating the complex load-deformation behavior of the different partition walls as well as the onset of multiple levels of partition damage. Ultimately, the calibration of such models will provide a means of predicting load carrying capacity, deformation mechanisms, and the onset of partition damage without the requirement of physical testing of these components. This work not only furthers my research in unifying architectural and structural systems, but also may provide a way to more easily characterize structural component damage without the need of physical testing. This will be instrumental in expanding the library of fragility data for use in performance-based earthquake engineering (PBEE).

In addition to this endeavor, I have been privileged to be involved in one of Professor Nakashima's ongoing projects with several current graduate students in his lab. The experimental program involves determining the behavior of several pieces of hospital equipment when subjected to an array of seismic ground motions. Many of these components sit on casters and undergo complex movement when shaken. The overall goal of the project is to determine the susceptibility of damage to hospital equipment and injury to people in hospitals in earthquake-prone areas. This is important in ensuring the operability of such facilities after severe earthquakes. During the testing period, I assisted in setting up test equipment, installing instrumentation to monitor performance, and observing behavior during repeated physical testing of each of the pieces of equipment.

8. Please add your comments (if any):

I would like to thank the officials from JSPS and NSF for their helpfulness and generosity during this program. Their assistance has made the logistical arrangements for this experience very simple and pleasant. I also am very appreciative to JSPS and NSF for funding this terrific research experience. I would like to express my appreciation to my host professor, Professor Masayoshi Nakashima. He has been extremely generous and his helpfulness has made my stay enjoyable and productive. The students and staff of Professor Nakashima's research lab at Kyoto University have also been most welcoming and accommodating to me during my stay.

9. Advisor's remarks (if any):

Through my interaction with Scott Swensen for the past two months, I found him very intelligent and motivated. I also appreciate very much his attitude to try to understand a different culture. In fact, he has been excellently integrated in my group; he has had many rounds of communications with other students, often through dinners and other social occasions. I am very glad to have hosted Scott and hope that his friendship with other students of mine will continue for many years to come. As for the research aspect, he has worked very hard to acquire information that is useful for his graduate study. In addition, he joined two experimental projects that were implemented during his stay here. Although those tests were new to him, he did work very seriously, and other members involved in the tests showed their sincere appreciation to his devotion. I wish that these experiences of his would enlarge his scope about earthquake engineering.

RESEARCH REPORT

1. Name: Linda Takamine （ID No.: SP10061）

2. Current affiliation: University of Michigan at Ann Arbor, Department of Anthropology

3. Research fields and specialties:
Social Sciences

4. Host institution: Osaka University

5. Host researcher: Muta Kazue

6. Description of your current research

My research this summer was the first phase of my dissertation fieldwork in sociocultural anthropology. My dissertation focuses on the processes and mechanisms by which members of Alcoholics Anonymous (A.A.) in Kyoto undergo profound changes in self, or what they call a "spiritual transformation." I intend to provide an account of how people experience and categorize forms of suffering and employ "spiritual healing" for their mental and physical well-being. In addition, I will describe the phenomenal aspects of their experience of self-transformation. Finally, in the course of my research, I hope to address fundamental questions such as What is self? How can we think about how the self experiences the world? This summer, I established contacts within A.A., determined how members were introduced to the organization, and made general observations about how members spoke about alcoholism and recovery and what concerned them the most about the recovery process. I also asked questions about their reactions to A.A.'s concept of a "Higher Power."

7. Research implementation and results under the program

Title of your research plan: Spiritual Transformation in Alcoholics Anonymous: Agency, Self, and Causation

Description of the research activities:

I attended open meetings of A.A., had extended conversations with members, and read all available A.A. literature. My main goal this summer was to establish relationships within A.A. that I will expand upon during my primary fieldwork, which will take place in Kyoto beginning in 2011 for a period of about eighteen

months. Sociocultural anthropology relies on qualitative, rather than quantitative, analysis and focuses on long term, close collaboration with relatively small groups of people. Given this disciplinary norm, and the personal and private nature of the issues I am researching, much of my time was spent cultivating trust-based relationships. I spoke mainly to members with six months or more of sobriety, spent most of my time gaining a general understanding of their situation through informal conversations, and I refrained from asking invasive questions. In any case, I found that the vast majority of members came to A.A. through institutions such as local hospitals, health care consultation services run by local government, and a growing system of voluntary recovery centers. While there does not appear to be much public awareness of alcoholism as a health condition, there definitely appears to be institutional awareness of a problem. Next year I plan to track how members' contact with this institutional awareness helps shape their formulation of their condition. When I did ask questions about why members chose to remain in A.A. and what they thought of the role of a "Higher Power" in their recovery, their answers remained unclear. After considering this for some time, I realized that this was due to the nature of my questioning; I had been asking them to cast their experience in conceptual terms when their experience is nothing like that. Consciousness, reflection, and thought do not govern the process of "spiritual transformation"; rather, it is action- and practice-based. Therefore, I feel that theories of perception and experience based upon phenomenology and embodiment will be useful for my future research.

RESEARCH REPORT

1. Name: Kirubel Teferra （ID No.: SP10062 ）

2. Current affiliation: Columbia University Fu Foundation School of Engineering and Applied Science

3. Research fields and specialties:

Engineering Sciences

4. Host institution: University of Tokyo

5. Host researcher: Tsuyoshi Takada

6. Description of your current research

Probabilistic characterization and simulation of morphological structures of random heterogeneous materials is an interdisciplinary research topic spanning the fields of Biology, Medicine, Structural Mechanics, Electro-physics, and many more. Once morphological structures are characterized, various physical phenomena, such as fluid and contaminant transport, structural mechanical behavior, or chemical reaction processes, can be analyzed. It is often the case that random morphological structures exist at micro- and nano-scales, and attempts have been made to determine Representative Volume Elements(RVEs) through characterization of the random morphologies. Furthermore, a field of micro-mechanical analyses of heterogeneous materials is emerging in order to quantify the effects that phenomena occurring at the micro-scale have on observed macroscopic responses, such as the propagation of micro-cracks, or the determination of Greens functions or RVEs for the use of multi-grid or multi-scale models. The research project that I am interested in is to develop a novel method to simulate two-phase heterogeneous media, meaning generate virtual samples matching various statistical properties of the microstructure of a material.

7. Research implementation and results under the program

During this summer I implemented a Genetic Algorithm Fortran 90 code in order to match the autocorrelation function of a Binary Random field from a level-cut translated Filtered Poisson Field on a parallel computer. I have been successful for homogeneous isotropic Binary Random Fields and now I am in the process of repeating the experiment for an anisotropic random field.

Title of your research plan:

Simulating Microstructures using Level-cut Filtered Poisson Fields and Genetic Algorithms.

Description of the research activities:

My work for this project during the summer entirely involved writing Fortran 90 code for a parallel computer.

RESEARCH REPORT

1. Name: Levi Thatcher （ID No.: SP10063）

2. Current affiliation: University of Utah

3. Research fields and specialties:
Mathematical and Physical Sciences

4. Host institution: University of Tokyo

5. Host researcher: Yukari Takayabu

6. Description of your current research

Hurricanes are one of the most destructive natural disasters that threaten much of the world on a regular basis. The strength of these storms is notoriously difficult to predict due to the varying scales on by which they interact with the environment and because the scientific community simply lacks a sufficient understanding of the processes related to their intensification. This is also due to the fact that the storm's atmospheric characteristics differ markedly from the atmosphere in general. Hurricane's clouds have even been noted as being distinct from those elsewhere in the tropics (Houze 2010).

In order to test the hypothesis that the environment accompanying hurricanes (tropical cyclones or TCs) is different from the tropical atmosphere in general, a study is undertaken to examine the characteristics of precipitation features surrounding TC environments. This is done with the help of a new project developed jointly by NASA and JAXA called the Tropical Rainfall Measuring Mission (TRMM). Among other instruments, TRMM is comprised of a precipitation radar (PR) fixed to a satellite which circles the earth 16 times per day monitoring the tropical atmosphere; operating at 13.8GHz, this precipitation radar is unique in that it provides knowledge of the vertical structure of rainfall in the atmosphere (with a resolution of 250m). This data set, which begins in 1998, is the basis of the research.

Recently Yokoyama and Takayabu (2010, in manuscript) have provided a general picture of the tropical atmosphere regarding the size and height of typical precipitation features. This work was done using precipitation feature (PF) data, derived from TRMM PR 2A25 data. The PF data is based on the TRMM data, in that when the precipitation radar provided a contiguous pixilated rainfall signal the corresponding precipitation feature (defined by a certain area, height, and volume of rainfall) was noted and now treated as one unit. In their research, Yokoyama and Takayabu determined the distribution of these PFs (by size and height) over the tropics and provided an estimate of not only the height and size of the most common PFs, but also the characteristics of those that are responsible for most tropical rainfall.

Using their work as the standard for the tropics, here the work has been concerned with finding the corresponding distribution of PFs in the environment of hurricanes. In order to accomplish this, the tropical cyclone best track dataset from the Joint Typhoon Warning Center (JTWC) was used to identify storms greater than tropical depression strength for the years 1998-2007 over the Northwest Pacific Ocean. The six-hourly data was linearly interpolated to one-hourly. Using this and the PF dataset, a program (originally created by Yokoyama and Takayabu) to evaluate PF distributions was modified such that the concurrent TC positions were taken into account. When a PF was located within 500km of a TC within the same hour, the corresponding characteristics were noted and brought into a database from which the

overall PF distributions are drawn. The dataset provided information on 295 tropical storms; over the 10 year period the satellite missed only 2 TCs.

7. Research implementation and results under the program

Title of your research plan: A TRMM-based view of tropical cyclone rainfall characteristics.

Description of the research activities:

After obtaining the data sets, the program was modified such that only PFs collocated with TCs were considered when gathering characteristics of rainfall in the tropics. Due to the amount of files, data, and the level of complexity involved, the efficient coding of this program took much effort. Considering the amount of data involved the testing of the program was quite labor intensive and involved the creation of a directional characteristic (relative to TC movement). This was done so that the various sizes and heights of PF types could be studied in the context of their positioning, not only in terms of distance from the TC center, but also relative to the TC track.

The results from this work showed that the PFs associated with TC environments tend to be markedly larger than the PFs associated with the tropics in general; this is in terms of the highest rainfall producing PFs. In the general tropics the area of such PFs is most commonly at 1E4.7km^2, whereas for TC related PFs the area was closer to 1E5km^2. The brunt of the concentration was also concentrated at a higher altitude, with the highest rainfall coming from PFs up to 18km, whereas it was around 16km for the general tropics. While neither of these conclusions is surprising considering the structure of a TC, it does, however, quantify the characteristics and contribution of PFs associated with TCs.

The directional alignment of the PFs surprisingly turned out to be a moderately strong function of height, at least for PF areas below 1E3.5km^2. While the PFs below 8km were largely concentrated on the left and rear sides of the TC, PFs above 8km tended to be positioned to the right and rear of the TC. Considering the various TC-related factors that could be playing a role, more investigation is necessary to determine what exactly is lying behind this left-right dichotomy as height changes.

8. Please add your comments (if any): I feel very fortunate to have had the opportunity to be a JSPS/NSF fellow and to have been able to work with such fine people at the University of Tokyo. The guidance received was always interesting and helpful and the intellectual environment was second to none.

9. Advisor's remarks (if any): I would like to thank JSPS for sending Levi to our laboratory. Not only he is very diligent for his study, Levi is very friendly and always willing to communicate with people in and around our laboratory, which has made our collaboration through this opportunity very fruitful even though it was such a short visit. He has worked very hard on the analysis of precipitation characteristics in the tropical cyclones and made a presentation to our laboratory members yesterday. In a short term, he used a huge amount of satellite data and brought us very interesting results. We will continue this collaboration to publish his study here in near future. He also attended the laboratory reading (reading published papers) every week and his attendance stimulated my students and post doc researchers a lot. He will certainly become a bridge between the University of Utah and our place.

RESEARCH REPORT

1. Name: Luis C. Vargas （ID No.: SP10064 ）

2. Current affiliation: Yale University

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: National Astronomical Observatory of Japan (NAOJ)

5. Host researcher: Prof. Wako Aoki (青木和光助教授)
Prof. Nobuo Arimoto (有本信雄教授)

6. Description of your current research

My current research, both at Yale and in Japan, centers on the local universe, in particular our galaxy and its satellites. As I am in my pre-dissertation phase, I thought it useful to expand my toolkit of analysis techniques. Thus, whereas my research at Yale centered on newly discovered dwarf galaxies, my focus was different this summer. The project's aim was to analyze high-resolution spectra of red giant stars belonging to our Galaxy's "halo" taken by the Subaru Telescope. This roughly spherical, low-density component extends much beyond the orbit of the Solar System around the Galaxy. It is believed that a non-negligible fraction of halo stars actually formed in nearby satellite galaxies, which were subsequently accreted into our own. In order to elucidate the origin of halo stars, astronomers have compared the element abundance pattern of halo stars with those found in stars in nearby satellite galaxies. However, due to their distance, only the brightest, coolest red giant stars from other galaxies have been observed. On the contrary, the comparison sample of halo stars is dominated by hotter red giants and even "dwarf stars", both of which are not as far along in their evolution along this "red giant branch". Moreover, even if assuming that secular processes in stellar evolution did not affect chemical abundance patterns in the stars atmosphere, the cooler, brighter stars are known to be in a state of non-local thermodynamic equilibrium (NLTE), whereas the analysis relies on computer models that assume LTE, given that it is simpler to treat numerically. Instead of trying to account for all known and unknown NLTE effects and possible secular abundance changes, I have analyzed 23 red giant stars in a comparable evolutionary state to the stars observed so far in dwarf galaxies using the standard analysis procedures (described below).

7. Research implementation and results under the program

Title of your research plan:
Galactic Archeology: Elemental Abundances in the Milky Way Halo

Description of the research activities:

I relied on archival data taken with the High-Dispersion Spectrograph at the Subaru telescope over the course of several years. The spectrum of each star in the sample had a high enough resolution to identify individual spectral lines produced by different quantum transitions of various elements. The first step was to determine certain global parameters of the stars' atmospheres. I relied on a list of spectral lines compiled by Ishigaki (priv. comm.), in order to identify a large number of neutron iron (Fe I) and single-ionized iron (Fe II) in each spectrum. I then measured the *equivalent widths*, a measure of the depth or strength of the line by fitting its profile to a Gaussian curve.

The analysis was carried out using MOOG (Sneden 2009), a free, abundance analysis software, in particular its *abfind* package. I first calculated the star's iron abundance for a variety of stellar models

with varying atmospheric temperatures, surface gravities (a measure of the size of the star), and microturbulent velocity (a single parameter that encodes how turbulent the gas motions are in the star's atmosphere). The best-fit stellar model is that for which the iron abundance is shows no trend as as a function of the line's equivalent width, different excitation potentials, and different wavelengths. More recent generations of stars have higher iron abundances due to the iron produced in previous generations' supernova explosions. Aoki & Honda (2008) previously published stellar parameters for a few stars in my sample. Their parameters agree with those of my analysis within the estimated 1-σ uncertainties, with a few exceptions in the case of the surface gravity parameter.

The next step in the analysis was to use the best-fit model in conjunction with measurements of equivalent widths of lines for other elements to calculate their abundances in each star. The elements analyzed were: Mg, Si, Ti, Ca, Na, Cr, Ni, Zn, Cr, and Mn (other elements detected in the stellar spectra included Co and Sc, but their spectral lines suffer from hyperfine-splitting, which will require additional steps to properly measure their abundances).

Using the entire sample, I explored whether the evolutionary stages of a red giant stars affects the derived chemical abundances. The new sample consists mainly of stars with effective atmospheric temperatures of $4000 < T_{eff} < 4600$ K. For each element X, I created plots of abundances for such element *versus* the iron abundance of each star. Identical plots were produced for a comparison sample of hotter, dimmer red giants (Venn et al 2004). I emphasize that the conclusions presented below are preliminary, pending a complete uncertainty analysis, which has not yet been finalized. I conclude that temperature-related effects are *not* significant for all elements analyzed with the exception of titanium. In the case of Ti, I confirm the temperature dependence previously described in Lai et al (2009) in the case of lines of neutral Ti. Lai et al (2009) reported that Ti abundances estimated from both neutral and singly-ionized Ti lines show a linear trend with temperature for red giant stars with $4500 < T_{eff} < 6500$ K. The present study extends their results to lower temperatures for Ti I, whereas the scatter in Ti II abundances is too large to identify a temperature-dependent trend. This scatter may be a consequence of the relative weakness of the Ti II lines, which results in larger inaccuracies in the analysis of these lines. Although the cause of this temperature dependence is yet unclear, it is clear that comparing Ti abundances for samples of stars with different temperature ranges results in an erroneous conclusion about the *relative* abundance of Ti in the two samples.

References

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8. Please add your comments (if any):

Prof. Aoki was a great advisor this summer, and I appreciate his support and willingness to meet with me often to converse about the project, and roadblocks I encountered along the way. I would also like to acknowledge Dr. Ishigaki, a postdoctoral researcher in the same group, whose day-to-day support and science chats made my stay at NAOJ very enjoyable. I have had a great time in Japan, and look forward to coming back at some point in my future career. Besides astronomy, I was happy to be able to use the little bit of Japanese I learnt during college during my day-to-day life!

RESEARCH REPORT

1. Name: Stephen Alex Young （ID No.: SP10065）

2. Current affiliation: Virginia Tech

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Keio University

5. Host researcher: Dr. Masaki Takahashi

6. Description of your current research

This research seeks to enable cooperative, energy efficient, formation flight of multiple small autonomous air vehicles (UAVs). Toward that end, the research conducted during the 2010 NSF-EAPSI/JSPS summer program focused on adapting the Expanded Fuzzy Potential Method (EFPM) for obstacle avoidance to enable coordinated flight of multiple simulated UAVs.

The EFPM has been developed and implemented on ground vehicles in the Takahashi Lab at Keio University. This method allows for robust, computationally efficient avoidance of multiple mobile obstacles in a two dimensional space. This is accomplished by representing the influence of both waypoints and obstacles on the desired direction of movement of a vehicle using Potential Membership Functions (PMFs) which are combined into a single PMF using Fuzzy Interference. This mixed PMF determines the direction and magnitude of movement for the vehicle. Currently this method has been used for avoidance of multiple, mobile obstacles supplemented with the A* algorithm for more robust path planning. Applying the EFPM to cooperative movement of multiple vehicles requires adding a new PMF that represents another vehicle as both an obstacle and a goal point. Expanding the EFPM to accommodate multiple vehicles was the primary focus of the research conducted this summer.

7. Research implementation and results under the program

Title of your research plan: Cooperative UAV Formation Flight and Obstacle Avoidance using Expanded Fuzzy Potential Method

Description of the research activities:

The first goal of this summer research was to develop new simulations of the existing EFPM algorithm as well another popular algorithm for obstacle avoidance, the Artificial Potential Method. This was done so that valid comparisons of the performance of the algorithms could be made without being affected by the differences in data structure or programming environment. The two most important criteria for evaluating these methods were computation speed and the ability to deal with small gaps between obstacles. These are important for two reasons. First, the cooperative UAVs of interest to this research are small, lightweight, solar powered vehicles with limited computational capacity. Second, since the APM uses gradient decent of a potential field, it has an inherent susceptibility to becoming trapped in local minima. Addressing this issue requires more sophisticated representation of obstacles which increases computation load.

Both the EFPM and APM simulations were developed using identical data structures and in the same programming language which mitigates performance differences that may result from non-parallel development. The figures show the computation speed of each algorithm with mobile and static obstacles as a function of number of obstacles. The APM simulation was significantly affected by the number of mobile obstacles. Figure 2 is an example of the APM becoming stuck in a minimum while the EFPM does not. This is a result of the gradient decent forcing the APM to move the vehicle outside the zone of influence of the obstacle while the EFPM allows attraction to a goal point to partially overcome the repulsion of an obstacle thus the simulated vehicle can navigate through the obstacles while violating the zone of influence, green, but not the avoidance radius, yellow.

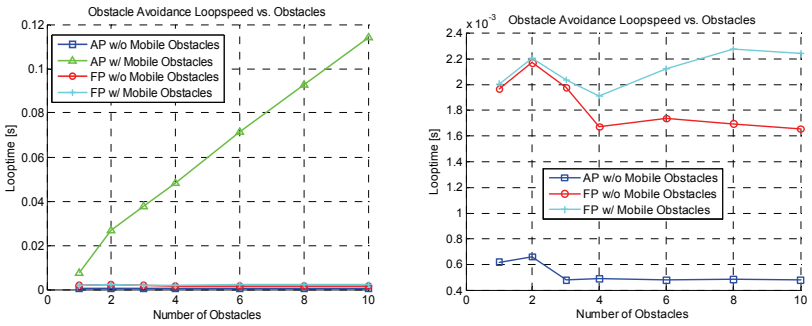


Figure 1: Computational Performance of the EFPM and APM

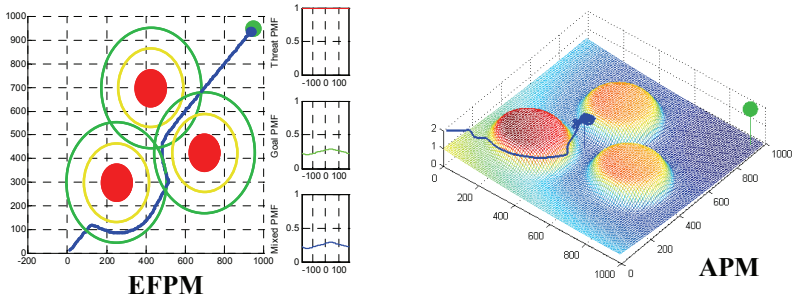


Figure 2: Comparing Performance With Close obstacles

After successfully completing the simulation of the EFPM, an investigation began to explore the ability of this algorithm to accommodate coordinated formation flight. This was accomplished by representing other vehicles in the fleet as both obstacle and target. Adding an additional PMF that alternates between a goal and threat PMF depending on closure rate allows coordinated flight among two vehicles. This is seen in figure 3.

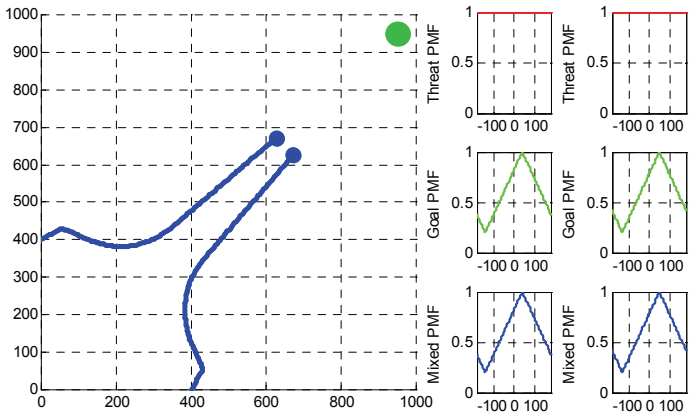


Figure 3: Coordinated flight using the EFPM.

Initial results have been promising however there are significant issues that need to be addressed in further work. Chief among these issues is the robustness of the obstacle avoidance when in a cooperative scenario. Representing other vehicles as a false obstacle has resulted in the mixed PMF inaccurately determining the proper direction of movement and causing collision with obstacles in certain scenarios. This is a result of both improper tuning of the PMF parameters and more significantly an unresolved formulation issue of the false obstacle PMF that is a result of the way multiple obstacles are treated in the mixed PMF. Once these issues can be addressed, future work can address the proper way of weighting movement towards a goal point versus movement towards a cooperative vehicle. This will allow the PMF that attracts two vehicles together to be tuned based on the energy state of each vehicle, thus enabling more energy efficient intercept and formation flight as well as obstacle avoidance using a single computationally light algorithm.

RESEARCH REPORT

1. Name: Lubna Ahmed (ID No.: SP10101)

2. Current affiliation: Goldsmiths, University of London

3. Research fields and specialties:

Psychology

4. Host institution: Kyoto University

5. Host researcher: Professor Jun Saiki

6. Description of your current research

At any given moment we are exposed to a great deal of visual information. The visual attention system manages the processing of such information by enabling enhanced processing of relevant information, and ensuring superfluous visual information is disregarded. My current research investigates how the efficiency of this selective attention system is affected by individual differences (e.g. working memory capacity; WMC) and also external factors (e.g. cognitive and perceptual load).

An individual's WMC is a strong predictor of higher order functioning and general intelligence; some theories suggest that variations in selective attention underlie the WMC –related correlation with higher order processes. My research aimed to identify which types of attention and attentional conditions WMC-related differences in attention occur in. The results demonstrated that low WMC individuals are less able to direct their attention to task relevant visual information in response to an external event (i.e. exogenous orienting), and are also worse at directing their attention internally (i.e. endogenous selective attention), compared to high WMC individuals. The findings demonstrate a strong WMC-related variation in the efficiency of attentional processes; supporting the view that such variations may contribute to the known differential higher order abilities between high and low WMC individuals.

Secondly, I investigated the effect imposing external cognitive load has on the ability to selectively attend to relevant visual information. In a series of experiments I asked participants to remember information that was either difficult or easy to maintain (high or load working memory load) whilst selectively attending to relevant visual information amongst irrelevant. The results demonstrated that the processing of irrelevant visual information increased when the external working memory load was high compared to low. This portion of my work shows that the efficiency by which attention can be constrained to relevant information is reduced under conditions of high external load.

7. Research implementation and results under the program

Title of your research plan: Cultural difference in visual selective attention

Description of the research activities:

Background

The objective of the research was to investigate if variations in the cultural environment, namely between British and Japanese societies may affect visual attention efficiency. It is well known that the culture and social practices between western and east Asian societies are distinctly different. Western culture is individualistic, prompting individualism, autonomy and focus on personal goals. In contrast east Asian cultures are interdependent, promoting collectivism, harmony and focus on group relations and goals. Previous research shows that these differential social orientations drive the cultural differences in attention, which are congruent with cultural needs; east Asian attentional setting is holistic or global, compared to the comparative analytical or local setting in westerners.

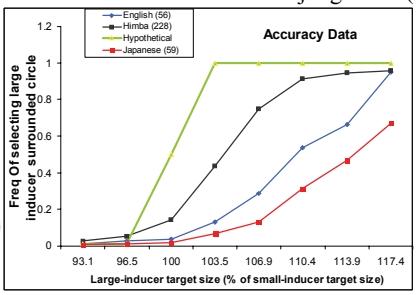
During my visit I recorded the attentional processing of 63 Japanese students on 5 selective attention tasks, and compared the performance of Japanese individuals with the data I already have for Western (British) and African (Himba tribe) individuals. Group differences were found in three of the 5 tasks; which are summarised below.

Method:

All experiments were run on individual computers. Participants attended to information presented on the screen and pressed a key when they identified the target stimulus. The participants' response time and accuracy provides an indication of their selective attention efficiency in the tasks.

Experiment 1: Ebbinghuas illusion

In this task participants must decide which of two central circles is larger. The central circles are surrounded by distracting information. Perception of the distractors leads to inaccurate size judgments (see figure below).

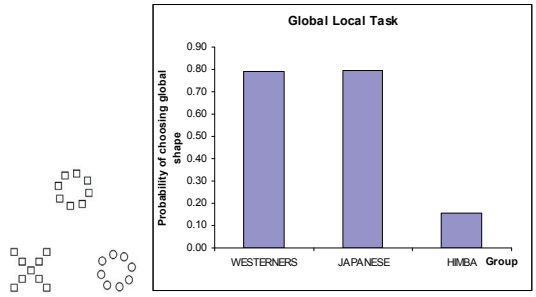


The performance of the 3 cultural populations is summarised in the graph above. The African groups' performance was best on this task,

followed by westerners and finally the Japanese groups' performance was worse, i.e. they were affected by the surrounding irrelevant information most. The result support that the attentional setting is more global in Japanese individuals.

Experiment 2: Local Global task.

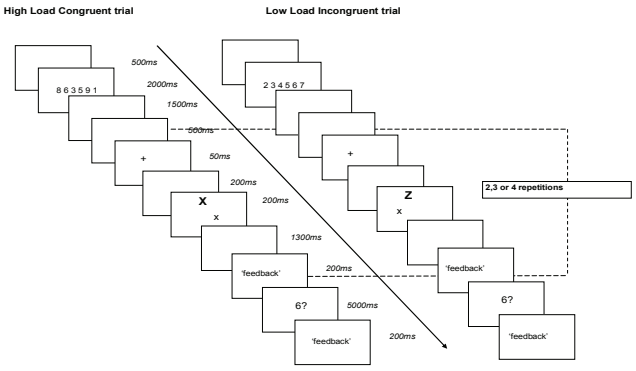
In this task participants see a `judgement` hierarchical shape, and two comparison shapes. The task is to decide which of the two comparative shapes the judgment shape is more `similar too` (see figure below).



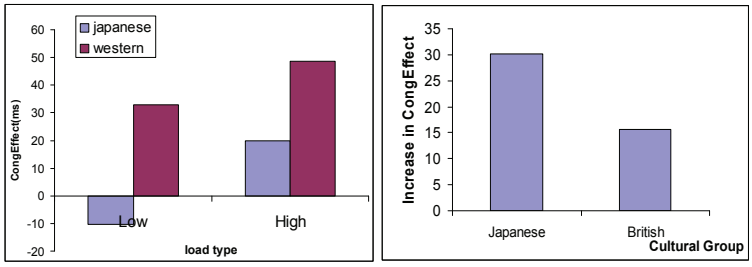
The shapes can be similar on either the global or local level; the level each group selects provides an indication of their attentional setting. The results are summarised in graph above. The Japanese participants selected similarity at the global level 80 % of the time, which again is inline with their attentional window being more holistic. Interestingly the western samples results were similar to the Japanese sample, rather than more localistic, which may have been due to cultural heritage not being controlled for in the comparatively more cultural diverse student population in Britain.

Experiment 3: Flanker task.

In this task participants are required to detect the identity of centrally presented letters by pressing the correct key response for each letter type, whilst ignoring peripherally presented distracting (task irrelevant letters). The peripheral letter can either be the same (congruent) or different (incongruent) to the target letter. The difference between response times on congruent and incongruent trials is the congruency effect which indexes the degree to which attention is successfully directed to the target letter alone. We asked participants to perform this task under high and low cognitive load conditions by maintaining a random or sequential digit sequence in mind respectively (see figure below).



The increase in congruency effect as a function of load demonstrates how demanding it is to attend to the target letter. As represented in the graph below although the overall congruency effect was smaller for the Japanese group the increase in congruency effect, as a function of load was greater for this group compared to the westerners. These results, in line with a global setting hypothesis in the east Asians, indicates that it is more cognitively demanding for the Japanese individuals to focus on the local information and ignore the peripheral distractor information .



8. Please add your comments (if any):

In three of the five experiments, the Japanese groups were affected more by peripheral visual information, which supports a more global attentional setting in this population. The performance on the two remaining selective attention tasks however was no different between the groups. A future plan is to modify these paradigms to try to isolate which circumstances and stimuli type lead to cultural variations in attention actually affecting task performance. Overall the research project has been very productive given the short space of time and has resulted in interesting findings, formation of collaborative links with Jun Saiki`s lab, and a promising research plan for the immediate future.

RESEARCH REPORT

1. Name: William D. R. Baker （ID No.: SP10102）

2. Current affiliation: Loughborough University

3. Research fields and specialties:

Social Sciences

4. Host institution: Kinki University (Osaka)

5. Host researcher: Prof. Setsuo Maeda

6. Description of your current research

The current field of research is concerned with the human response to vibration, in particular the effects of whole-body vibration (WBV) exposure on activity interference. Whole-body vibration (WBV) occurs when a person is supported by a shaking surface and the vibration affects body parts that are not specific to the point of contact. People experience such vibration almost on a daily basis, in a number of different environments (for example, passengers and crew members on road and rail transport systems, aircraft or ships).

The majority of exposures to WBV occur in seated postures; however there are many situations where standing people experience WBV (for example, during peak travel times on public transport systems). Rail transportation in particular, has been selected as the environmental context for the current research. This selection was based on two factors, namely: (i) the high passenger numbers mean people are often required to stand while travelling, and (ii) with the demands of a time-pressured culture, rapid development of mobile technologies has provided people with innovative means of working while travelling. Indeed, many standing passengers chose to utilise hand-held devices to engage in various activities while travelling.

Historically, research conducted on activity interference has focused on seated postures, using a range of performance tests to investigate human capabilities in vibration environments. From these studies, fair agreement exists that, for a given vibration spectrum, performance is progressively degraded as the magnitude of vibration is increased, above a certain threshold. There has however been no work conducted on activity interference in standing individuals or the use of hand-held devices. In standing postures, compromised stability and unintended movements associated with maintaining posture could distract attention from the task at hand, potentially leading to further interference with performance. Therefore, the current research objectives have been to quantify the extent to which WBV exposure causes interference with the performance of manual control tasks in standing postures. In order to fully understand these effects, the contribution from specific vibration characteristics must be determined. The influence of vibration magnitude and direction has been investigated during initial studies, however frequency effects have not been considered.

7. Research implementation and results under the program

Title of your research plan:

Activity Interference during exposure to Whole-Body Vibration: A Comparison between Seated and Standing Individuals.

Description of the research activities:

The objectives for the research conducted during the JSPS Summer Program were:

(i) to identify the effects of frequency content of whole-body vibration on the performance of a manual control task.

(ii) to provide a comparison of the responses to vibration exposure between seated and standing postures.

(iii) to determine the influence of vibration magnitude and vibration direction on performance.

Final planning and preparation for this research was conducted at Kinki University (Osaka), although the equipment and location for the experimental work was situated at JNIOSH (Tokyo). Ethical approval had been obtained prior to commencement of the study and signed consent was given by all participants. A 6 degrees-of-freedom multi-axis vibration simulator was used to generate sinusoidal motions within the fore-and-aft (x-axis), lateral (y-axis) and vertical (z-axis) directions. After pilot testing, two vibration magnitudes (low condition: $0.4ms^{-2}$ and high condition: $1.2ms^{-2}$) and four frequencies (1.0, 2.0, 4.0 and 8.0Hz) were selected for inclusion in the study. Vibration exposure occurred in two postures, a seated posture without back support and a free-standing posture; representing a total of 48 vibration conditions and 8 control (no vibration) conditions. During these test conditions, participants were required to perform a number entry task using a hand-held keypad. Performance was determined by measurements of total time, reaction time and error rate and further subjective ratings of difficulty were taken to represent the workload experienced by participants.

Preliminary analysis has been conducted on the ratings of difficulty which provide insight into the subjective workload experienced by the individual to successfully perform the task during each condition. The results show peak subjective ratings occurred in low frequency (1 and 2Hz) vibration conditions in the x- and y-axis, during both low and high magnitude exposures. In the z-axis, the peak ratings were identified at 8Hz, with standing postures producing higher ratings than seated. During the high magnitude conditions, these trends were altered and postural distinctions were only found during vibration exposure in the y-axis. Transmission of vibration from the driving point (contact area with the moving surface) to the upper body is likely to be the contributing factor for interference and could explain the differences in frequency for peak ratings between horizontal (x- and y-axis) and vertical (z-axis) vibrations. Additionally, during horizontal vibration exposure, individuals could use the standing posture to mitigate vibration transmissibility through the body by bracing against the direction of movement (particularly in the y-axis where the base of support at the feet was greatest). Further assessment of the objective (time and error data) and subjective results will be conducted to determine the influence of WBV on performance, based on information obtained from this research study.

RESEARCH REPORT

1. Name: Saleem Denholme （ID No.: SP10103 ）

2. Current affiliation: Glasgow University

3. Research fields and specialties:

Chemistry

4. Host institution: National Institute for Materials Science

5. Host researcher: Prof Yoshihiko Takano

6. Description of your current research

My project at the university of Glasgow has consisted of synthesising novel compounds on the nanoscale and analysing any unusual properties which they exhibit. At the national institute for materials science I planned to continue this work but focus on a specific system called iron-based chalcogenides which exhibits a fascinating anomaly known as superconductivity. This class of compounds has been thoroughly investigated by Prof Yoshihiko Takano and his research group. I was taught the processes by which they study these compounds and made some attempts to link it with my own research by trying to see if examples of these compounds could be synthesised on the nanoscale in the hope of seeing an enhancement in their superconducting properties.

7. Research implementation and results under the program

Title of your research plan:

A Nanoscale Investigation of Superconducting Materials

Description of the research activities:

My research this summer has revolved around learning both the synthesis and analysis techniques that Prof Takano's research group regularly employ to investigate a class of compounds known as iron-based chalcogenides superconductors. This involved a brief introduction to activities such as glass blowing and the use of specific instrumentation such as Super Quantum Interference Device (SQUID) and Physical Properties Measurement Device (PPMS) to measure the magnetic susceptibility and electrical resistivity of synthesised materials, which are two key properties of a superconducting material.

The research I conducted can be split into three categories. First was the attempted synthesis of tetragonal iron sulfide. Of the iron chalcogenides both tetragonal iron selenide and telluride are known to exist. The former which exhibits superconductivity below 8 K at ambient pressure. Tetragonal iron sulfide however has remained elusive with the hexagonal form usually being the most abundant phase. Using reactions methods which I am already familiar with due to my PhD research at Glasgow university. I tried to make this compound in the lab.

I also focused on performing high-pressure resistivity measurements on single crystals of FeTeS. Oxygen annealed FeTeS exhibits superconductivity, therefore it is thought that if you put the compound under pressure a similar effect could be observed. This involved learning how to set-up a pressure cell which is an interesting but long process.

The third stem of my research was to investigate FeTeSe single crystals. To cut a micro scaled Josephson junction with the aid of a focused ion beam (FIB) in the centre of a micro-scaled single crystal and measure the superconducting properties of this down the c-axis. A topic of which there is few studies on.

These three projects required a lot of time for sample preparation and for learning the skills necessary to set up the analysis of these reactions. As a result, despite progress, no results as such have so far been gained. It is the hope of Prof Takano however that the high pressure work on the FeTeS single crystals will continue and that it will be the start of a collaboration between his group and that of my supervisors back home.

8. Please add your comments (if any):

In addition to learning key skills such as those described above, I was also involved in weekly meetings. During these each member of the group had to give a brief presentation on their research progress. This way I learned about many different areas of research new to me and was able to fully experience how research in Japan compares to that of Britain. I felt that the placement as a whole was an excellent introduction to Japan.

RESEARCH REPORT

1. Name: Piotr Gryko （ID No.: SP10104）

2. Current affiliation: Materials department, Imperial Collage London

3. Research fields and specialties:

Interdisciplinary, Biomaterials

4. Host institution: Bioengineering Department Riken Institute Wako

5. Host researcher: Dr Maeda

6. Description of your current research

Development of peptide functionalized gold nanoparticles for enzymatic detection.

Peptide coated gold nanoparticle aggregates have been demonstrated for use as colour-metric assays for the detection of biomolecules. These can be separated into two categories, crosslinking, and non-crosslinking induced aggregation. Crosslinking systems use interacting biomolecules such as DNA, peptides and ATP to form bridges between particles, where as non-crosslinking systems rely on the change of nanoparticle surface charge. The behavior of peptide coated nano-particles is still not well understood, particularly with physiological proteins.

We focus on the simpler crosslinking method as a model for understanding the effect of protein absorption on colloidal stability and nanoparticle assembly. We use a system developed by Laromaine et al, who made use of nanoparticles coated with a designer tri-peptide tripeptide Fmoc-Gly-Phe-Cys-NH2 to detect the protease Thermolysin (from B.Thermoproteolyticus rokko) at concentrations as low as 90zg/ml (Laromaine, Koh et al. 2007). The novel modular approach of the system has the advantage of being easily tailorable and obviates the need for major redesign when targeting other proteases. For example, the same design has been applied to prostate specific antigen (nACT-PSA) (Laromaine, Koh et al. 2007), a protease related to prostate cancer (Mazhar, Ngan et al. 2006) and may be valuable in early monitoring and detection of disease relapse after the surgical treatment of prostate cancer.

We focus on understanding the roles of particle size, particle preparation steps and the role of BSA on system aggregation and dispersion.

7. Research implementation and results under the program

Title of your research plan:

Mapping the salt stability profiles of peptide functionalized gold nano-particles.

Interaction of Bovine serum albumin with gold nano-particle aggregates.

Stability of BSA to enzymatic degradation by the enzyme thermolysin.

Description of the research activities:

We use a model system consisting of gold nanoparticles coated with a designer tri-peptide Fmoc-Gly-Phe-Cys-NH2 developed by Laromaine et al.

Stability profiles of peptide functionalized gold nano-particles

The use of gold nanoparticles relies heavily in particle stability changes for enzymatic dispersion. Specifically the particle size and surface coating of nanoparticles is thought to play an important role in particle stability.

We have mapped out the stability of gold nanoparticles (10nm, 20nm and 40nm in diameter) coated with citrate, BSPP or Fmoc-Gly-Phe-Cys-NH2 to the addition of NaCl using a Tecan Safire 2 plate reader. A total of 400 samples were screened with experiments repeated to ensure reliability.

We find that the stability of gold nanoparticles changes as a function of their size and coating. Within these profiles, lie stability cross-regions where enzymic cleavage would produce and improvement in particle stability and aggregate dispersion.

Interaction of Bovine serum albumin with gold nano-particle aggregates

Bovine serum albumin (BSA) is a serum albumin protein that is commonly used in biochemical applications including ELISAs (Enzyme-Linked Immunosorbent Assay and immunohistochemistry. This role has been extended for use in gold nanoparticle assays. However, BSA is known to bind to the surfaces of gold nano-particles, but its role in stability particle change is unknown.

We have investigated the interaction of BSA with gold nanoparticles using dynamic light scattering (DLS) and stability assays. Dynamic light scattering was used to measure change in particle hydrodynamic radius and thereby confirm absorption of BSA to the particle surface.

We have mapped out the stability of BSA and gold nanoparticles (10nm, 20nm and 40nm in diameter) coated with citrate, BSPP or Fmoc-Gly-Phe-Cys-NH2 to the addition of NaCl. A total of 110 samples were screened using a Tecan Safire 2 plate reader. Gold nanoparticles with BSA were found to be far more stable to the addition of NaCl. We find that this stability varies depending on particle coating, suggesting a possible binding affinity between BSA and Fmoc-Gly-Phe-Cys.

These results, demonstrate that BSA cannot be treated as a non-interacting partner when used in nanoparticle assays. Specifically, that it plays an important role in the design and implementation of peptide coated gold nanoparticles for use in biodetection.

Stability of BSA to enzymatic degradation by the enzyme thermolysin

We checked for non-specific cleavage of BSA by the enzyme Thermolysin using SDS-PAGE electrophoresis. SDS-PAGE gel electrophoresis, is a technique widely used to separate proteins according to their electrophoretic mobility. We find that BSA can be degraded by Thermolysin, however the time-scale of degradation is longer than that of experiments typically used in gold nano-particle assays.

RESEARCH REPORT

1. Name: Alana James （ID No.: SP10105）

2. Current affiliation: Unit for School and Family Studies, Goldsmiths, University of London

3. Research fields and specialties:

Social Sciences

4. Host institution: Osaka Kyoiku University

5. Host researcher: Professor Yuichi Toda

6. Description of your current research

Peer support schemes, where selected pupils offer formal support to others in their school, are used to improve pastoral care in schools in many countries. Peer support should be run by children, for children and can be described as “social support by individuals who are similar in age and/or social conditions to the person receiving support” (Toda, 2001, p. 59). They are increasingly popular in schools in the UK, where an estimated 62% of all schools use peer support (Houlston, Smith & Jessel, 2009). Schools in the UK using peer support aim to benefit target pupils, the peer supporters and the whole school climate (Houlston, Smith & Jessel, 2009).

In my PhD research I am investigating what impact peer support schemes in secondary schools actually have. I have conducted two longitudinal case studies of peer support schemes, where peer listening was used; pupils could go to a peer supporter at breaks to talk about their problems. Target pupils were surveyed every six months: in one school 4 surveys over 18 months and in the second two surveys over six months. Knowledge of, attitudes towards and use of peer support were surveyed, as well as experiences of school bullying and school climate. Focus groups and individual interviews were also held with pupils who and pupils who had not used peer support, peer supporters and co-ordinating staff.

In addition, I have also conducted a small-scale study of the use of peer support and other anti-bullying initiatives in South Korea. Interviews were held with teachers, researchers in the field, government employees and a national children’s charity.

7. Research implementation and results under the program

Title of your research plan:

A cross-national investigation of peer support in schools

Description of the research activities:

Background

Peer support is becoming widely used in Japanese schools, where practitioners are supported by the Japanese Peer Support Association (JPSA). Although peer support is used internationally, it can take different forms in different countries. In the UK peer support is typically conducted face to face, whereas in Japan it is often conducted anonymously. For example Q&A handout methods usually allow pupils to submit anonymous notes about their problems and answers are given via a handout to the whole school. It has been proposed that anonymous methods are more suited to the Japanese context due to high levels of shame concerning admitting personal problems (Toda, 2005).

The role of cultural factors on the nature and effectiveness of peer support has not yet been widely investigated. This research builds upon previous work by the researcher into peer support in the UK and South Korea, which found that cultural values, the education system and the nature of school bullying, influence the use of peer support.

Aims

•To investigate the types of peer support used in Japanese schools

•To investigate practical and cultural factors which influence the effectiveness of peer support in Japan

•To inform a comparison of peer support use and effectiveness in western and eastern countries

Methods

•Semi-structured interviews with key informants in Japanese peer support work, including researchers, JPSA members, teachers and peer supporters.

•Questions on knowledge and experience of peer support, work, attitudes towards peer support in schools and identification of factors

which influence its effectiveness.

Results

Preliminary analysis of the data indicates the following findings:

•There is a wide range of peer support methods used in Japanese schools, including Q&A handout schemes, peer tutoring, peer mediation, peer education, student summits and 'community' schemes where all or a sample of pupils are trained to use peer support skills in daily life. Peer support is used in elementary, junior high and high schools. Methods are both anonymous and face to face. Community methods of peer support particularly contrast with UK methods; they aim to improve school climate through informal, daily support rather than formal schemes. Many of the methods used in Japan had an emphasis on involving both the school and wider community. This may reflect the more collectivist cultural context compared with the UK.

•The peer support schemes surveyed were generally held to have had a positive impact upon pupils and school climates. However this was often by teachers' subjective perspectives or pupil surveys given immediately following peer support training or activities. Overall fewer practical problems were identified than apparent in the UK or South Korea. Practical factors for this may be the nature of the methods used or the much longer hours typically worked by Japanese teachers compared with teachers in the UK. As in South Korea however the main difficulty was finding time to give training or run the schemes due to the heavy workload of pupils.

•Peer support is becoming used in increasing amounts of schools. JPSA is a national organization and it was found that some executive directors are being asked to lecture teachers in entire cities on peer support. Peer support is now mentioned in teacher training, and researchers and teachers are also instigating peer support outside of JPSA. The popularity of peer support appears to be developing to similar levels as in the UK, much greater than levels previously found in South Korea.

•Support for these schemes is available in different ways in Japan, than in the UK or South Korea. JPSA provides its members with frequent training, study visits abroad and a support network of other practitioners. Participants reported its activities are very useful for their work. However financial support is not provided by the government and not usually by schools. In contrast, in South Korea where peer support existed it was by the initiative of individual teachers or by a charity. In the UK peer support training and support is provided by a multitude of organizations and has received much support from the government

8. Please add your comments (if any): The JSPS summer program was an excellent opportunity to extend my current research. I am very pleased with the extent of the work I was able to carry out, due to the considerable support of my host researcher. We were able to sample peer support schemes in several prefectures, giving the findings stronger validity. Two months was a suitable period in which to conduct the research project itself, but I had not considered beforehand the extra time that will be needed to fully analyse and write up the research.

9. Advisor's remarks (if any):

Research: Excellent

The research fields were extended than the previous plan assumed. In Tottori, Kochi, Okayama, Hiroshima, Tokyo and Osaka, more than ten teachers and three professors were interviewed. Furthermore, many junior high school students and university students were met and some of them were interviewed in depth.

The effort to complete the interviews was much more than expected beforehand, and also the cost for journey was bigger than the previous balance sheet.

Discussion: Good

The reason why it was not excellent is not attributed to the ability of the researcher. The discussion was done and worthwhile but not enough due to the restriction of time and difficulty of schedule matching with the advisor myself.

This would be covered by talking on-line and e-mailing.

Future publications: Excellent (hopefully)

At least two academic papers are expected to be published, and the essence would be included in a planned book which is concerning bullying and its prevention and intervention.

Educational impact: Excellent

Some students from Kyoto University, Osaka Kyoiku University and Nara Women's University were interviewed by focus group method. Especially, one of the students was accompanied to Tottori, Kochi and Osaka interview. The student decided her own research theme for graduate thesis to be concerning to peer support. Other students who were interviewed have also learned much from the visiting researcher. This educational effect should be evaluated as an effect of this scheme.

RESEARCH REPORT

1. Name: Le Vo Phuong Mai (ID No.: SP10106)

2. Current affiliation: Cardiff University

3. Research fields and specialties:
Social Sciences

4. Host institution: Institute for Economic Research, Hitotsubashi University, Tokyo

5. Host researcher: Professor Toshiaki Watanabe

6. Description of your current research:

The experience of the US housing market and global financial crisis in the period of 2007-2009 shows that the housing and financial sectors are important driving forces of business cycles. However, many DSGE model do not include these sectors (Christiano et al., 2005; Smets and Wouters, 2003, 2007; Le et al., 2010). Thus, they could not be used to predict the subprime shock, banking collapse and could not analyse banking behaviour. They were, however, equipped enough to assess the impacts of a credit crunch shock and the monetary and fiscal responses (Minford, 2009). However, for the policymakers, it is desirable to develop models that explicitly include the housing market and financial imperfections because, during the financial crisis, policy makers had to respond to shocks without having good models of the shock themselves. A more complete model would help them to understand the nature of shocks, to allow for simulating a crisis that has some of the features of the current down turn, and to understand the role of interbank market imperfections in the propagation of shocks, and to analyse the unconventional and conventional policy responses.

My model features two sectors, heterogeneity in households' discount factors, an active interbank market, costly loan production functions and collateral tied to housing values. There are two types of households: patient and impatient. Patient households work, consume, accumulate housing and make deposits to the savings banks. Impatient households work, consume and accumulate housing that can be used as collateral. The consumption and housing are produced using labour. The banking sector consists of two banks (savings and lending banks) that offer different banking services, hold reserves and interact in an interbank market. There is a central bank that uses Taylor rule, but in crisis it injects money.

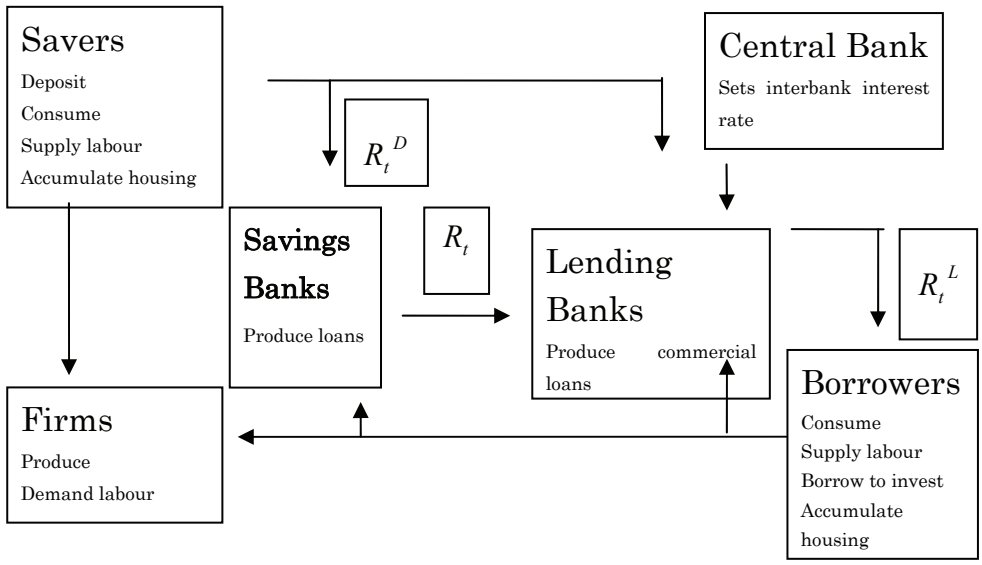
7. Research implementation and results under the program

Title of your research plan:

Banking and Housing Sectors in a Business cycle Framework

Description of the research activities:

1) Build the model's cohesive structure



2) Express the model structure through mathematical expressions

3) Solve the model for the steady state. Qualitatively show that the loan production causes spreads between policy rate, R , and deposit rate, R^D, and lending rate, R^L, and policy rate,R:

$$R^D = R - \frac{W^S}{\alpha\alpha_2\left(\frac{B^{IB}}{L^{SB}}\right)}(1-\alpha_1) < R < R + \frac{W^S}{\alpha\gamma_2\left(\frac{B^{LB}}{L^{LB}}\right)}(1-\gamma_1) = R^L$$

where W^S is the wage paid to saver, B^{IB} is the interbank loan, B^{LB} is the commercial loan, L^{SB} is the savers' labour used in production of interbank loan, L^{LB} is the savers' labour used in production of commercial loan. The wedges between interest rates are caused by the labour's costly usage in loan production functions.

4) Log-linearise the model's equations, ready for the simulation exercise.

RESEARCH REPORT

1. Name: Sarah J. Porter （ID No.: SP10107）

2. Current affiliation: Durham University, UK

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

5. Host researcher: Dr. Katsuhiko Suzuki

6. Description of your current research

To fully understand petroleum systems it is essential that we are able to gain insight into the formation of petroleum source rocks. It is therefore critical that we are able to determine the timing and environment of source rock deposition.

The organic-rich composition of source rocks promotes the preferential uptake of trace elements (including nickel and vanadium) as well as rhenium and osmium, leading to an overall relative enrichment of these elements in the source rock. We combine trace element geochemistry together with rhenium–osmium (Re-Os) geochronology to ascertain the environment (redox and seawater osmium compositions) and timing of source rock deposition, respectively.

The IFREE (Institute for Research on Earth Evolution) group at JAMSTEC has recently expressed an interest in analysing organic-rich materials using the Re-Os technique. As this procedure is effective and well-established at Durham, a major part of this summer placement has been to set up our analytical procedure at JAMSTEC.

7. Research implementation and results under the program

Title of your research plan:

Investigating Petroleum Source Rocks: Timing and Environment of Deposition

Description of the research activities:

Objectives:

1) Analyse an immature Jurassic source rock (black shale). 40 samples taken at regular intervals across a vertical section in Robin Hood's Bay, UK (north-east coast)

2) Conduct Rhenium-Osmium (Re-Os) geochronology to determine the precise and absolute age of the source rock

3) Create Os isotope profiles through the vertical section to potentially determine whether Os isotopes can be used as proxies for redox conditions at the time of deposition

4) Determine the initial Os isotope ratio and the evolution of Os seawater compositions during this stage of the Jurassic

Analytical protocol:

1) Digest the powdered sample and isotopic spike (Os) in a chrome-sulphuric acid solution for 48 hours

2) Separate osmium via solvent extraction and back extraction procedures, using chloroform and Hydrobromic acid, respectively

3) Reduce the chrome in the remaining sample using ethanol

4) Separate Re using anion exchange chromatography

Mass spectrometry: Once Re and Os had been separated and purified, samples were loaded onto nickel and platinum wire filaments, respectively, and their isotopic compositions determined using thermal ionisation mass spectrometry (TIMS)

Results:

- The Re-Os analytical protocol from Durham has been successfully established in the JAMSTEC laboratories
- Re-Os geochronology yielded:
  - an absolute age for the Robin Hood's Bay black shale section
  - an Os isotope profile for the section
  - initial Os isotope values, indicating the seawater Os isotope composition for that stage of the Jurassic period

8. Please add your comments (if any):

This summer placement has provided a unique opportunity to work closely with world-class researchers in the Geosciences field. The experience of working in a research institute opposed to a university has also been invaluable and has impacted significantly on my post-PhD career decisions.
My colleagues at JAMSTEC have been fantastic, really supportive and fun. It's been a great working environment for the last 8 weeks and I'm extremely grateful that they agreed to have me here this summer.
I will definitely recommend the JSPS summer program to my colleagues and co-workers back in the UK.

9. Advisor's remarks (if any):

It has been great for me and members of my group to spend time with Sarah not only in a laboratory but also in a small trip to Mt. Fuji. Time flies! Two months are too short. But I am sure it is just a start of our long and nice relationship. I really hope Sarah will visit Japan again (often!) and we can continue our research work. Of course, I will visit her when I visit UK.

RESEARCH REPORT

1. Name: Marta Varela （ID No.: SP10108）

2. Current affiliation:

Imaging Sciences Department, Imperial College London, London, UK

3. Research fields and specialties:

Mathematical and Physical Sciences, Medical, Dental and Pharmaceutical Sciences

4. Host institution: Nara Medical University

5. Host researcher: Dr Toshiaki Taoka

6. Description of your current research

Cerebral Perfusion (or Cerebral Blood Flow, CBF) measures the amount of blood delivered to a unit volume of brain tissue in a given time.

Moyamoya disease is a rare cerebrovascular condition, most common in East Asia. In Moyamoya disease, some of the arteries that irrigate the brain become progressively narrowed and even occluded. Blood transit time from the vasculature to the brain is generally increased and cerebral perfusion can be lowered, increasing the risk of cerebrovascular accidents and subsequent neurological damage. To decrease this risk, Moyamoya patients often undergo arterial bypass surgery, where a healthy extra-cranial artery is deviated into the brain to provide an additional pathway for blood flow.

To monitor the progression of the disease, cerebral perfusion measurements are regularly performed on moyamoya patients. These usually require exposure to ionising radiation, as in SPECT or PET. Arterial Spin Labelling (ASL) is an MRI based technique that is completely non-invasive and is therefore particularly well-suited for repeated studies, as in moyamoya disease. ASL is a multi-parameter, technically challenging technique, which requires careful optimisation when used in patient groups with abnormal haemodynamics. The use of ASL in Moyamoya patients has thus far merited little attention in the literature.

7. Research implementation and results under the program

Title of your research plan: Optimising Cerebral Perfusion Measurements using Arterial Spin Labelling in Moyamoya Disease

Description of the research activities: In ASL, magnetically-labelled endogenous blood water is used as the contrast agent (bolus). An ASL experiment starts with the labelling of arterial blood in the neck region. Some time later, an image of the brain (perfusion weighted image) can be acquired, whose intensity is proportional to the amount of labelled water molecules in each pixel and therefore related to CBF. These images can then be converted into quantitative CBF maps using suitable mathematical models. As the perfusion signal is very weak, the image acquisition process needs to be repeated typically tens of times to increase its intensity relative to image noise.

The main challenge posed by moyamoya disease to ASL is the increase in the transit time between the arteries and

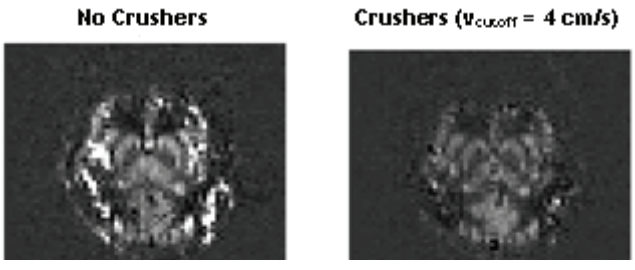


Fig 1 – Perfusion weighted images of the same subject, showing how the use of crushers can eliminate most of the hyperintense intra-arterial signal.

brain tissue. This has three main consequences:

1. Labelled blood might not have reached brain tissue at the time perfusion images are created and still remain in the feeding arteries. This can lead to an overestimation of CBF, as the signal from the abundant collateral arteries can be mistaken to be a hyperperfused brain area.

To minimise this artifact, an MRI tool capable of attenuating signal from water molecules travelling through the image plane with a high velocity was used. This greatly reduces the signal from arteries or veins, leaving capillary blood and brain tissue virtually unaffected (Fig 1).

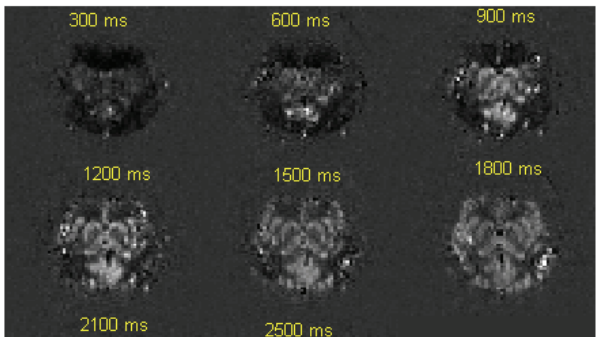


Fig 2 – Perfusion weighted image time series in a Moyamoya patient. (Acquisition times are shown in yellow.)

2. Following labeling, the modified water molecules quickly return to their original state and the amount of available perfusion signal decreases exponentially with time. As the long transit times in Moyamoya disease force the use of longer sampling times, the decrease in the available perfusion signal is also of concern. An effort was made to get the maximum signal from the experiment, whilst keeping scan time at a minimum. A prospective motion correction algorithm was also used throughout the examination to minimise the impact of subject motion on image quality.

3. If the delay in the arrival time of blood to brain tissue (□t, bolus arrival time) is not taken into account, CBF might be underestimated. Images were acquired at different times following labelling, in order to obtain a time series of the perfusion signal (Fig 2). This time series was then fitted to a mathematical model, to obtain the values for CBF and □t that best describe the acquired data in every pixel.

Fig 3 shows the CBF and □t maps obtained using the optimised protocol in the same Moyamoya patient before and after bypass surgery was performed. In the brain region located near the site of the surgery, it can be seen that CBF does not undergo a sizeable change, whereas the bolus arrival time is considerably shortened. This suggests that bolus arrival time, which cannot be determined using techniques such as PET or SPECT, may be a useful biomarker in the assessment of the success of the bypass procedure.

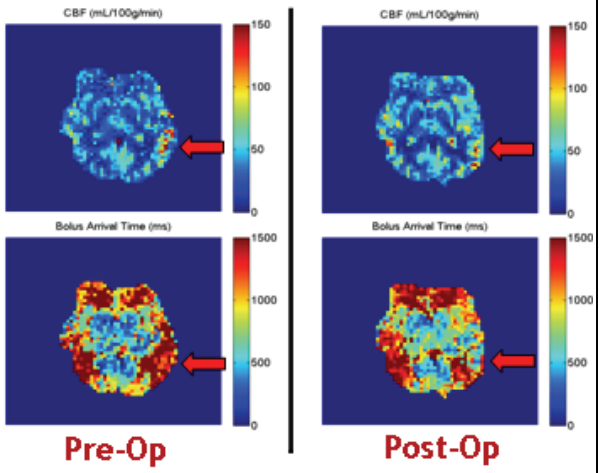


Fig 3 – CBF and Δt maps acquiring using the developed method in a Moyamoya patient 1 day before and 13 days after bypass surgery. Arrival time is markedly decreased near the bypass area, as shown by the red arrow.

Further studies are needed to establish the clinical usefulness of the developed ASL protocol, but the acquired preliminary data suggests it may contribute to the understanding of haemodynamics in moyamoya patients.

9. Advisor's remarks (if any): Dr. Varela worked hard and has made great advance in this two months. As shown in the report above, moya-moya disease shows complicated hemodynamics and simple ASL method could not reflect the pathological circulation. In addition, bypass surgery which is one of the typical treatments can make their hemodynamics more complicated. Her idea to use multiple TI in ASL for evaluation of complicated hemodynamic changes in moya-moya disease seems to be promising method and we appreciate her effort to build up such a sophisticated method in this short term. Aside from her academic achievement, she brought us exciting experience to communicate with people of different background and she gave us happy time by her friendly character.

RESEARCH REPORT

1. Name: Oliver Wilkinson (ID No.: SP10109)

2. Current affiliation: University of Sheffield, UK

3. Research fields and specialties:

Chemistry, Biological Sciences

4. Host institution: Osaka University

5. Host researcher: Professor R. Masui

6. Description of your current research

The theme of my PhD thesis is the investigation into the characteristics of an ATL protein from *S.pombe*, Atl1. ATL proteins are structural homologues of an extensively studied family of proteins known as O^6-alkylguanine-DNA-alkyltransferases (AGTs). The human form of this protein is MGMT, and it is a direct reversal repair protein that removes alkylation damage from the O^6 position of the guanine base in DNA. Such damage if left unrepaired is highly toxic to the cell. The repair reaction is an irreversible process in which the alkyl group is transferred to cysteine in the MGMT active site. ATL proteins differ from AGTs in that the active site cysteine residue, crucial for alkyl transfer, is replaced with another amino acid, usually tryptophan or alanine. ATL proteins have been isolated and characterised from *S.pombe, E.coli* and *T.thermophilus* and in all cases these proteins bind to DNA containing O^6–alkylguanine but do not repair it. Current thinking is that these proteins when bound to DNA act as a signal to other DNA repair proteins and may in some cases deal with alkyl lesions that are not repaired by MGMT. Currently I am investigating the substrate specificity of Atl1, and in particular am investigating whether it and a variety of mutants of this protein bind to DNA containing a wider range of O^6-alkylguanine adducts than are recognised and repaired by MGMT. This has involved using gel-shift analysis during electrophoresis (EMSA) and fluorescent techniques using anisotropy measurements. In addition, we would like to discover the mechanisms by which ATL proteins protect cells against the deleterious effects of alkylation damage, despite lacking the ability to engage in direct repair.

7. Research implementation and results under the program

Title of your research plan: DNA-protein Binding Studies: Investigating an ATL Protein from *Thermus Thermophilus*

Description of the research activities:

In Osaka this summer, I have successfully completed a study of the substrate specificity of TTHA1564, an ATL protein from *T.thermophilus*. Having already carried out an identical study with Atl1 from *S.pombe* in Sheffield, I am now in a position to make direct comparisons between the two proteins. This is especially interesting as one organism is eukaryotic and the other prokaryotic, the proteins have a slightly different active site sequence, and both organisms lack an active alkyltransferase (AGT) protein. I found that despite a few subtle differences, both ATL proteins recognise and bind DNA containing a broad range of O^6-alkylguanine adducts. This may have implications for their proposed role of signaling damaged DNA for repair by the nucleotide-excision repair (NER) pathway.

8. Please add your comments (if any):

This collaboration has been extremely rewarding and I have thoroughly enjoyed my time in Osaka.

RESEARCH REPORT

1. Name: Glenn Wright （ID No.: SP10110）

2. Current affiliation: Queen's University Belfast

3. Research fields and specialties:

Chemistry

4. Host institution: Nara Women's University

5. Host researcher: Professor Kaoru Iwai

6. Description of your current research

The research I carried out for my PhD is concerned with the fabrication of molecular logic gates. These small organic compounds can perform binary logic operations in the same way as those silicon-based logic gates found inside computers. However, instead of using inputs and outputs of voltages, molecular logic gates use chemical species as inputs and light, in the form of fluorescence, as the output.

This is achieved by utilising a mechanism called photoinduced electron transfer (PET). PET can be used to quench the fluorescence of a molecular logic gate in the absence of a chemical species (giving an output of 0). When that species then binds to the logic gate, PET is prevented and fluorescence is switched 'on' (giving an output of 1). Such behaviour is equivalent to a YES logic gate. My research has focused on synthesising a number of these gates using various constituents, which change the input and output parameters, such as the binding species and the colour of fluorescence.

Furthermore, I have then bound these molecular logic gates to solid particles such as aminopropyl silica and polystyrene, with the intention of using them in an application known as molecular computational identification (MCID). This allows for the identification of a large population of very small objects, as each identifier will have a unique set of parameters with regard to its fluorescence behaviour, for example, the colour and intensity of fluorescence, the exciting wavelength and the switching behaviour in the presence of various ions and at different pH values etc. By combining these parameters, it is possible to potentially create thousands of unique identifiers and use them to tags small objects such as solid particles and biological cells.

7. Research implementation and results under the program

Title of your research plan:

The Synthesis and Evaluation of a Molecular Fluorescent Thermometer based on Polymer Chemistry

Description of the research activities:

The objective of my research activities in Japan was to synthesise a fluorescent polymer that would repsond to temperature, fully characterise its photophysical and thermal behaviour, and then coupling this thermo-responsive fluorescent polymer to aminopropyl silca (APS) in order to demonstrate its potential use in molecular computational identification (MCID).

This was achieved by taking a number of steps to firstly synthesise the fluorescent monomer and characterise its structure, using ^{1}H NMR and HPLC mass spectrometry. Several purifications of the intermediates were required in order to attain sufficient purity for the polymerisation step.

The copolymer was synthesised with three constituents: NIPAM (which provided the polymer with its thermoresponsivity), the previously synthesised fluorescent monomer and acrylic acid, which would facilitate coupling to the APS. Two polymers were synthesised, the first without the fluorescent monomer, and the second with it. This allowed the effect of the acrylic acid on the polymer to be ascertained in the absence of the fluorescent monomer. These polymers were characterized by Gel Permeation Chromatography (GPC), which allowed the relative molecular weight and the size distribution of the polymer to be ascertained, as well as being characterised by MALDI-TOF-MS *(*Matrix-assisted laser desorption/ionization time of flight mass spectroscopy). The fluorescence behaviour of the second polymer (i.e. that which incorporated the fluorescent group) was also analysed at various temperatures. This showed that the fluorescence of the polymer was significantly higher at increased temperatures. This polymer will later be covalently bound to APS, and the studies on this solid-bound polymer will be carried out at Queen's University, Belfast.

8. Please add your comments (if any):

I'd just like to thank JSPS and the British Council for providing me with this wonderful opportunity to work with a great group of Japanese researchers, as well as being able to explore the beautiful country of Japan. I would also like to give a special thanks to Professor Kaoru Iwai, who has been an excellent host, and shown much generosity to me during my stay. The girls of the Iwai lab have also been an absolute pleasure to work with, and have made my time in Japan all the more enjoyable.

I have met some fantastic people during my stay, both from the university and other JSPS fellows, and I'm sure these friendships will continue when the program is over. This fellowship will be of great benefit, to my future career, as well as personally, and it is something I would heartily recommend to others. Arigato gozaimasu.

9. Advisor's remarks (if any):

I would also like to thank JSPS and the British Council for giving us this good opportunity to have a young researcher from Belfast as a coworker. The girl students in my lab and I have had a splendid time with him during his stay. I think that this program provides a great benefit to young people, not only the fellow but also the students. So I would like to be a host again if I had another chance.

RESEARCH REPORT

1. Name: BEYLER Maryline （ID No.: SP10201）

2. Current affiliation: Université de Strasbourg, France

3. Research fields and specialties:

Chemistry

4. Host institution: Department of Applied Chemistry, University of Tokyo

5. Host researcher: Prof. Makoto FUJITA

6. Description of your current research

Catenanes, topologically non trivial molecules, continue to attract much attention. Originally, these compounds used to represent mostly synthetic challenges. Nowadays, they are also made and investigated in relation to controlled dynamic species ("molecular machines"), electron and energy transfer processes or novel materials. Whereas the preparation of catenanes synthesized by forming stable covalent bonds in the last ring-forming step is much documented, the formation of such compounds under thermodynamic control using non-covalent bonds is much less common. My Ph.D. project in Prof. Sauvage's group consists in the synthesis of [2]catenanes assembled thanks to coordination bonds. These sophisticated architectures were synthesized in high yield as thermodynamic products. They were formed in two steps, from a zinc(II) bis-porphyrin and a dipyridyl chelate, by using Cu(I)-N bonds to assemble acyclic complexes and Zn(II)-N interactions to generate rings.

7. Research implementation and results under the program

Title of your research plan:

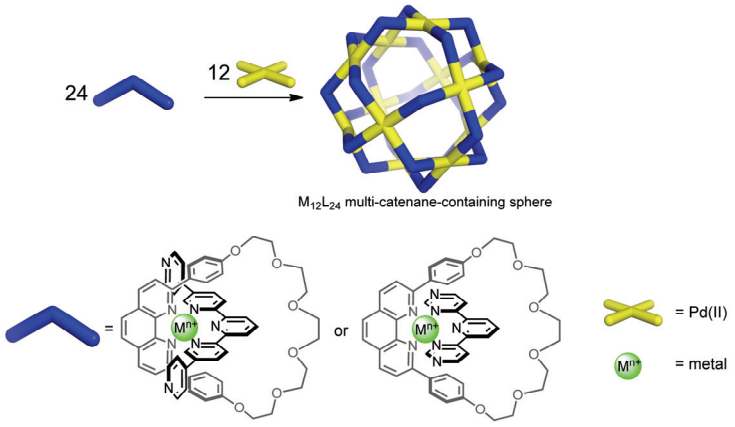
Synthesis of non-covalent [2]polycatenanes and of multi-catenane spheres

Description of the research activities:

One of the research plans was the synthesis of multi-catenane spheres.

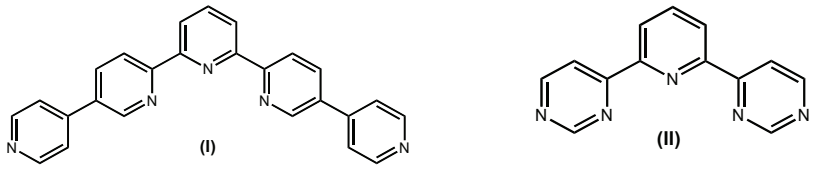
In 2004, the Fujita group showed that the formation of a $M_{12}L_{24}$ sphere is obtained by interactions between Pd(II) (M) and a bis-pyridine (L) if two pyridyls group axes borne by the spacer form an angle of 120°.

The objective of our collaboration was to synthesize such $M_{12}L_{24}$ spheres but these spheres would be multi-catenane-containing spheres. The principle is depicted in Scheme 1.



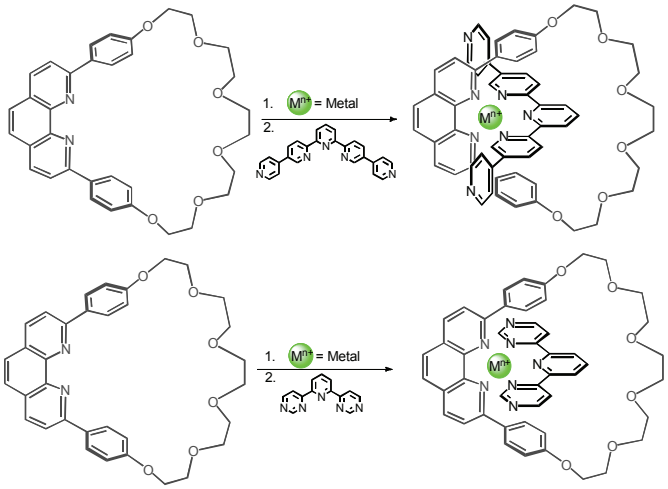
Scheme 1. *Principle of the synthesis of spheres containing catenanes.*

In a first time, two bridging ligands (I) and (II) were synthesized (Scheme 2).



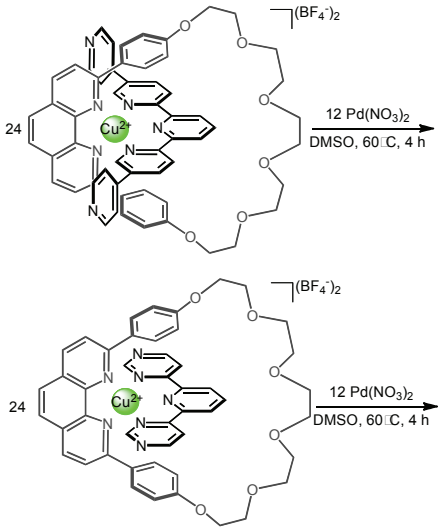
Scheme 2. *Terpyridine ligands for the formation of a $M_{24}L_{12}$ spheres.*

The ligands are functionalized by a terpyridine. Terpyridines can coordinate a metal. More precisely, the ligands can be threaded into a macrocycle (also functionalized by a chelate) thanks to the template effect of a metal. The principle of the threading reaction is depicted in Scheme 3.



Scheme 3. *Threading reactions.*

Different metals were used but only satisfactory results were obtained with copper (II). Finally, coordination of these Cu(II) complexes with $Pd(NO_3)_2$ was tried to see if a $M_{24}L_{12}$ sphere could be obtained (Scheme 4).



Scheme 4. *Tentative of synthesis of multi-catenane spheres.*

As far the obtained species could not be identified, analyses still have to be performed. Moreover several conditions have to be tried (change of concentration, temperature, equivalent of palladium…). This work will be continued in Prof. Fujita group.

RESEARCH REPORT

1. Name: BUHNIK Sophie （ID No.: SP10202）

2. Current affiliation: Paris 1 University (Pantheon-Sorbonne), France

3. Research fields and specialties:

Social Sciences

4. Host institution: Osaka City University, Graduate School for Creative Cities; collaboration with the Graduate School for Human Life Science and Department of Geography.

5. Host researcher: Professor Hiroshi YAHAGI

6. Description of your current research

Since the mid-2000s, a growing number of Japanese cities are losing population and aging faster than in any other OECD country, after several decades of uninterrupted growth. It draws the attention of research network studying cities in decline on a global scale (Oswalt et al., 2006; Cunningham-Sabot and Fol, 2009). Urban shrinkage defines the combination of decreasing demographic, economic and social trends in urban spaces in opposition to growth and development. The notion originates in research on US and European cities where de-industrialization has resulted in the restructuring of the city's economic, social and cultural base. In mature industrial countries, economic globalization (Van de Kaa, 1987) impedes the development of cities or urban regions failing to "connect" to information and economic networks (Castells, 2003) and combines with the effects of the Second Demographic Transition (Van de Kaa, 1987).

While the prospect of shrinking population and aged society is presently one of Japan's most discussed topics, the expression "urban shrinkage" does not seem common. Only recently have Japanese-speaking works translated "shrinking cities" (Yahagi, 2009) as a notion coming from English-speaking urban studies. A late transfer does not mean that the phenomenon hardly applies to the Japanese context. More likely, the local impacts of a global process have only recently become apparent, in the aftermath of Japan's post-Bubble structural crisis. But precisely how urban shrinkage processes relate to the evolution of Japan's cities has not been clearly articulated.

The aim of my stay at the Osaka City University was a clearer identification of the causes and spatial patterns drawn by urban decline processes in a Japanese agglomeration, namely the Osaka Metropolitan Area. In mature industrial countries, urban decline raises tough planning issues, especially regarding mobility in daily life for the remaining residents of shrinking areas, while financial resources are also declining in the process. With Japan's advance into an aging and shrinking society, how are urban stakeholders adapting their planning policies ?

7. Research implementation and results under the program

Title of your research plan:

Identifying urban decline patterns and their impacts on transportation infrastructures and elderly mobility in the Osaka Metropolitan Area.

Description of the research activities:

My research activities were divided into three main stages :

1) Bibliographical research at the Osaka City University Library. The OCU Library provides one of the largest library resources for geography, urban studies and urban planning in Japan. I could gather more

than 200 references pertaining to my topics of interest. These references were organized around the following keywords in particular : jinko (no) shukushou (population decline), toshi (no) shukushou (urban decline), koureika shakai (aging society), mobility…

2) Collecting relevant statistical data (population dynamics, employment rates, density of services, number of commuters…) and building geographic information about urban decline on several distinct scales (metropolitan area and prefectural level; municipal level; ward and neighborhood level), in order to see whether decline is correlated or not to various socio-demographic factors.

The OCU provided an ArcMap License (a Geographic Information System software) and access to numerous geocoded statistical data produced by public institutions or semi-public organizations (like ESRI Japan or Synfonica). As most data were in Japanese, it was first necessary to translate them, then to address the similarities and differences with the census methods used in other OECD countries. Another methodological issue lies in the definition of a metropolitan area over time : indeed a slight change in thresholds (for instance the number of residents commuting to another municipality for work) can bring substantial changes. It determines the approach of the specificity of Japan's urban dynamics from a foreign point of view.

3) Field studies : I visited with my host suburbs of the Osaka Metropolitan Area which are particularly concerned by decline processes. There, municipal representatives concerned with new town re-development strategies, elderly mobility and provision of care services were met.

Due to time constraint, field studies were concentrated on new towns located within a 20 km radius from Osaka city center : Senboku New Town and Shin Kanaoka in Sakai City (south of Osaka) and Senri New Town in Suita City (north). New towns were meant to afford housing for middle class families mainly from the 1960s to the 1980s, but are aging faster than other suburbs, because of the aging in place of the first generations who moved to such areas, combined with the out-migration of said generation's children. The choice of Senboku was motivated by the involvement of the OCU Graduate School for Human Life Science in an experimental project relying on information and communication technologies to improve access to care services for elderly residents.

Results : Map-making of relevant statistics clearly shows that the distant suburbs of Osaka city are declining and aging faster than areas close to main employment cores and business centers. Except for municipalities with less than 5 000 inhabitants, the density of shops and services is still important in most suburbs of the Osaka Metropolitan Area. However, the correlation between decline and aging aggravates the possible constitution of "food deserts", as the elderly's sphere of daily living is physically narrowing faster than the younger generations' one.

On a local scale (wards and neighborhoods) however, patterns of demographic growth or decline can be very fragmented. Among new towns for instance, dwelling statuses and railway fares influence suburban dynamics : in the absence of integrated fare system between transportation companies, middle class households with children will try to live closer to their workplace, in or near city centers. On the contrary, households with retired workers prefer to age in place, as they do not need to commute everyday anymore. Thus, age differentials between neighborhoods can strengthen depending from connexions to employment cores and commuting costs.

Researchers I met agree that the consolidation of social capital, community activities and local care services is more important than the creation of new infrastructures (apart from the already existing ones) in declining suburbs, in order to support elderly mobility and maintain a sustainable sphere of daily living.

RESEARCH REPORT

1. Name: Anne-Sophie Kremeur （ID No.: SP10203）

2. Current affiliation: Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Gif-sur-Yvette, France

3. Research fields and specialties:

Interdisciplinary and Frontier Sciences: Oceanography

4. Host institution: Tohoku University, Sendai

5. Host researcher: Dr. Toshio Suga

6. Description of your current research

Impact of physical processes on the biogeochemical budgets in the ocean

Main research interests:
Physical-biogeochemical coupling in the ocean
Mode water biogeochemical properties & influence on climate
Primary production modeling
Oceanic nitrogen and carbon cycles

Keywords
Physical-biogeochemical coupling ; global ocean ; North Atlantic; North Pacific; subtropical mode water ; nutrient cycling ; carbon cycling ; model developments and analysis.

My main research consists in understanding the coupling between physical and biogeochemical processes in the ocean.

Scientifically, my work is dedicated to the understanding of the biogeochemical properties of mode waters in the ocean, and their role on the climate system. My PhD thesis investigates the setting of the properties of the subtropical mode water in the North Atlantic (NASTMW), in order to extend the work of *Palter et al*. (Nature, 2005), which was based on observational analysis. *Palter et al*. (Nature, 2005) have shown with JGOFS transects that NASTMW is poor in nutrients and may explain the minimum in chlorophyll observed in the western part of the North Atlantic. The model developed as part of my PhD thesis has brought new insights on how the biogeochemical properties of NASTMW are set during the mode water ventilation, how they change, and how and where they control remotely the surface layers in the North Atlantic ocean (*Krémeur et al*., 2009). The results highlight that the nutrient content of NASTMW increases with time, and act as a fertilizer of the upper layers in the western part of the North Atlantic. In my postdoctoral work conducted with Laurent Bopp and Cyril Moulin at LSCE, I am pursuing the investigation of NASTMW at a longer timescale. The global ocean general circulation model NEMO-PISCES is used at a coarse resolution to emphasize the differences in the production regime between two periods (1960s and 1990s), characterized by major differences in the physical forcings. In this study, the coupling between physical and biogeochemical processes at the surface initiates a discontinuous signal in nutrient concentrations between the surface and the subsurface, contrary to intuition (*Krémeur et al*., submitted).

Regarding the technical part of my research, I possess skills in modeling that I developed at LOCEAN and at LSCE during my M.S., my PhD and my postdoctoral works. First, the implementation of the carbon and oxygen systems was done in a high-resolution regional bio-physical model (*Lévy et al*., 2004). Second, I developed a new idealized bio-physical configuration of the North Atlantic in the ocean general circulation model NEMO (*Krémeur et al*., 2009). The model I developed has been run at the Earth Simulator (Japan), and is the basis of the GYRE project conducted at the LOCEAN. Third, in collaboration with Mercator (Toulouse, France), I developped a new operational global bio-physical model of the ocean that includes physical data assimilation.

7. Research implementation and results under the program

Title of your research plan:

On the role of Subtropical Mode Water on the biogeochemical cycles in the North Pacific ocean

Anne-Sophie Kremeur[1], Toshio Suga[2]

[1] LSCE, Gif-sur-Yvette, France

[2] Tohoku University, Sendai, Japan

Mode waters are important water masses of exceptionally uniform properties over an extensive depth range, and are present in all Earth's oceans. In the North Pacific, one mode water, the North Pacific Subtropical Mode Water (NPSTMW), has been observed south of the Kuroshio in the North Pacific. NPSTMW occupies a large volume at subsurface and is renewed by subduction south of the Kuroshio every year. Then NPSTMW recirculates below the surface layers, where the phytoplankton uses nutrients and carbon for its metabolism. Even though they play an important role in the nutrient and carbon oceanic cycles, mode waters are still poorly understood in a biogeochemical perspective.

In the framework of the JSPS program, we seek the NPSTMW biogeochemical properties, at large spatial scale and on a decadal timescale, by analysing model solutions from an ocean general circulation biogeochemical model (NEMO-PISCES). Also, observations collected in the North Pacific (Japan Meteorological Agency) will be shown. First, the study is focused on the nutrient budgets within NPSTMW and its impact on the upper layers of the subtropical gyre. Then, the setting and variability of the NPSTMW biogeochemical properties are investigated. Finally, we propose some mechanisms that control the subtropical nutrient reservoir in the western North Pacific ocean.

Our results have shown that:

(1) Newly-formed NPSTMW is not a nutrient-poor water mass. This is related to the higher amount of nutrient at the surface in the formation region of mode water, compared with the North Atlantic ocean. The advection of nutrient-rich water masses is actually important in this part of the ocean, through the so-called Southward Ekman transfer mechanism.

(2) NPSTMW provides nutrient to the subtropical reservoir. This subtropical ocean is known as a depleted bowl shape induced by physics (Ekman pumping). Through its formation mechanism, it is evident from our data and model results analysis that NPSTMW injects nutrient in the northern part of the subtropical reservoir. As a consequence, the nutricline shallows and nutrients become more easily available to the surface.

(3) NPSTMW may influence the growth of phytoplankton in spring and summer downstream to their formation region. Indeed, NPSTMW resides between 100 and 300 m, which is just below the euphotic layer where the phytoplankton consumes actively nutrient through the photosynthesis process. We identify a spatial link between the location of NPSTMW and the enhancement of photosynthesis.

(4) The influence of NPSTMW on the upper layers seems more direct in the North Pacific than in the North Atlantic ocean, where subtropical mode water is known to produce a remote effect on primary production.

(5) On a interannual timescale, we show that high nutrient concentrations within NPSTMW are connected with low mixed-layer depths in the formation region, as in the North Atlantic. This may be due to the coupling between physical and biogeochemical processes, which occur during the formation of NPSTMW, as highlighted in the North Atlantic ocean. We will pursue our analysis to emphasize what possible mechanisms control the nutrient and carbon budgets in NPSTMW.

8. Please add your comments (if any): I really enjoyed my stay in Japan, which I found too short. Exchanging with Dr. Toshio Suga was a real source of inspiration. The friendly welcome and the kind help, as well as the enjoyable conversations and activities made these two months a pleasure and unforgettable. I had also the opportunity to meet scientists from different labs in Japan, while giving seminars in order to present my former results. Besides, our new results will be presented to JAMSTEC and to the japanese SOLAS meeting in August 2010.

I would like to thank my host researcher Pr. Toshio Suga both in academic as well as in non-academic personal matters, and the JSPS program.

Finally, living in Japan, discovering its culture and the people was a delightful experience. I will highly recommend it to other young researchers.

9. Advisor's remarks (if any): I really enjoyed hosting Dr. Anne-Sophie Kremeur. She has been active in both conducting research and experiencing Japanese life. Our mutual collaboration resulted in interesting outcomes, upon which we will extend our collaboration in near future. Her positive and friendly attitude had a good influence on Japanese students in my lab.

I would like to thank the JSPS program, which worked very well in many aspects.

RESEARCH REPORT

1. Name: Olivier MAJOULET （ID No.: SP10204 ）

2. Current affiliation: Université Lyon 1

3. Research fields and specialties:
Chemistry

4. Host institution: Waseda University – Inorganic Materials Chemistry Laboratory

5. Host researcher: Pr. Yoshiyuki Sugahara

6. Description of your current research

Nitride-type ceramics (BN, SiCN, and SiBCN) synthesized through the Polymer Derived Ceramics route have attracted considerable attention over the last decades. Such polymer-derived ceramics show an excellent thermal stability at high temperature. They are described as high durability materials and are in general used as fibers as well as composites or even coatings and workpieces with low specific area.
It seems interesting to combine the intrinsic characteristics of these nitrides with a controlled porosity in order to generate multifunctional materials. Our work naturally went on this way, in order to synthesize well organized porous nitride ceramics.

Different pathways to elaborate well organized porous SiBCN ceramics are considered. The first consists in infiltrating a media (in our case, the CMK-3, a mesoporous carbon with a large specific area) with the desired polymer derived ceramic. Once the infiltration done, the polymer-template composite is pyrolyzed in order to be converted into a ceramic-template composite. The latter underwent a specific treatment to remove the carboneous template and generate a well organized SiBCN ceramic.
The second way is focused on the use of ABA type block-copolymers. This latter is known to adopt a specific morphology into solution. Depending to the solvent choice, the organic polymer could show a hexagonal or a lamellar structure.
This way deals with the elaboration of an inorganic/organic composite based on a simple mix of the two polymers, followed by an evaporation of the solvent. An appropriate thermal treatment allows the conversion of the inorganic polymer into the derived ceramic and the removal of the organic copolymer at the same time.
The third way proposes to work directly on the structure of the polymer by mimicking the surfactant principle.

7. Research implementation and results under the program

Title of your research plan:

Preparation of Polymer-Derived Ordered Mesoporous Aluminium Nitride and SiliconAluminum CarboNitride

Description of the research activities:

Aluminum nitride (AlN) is one of the important nitride ceramics, because of its high thermal conductivity. Besides, AlN is an attractive ceramic due to its high thermal and chemical stability, and its low thermal expansion coefficient for porous material and composite applications. The introduction of silicon and carbon elements in the AlN network, i.e., SiAlCN system, allowed the derived material to exhibit much better oxidation and hot-corrosion resistance at temperatures up to 1200°C. Such materials are therefore particularly suitable for use in harsh environment. Then, the idea is to combine the exceptional properties of AlN and SiAlCN materials with an extended surface area.

Thus, the work has first consisted in the synthesis of AlN and SiAlCN preceramic polymers by essentially using polyalkylalanes and polysilazanes respectively as aluminium and silicium sources.

In a second time, the creation of the corresponding well ordered porous AlN and SiAlCN ceramics has been accomplished. Two principle routes have been followed. The first strategy is based on the infiltration of CMK-3 mesoporous carbon. Two steps of pyrolysis and template removal lead to well ordered mesoporous SiAlCN ceramics. Different Si:Al ratios in the polymer network have been tried to improve the properties of the derived ceramics.

The second strategy consisted in the elaboration of self-assembled polymer derived ceramic by mimicking the surfactant principle. The syntheses of the corresponding polyaluminasilazanes have been carried out during the stay. The final tests will be led later.

RESEARCH REPORT

1. Name: Mansuy Nicolas Roger （ID No.: SP10205）

2. Current affiliation:

Phd student at University of Québec at Montréal, Canada

3. Research fields and specialties:

Biological Sciences

4. Host institution: Department of Applied Chemistry, Faculty of Urban Environmental Sciences, Tokyo Metropolitan University

5. Host researcher: Professor Yoshizumi Kajii

6. Description of your current research

My current research is based primarily on wildland fire in boreal forest. In the province of Quebec, nearly 85% of forest area that burned between 1985 and 2004 was ignited by lightning. 75 000ha of forest go up in smoke each year. The combustion of organic matter during a summer of fire can represent over 35% of greenhouse gas emissions (CO_2, CH_4 ...), released by Quebec for a year. In the same time, in the context for fight against climate change, the potential role of boreal forest to sequester carbon is increasingly documented and it is of growing interest to national policy-makers. Therefore I also conduct studies on afforestation which is defined as the creation of a new stand of trees where none or few have existed for the last 50 years and is expected to sequester biologically atmospheric C. But to date, afforestation project in boreal forest to offset carbon is still in debate for several reasons (briefly: the investment, the natural disturbance regime, decrease in albedo, feedbacks of evapo-transpiration and aerosols following land use change related to VOC emission from plants).

In my host lab, my main purpose is to fill gaps about VOC from plants and to learn how to estimate their emission.

7. Research implementation and results under the program

Title of your research plan:

BIOGENIC VOLATILE ORGANIC COMPOUNDS (BVOC) EMISSION FROM PLANTS.

Description of the research activities:

Emissions of natural or biogenic volatile organic compounds (BVOCs) from vegetation are estimated to exceed all emissions of anthropogenic volatile organic compounds on the global scale and are roughly equal to global emissions of methane. They can have a dominant influence on the atmospheric chemistry of forests, rural areas, and some cities. The type of vegetation, solar radiation, and temperature determine the emission rates and species of BVOCs.

Thus the objective of this stage was to estimate the VOC emission from plants using Gas chromatography-mass spectrometry (GC-MS). Then compare these results with OH reactivity to verify the hypothesis that unknown reactive BVOCs provide the missing OH reactivity (details are given below).

The first step was to create a room to isolate the plants from the ambient air but also to control artificially and measure the light, the temperature and the humidity in this room. We tested different types of plants to briefly assess the amount of VOC emitted and keep the plants that emit the most. Finally a conifer, (Golden Cypress) was chosen.

The second step was therefore intended to determine precisely the VOC emitted by the plant chosen. In this experiment we used a dynamic flow-through enclosure system. A bag made of inert material, is placed around the plant part to be studied within the room. Clean air is then pumped into the enclosure and sampled at both inlet and outlet. The most widely used and recommended method for the separation, identification and quantification of the VOCs from air samples has been Gas chromatography (GC) followed by mass spectrometry (MS) (Cao and Hewitt, 1999; EPA, 1999b). In our experiment we used GC-FID (flame ionization detector) and also, the proton-transfer-reaction mass-spectrometry (PTR-MS). Generally, these methods can determine the species by identify the mass number but sometimes it is impossible to distinguish two VOCs with the same mass number.

Finally, the total OH reactivity was measured by the laser induced pump and probe technique. A detailed explanation of the instrument has been presented by Sadanaga et al. (2004a). In brief, BVOCs react with hydroxyl radicals (OH). A chemical's reaction frequency with OH is the product of its rate-coefficient for reaction with OH times its concentration. The sum of the reaction frequencies with OH for all chemicals is called the OH reactivity, which is the inverse of the OH lifetime. We estimated the decays of the OH lifetime for the VOCs that react with OH. In this case a fast decay suggests a high amount of VOCs, a slow decay suggest less VOCs. Up to date, the analysis is still ongoing and no results are yet available.

The third step not yet realized is to compare OH reactivity calculated from the outputs of PTR-MS and the outputs from the laser. We expect a greater concentration from the laser suggesting greater amount of VOC than calculated with the PTR-MS. These results should be consistent with the literature that demonstrated a large number of unknown VOCs.

8. Please add your comments (if any):

First, I would like to thank Professor Yoshizumi Kajji for inviting me in this Lab and for devotes me his time soon he could. I am also grateful for giving me the opportunity to familiarize myself with new technologies.

I would like also to sincerely thank all members of the Lab for their hospitality, their kindness, their expertise, but also for the good moments of relaxation spent together or interesting discussion. Especially I thank Professor Kajii, S, Khato, Yoshi N, Ida, Deutschf, Hirochi, and Onon and Elisa.

I thank all the team for giving me a pleasant stay.

9. Advisor’s remarks (if any):

Very good organization, Congratulations!

RESEARCH REPORT

1. Name: Sophal Mom （ID No.: SP10207）

2. Current affiliation: Molecular Chemistry Institute (ICMUB)　Burgundy University, France

3. Research fields and specialties:

Chemistry

4. Host institution:

a. Catalysis Research Center, Hokkaido University
b. Department of Chemistry, Faculty of Science, Kyoto University

5. Host researcher:

a. Associate Professor Masamichi Ogasawara
b. Professor Tamio Hayashi

6. Description of your current research

During my Master degree I synthesized new triphosphine ligands based on ferrocene frameworks in which the conformation was controlled by the use of several hindering substituents on the ferrocene rings. Some palladium complexes were synthesized to show that the controlled conformation was effective, a part were sent to our partners for tests in heterocycles C–H functionalization. A part of my work was devoted to the test of unusual conditions for alkynylation reactions of aryl iodides based on new copper systems with oxygenated/nitrogenated ligands. Since the beginning of my doctoral studies, I conducted the synthesis of a new ligand incorporating electron-rich substituants (as specified in the ANR program) and actively participated to the formation of new researchers in the group.

My PhD is focused on the synthesis of rationally designed new multidentate ferrocenylphosphine ligands. The development of several new ferrocenylphosphines relevant to activate chloride substrates is aimed; new electron-rich ligands will allow a faster oxidative addition of aryl or vinyl chlorides. The stability and longevity of the polydentates-palladium complexes will allow a substantial reduction of the metal/ligand loadings. The ligands coordination to both palladium and copper will be examined. The objective pursued is the synthesis, isolation, and structural characterization at solid state (X-Ray) and in solution (multinuclear NMR) of palladium and copper intermediates with the polydentates ligands formed to promote in catalysis more environmental and economical sustainable systems.

Major Publications:

J. Roger, S. Mom, M. Beaupérin, S. Royer, P. Meunier, V. V. Ivanov, H. Doucet, J.-C. Hierso, *ChemCatChem* **2010**, 2, 296-305.

D. Roy, S. Mom, M. Beaupérin, H. Doucet, J.-C. Hierso, *Angew. Chem. Int. Ed.* **2010**, 49, accepted.

Another article is in preparation on the results obtained during my master degree

concerning ligands with controlled conformation.

7. Research implementation and results under the program

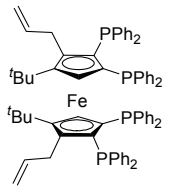
Title of your research plan:

Ferrocenyl tetraphosphine resolution and catalytic application of enantiopure ligand.

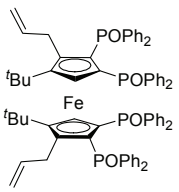
Description of the research activities:

The proposed research in Japan is focused on the resolution of ferrocenyl tetraphosphine chiral ligands, which will have to be synthesized in Catalysis Research Center at Hokkaido University from 22th June to 23th August. The direct resolution of the racemic mixture using HPLC with chiral columns will be made in the Department of Chemistry at Kyoto University from 25th August to 12th September. Following this work, the application in asymmetric catalysis for C–C bonds formation is envisioned.

The first purpose of my research in Hokkaido University is to carry out the synthetic experiments. All anaerobic and/or moisture sensitive manipulations were carried out under with standard Schlenk techniques under predried Nitrogen or with glovebox techniques under prepurified argon. The target compound is a new tetraphosphine ferrocene chiral compound whose structure is suitable for the separation of its enantiomers. The synthesis of the racemic diallylferrocene tetraphosphine ligand (1) failed. The difficulty in this procedure was the introduction of the allyl group on the 3,4-Bis(diphenylphosphino)-*tert*-butylcyclopentadienyllithium. This disubstituted phosphine cyclopentadiene was prepared from *tert*-butylcyclopentadienyllithium. This reaction didn't work. To succeed to introduce the allyl group, the phosphines have been protected to give phosphines oxides (2) and phosphines sulfides (3). Several tests of reduction of phosphines were made in particular with DIBAL-H, trichlorosilane, tris(trimethyl)silane. The synthesis of ferrocenes with (2) and (3) failed too. Consequently, we envisaged to change the target. So actually I try to synthesize the compounds (4).



(1)



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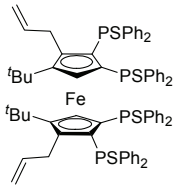
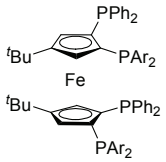


(3)



(4)

Ar = $PhMe_2$, $Ph(CF_3)_2$

8. Please add your comments (if any):

I would like to thank the CNRS and the JSPS for giving me the privilege to do research in Japan. I am grateful to Prof. Hayashi and Prof. Ogasawara for allowing me the opportunity to work in their laboratories. My stay in Sapporo has been a wonderful experience; I learned new experimental techniques that will be extremely beneficial both to my graduate research and my future career as a researcher. Thanks to all members of Ogasawara's group for their good humor and friendship. My colleagues have been patient, intellectually stimulating, friendly, and fun. I will never forget it!

This summer program is very interesting for the young scientists of foreign countries to know Japanese culture and tradition, as well as Japanese scientists and laboratories.

RESEARCH REPORT

1. Name: ORDRONNEAU Lucie (ID No.: SP10208)

2. Current affiliation: University of Rennes 1

3. Research fields and specialties:

Chemistry

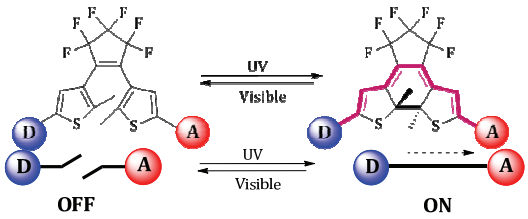
4. Host institution: University of Kyoto

5. Host researcher: Pr. Kenji Matsuda

6. Description of your current research

Photo-switchable materials (able to change their color in a reversible way under UV/Visible irradiation) are booming in different field. Industry uses them in order to produce daily life objects such as glasses or textiles but their main interest is in photonic.

In this context, photo active compounds able to change their properties under UV-irradiation are particularly interesting. Among them, dithienylethene (DTE) derivatives are very promising in particular thanks to their good photo-fatigue resistance, the thermal stability of the two isomers and to their short response time, required conditions for concrete applications, for example, this kind of compounds can be used for optical memories.



My PhD thesis deals with the study of Metal complexes (Zn, Fe, Ru) incorporating photochromic dithienylethene (DTE) units for modulation of non linear optical (NLO) activity.

I synthesized bipyridine ligands incorporating two DTE units (bpy-DTE-D) with various donor end groups (D = H, OMe, NMe_2) and their related zinc dipolar and octupolar complexes. I studied the NLO activity of the open and closed forms.

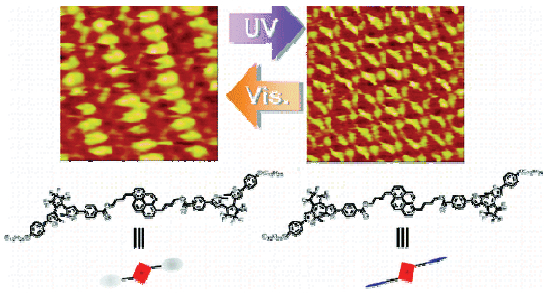
7. Research implementation and results under the program

Title of your research plan:

Synthesis and Scanning Tunneling Microscope (STM) measurements of photochromic compounds.

Description of the research activities:

STM measurements allow seeing open and close forms of photochromic compounds, because they have different properties.



My project in Japan was to study compounds I have already synthesized in France. First, I studied the photochromism of this compound and I tried to separate the "open" and "close" forms by High performance liquid chromatography (HPLC) and then try to do STM measurements on these two forms.

However, it is sometimes difficult to see all the compounds by STM. So my other project in Japan was to design and synthesize a new kind of photochromic compound to obtain good STM measurements. As some photochromic compounds have been already studied by STM and gave good STM images we try to design a new compound with aromatic core and alkyl chains in order to know if this kind of compounds can produce good STM images.

8. Please add your comments (if any):

I very enjoyed this JSPS summer program. I met Japanese students and researchers. I learned new experimental techniques that will be extremely beneficial both to my graduate research and my future career as a researcher. The experience of Japanese culture was also great.

I am very grateful for the opportunity to participate this summer program.

9. Advisor's remarks (if any):

I welcomed Ms. Lucie ORDRONNEAU to our laboratory for two months and enjoyed the collaborative research on the photochromic compounds. It was a very good occasion not only for myself but also for my laboratory members. I think JSPS summer program provides very good opportunity to the students from abroad and laboratories in Japan.

RESEARCH REPORT

1. Name: Jonathan Piard （ID No.: SP10209 ）

2. Current affiliation: PPSM = Photophysique et Photochimie Supra- et Macromoléculaires (CNRS UMR 8531) Institut de Chimie, Section 13, UMR 8531 ENS Cachan, France

3. Research fields and specialties:

Chemistry

4. Host institution: Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka University. 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan

5. Host researcher: Pr Hiroshi Miyasaka

6. Description of your current research

Nowadays, owing to the worldwide spreading of information, the volume of digital information generated grows every year. The design of miniaturized high capacity and high-speed transfer data storage devices is required. In order to increase the capacities of such devices, **downscaling the memory bit to nanometer** dimension is necessary. Devices based on optical properties, so called **photonic devices**, as memories or sensors are important elements. Moreover this requires high-throughput materials with an external trigger and a control of optical properties.

Photochromism is a reversible transformation induced by light between two forms with different chemical structure and physicochemical properties. Therefore, photo-switchable organic materials such as **photochromic** materials appear to be an efficient way to provide externally-triggered high-throughput. In addition, a combination with **fluorescence** can significantly improve nanomaterials' properties. Indeed, only a small number of photons is required for a **non destructive readout** of the information written on the media. In addition, the **high sensitivity and contrast** of fluorescence is also interesting in detecting signals of nanometer-sized photo-active materials.

My present research deals with the investigation of fluorescence and photochromic properties of organic nanoparticles. These nanoparticles are mainly prepared via a light-induced process: the **laser ablation** method. Indeed, the laser beam of a ns pulsed laser is guided to a cuvette containing the compound (bulk state) dispersed in a water-surfactant mixture. Photo-fragmentation of the matter by absorbing laser light leads to nanoparticle formation. A comprehensive size analysis of the nanoparticles obtained is led before further investigations. Then, nanoscale properties are investigated and also compared to the solution and bulk state.

7. Research implementation and results under the program

Title of your research plan: Investigation of multiphoton-gated cycloreversion reaction of a diarylethene derivatives : from solution to nanoparticles

Description of the research activities:

Among various photochromic compounds, **diarylethenes (DAE)** have attracted much attention since they fulfill all the requirements for data storage materials, such as high stability and fatigue-resistance. In such systems, cyclization and cycloreversion reactions are reversibly induced by

light. Products resulting from cyclization and cycloreversion are respectively called Closed Form (CF) and Opened Form (OF).

However, fulfilling non-destructive capability for such systems still remains an issue, since both writing and reading process require the absorption of light. Over the years, Miyasaka's group reported a **laser-induced enhancement** (>50x) of the cycloreversion reaction in diarylethene derivatives through picosecond-laser irradiation. A **successive two-photon absorption** process is commonly admitted to explain such behaviour. Indeed, the higher excited states of the CF reached by this way could open more effective channels to the OF. By opposition, commonly used continuous wavelength systems only conduct to one photon absorption process. This multiphoton gated reaction may provide an interesting alternative to non-destructive readout media, especially when cycloreversion reaction efficiency is very weak under classical irradiation.

My research activities in Miyasaka's Group deals with the investigations of potential multiphoton gated cycloreversion reaction of diarylethene nanoparticules. A diarylethene derivatives exhibiting a low efficient cycloreversion reaction was selected to conduct this work. Photochromic reaction dynamics was studied by using picosecond and femtosecond laser experiments. Both nanoparticles and solution state were investigated. Multiphoton gated cycloreversion enhancement was noticed in both cases. A peculiar and complex behaviour of the nanoparticles through laser irradiation was also observed. Further experiments and analysis need to be conducted to a better understanding of the results.

8. Please add your comments (if any):

It was a great pleasure to spend some time in Pr Hiroshi Miyasaka laboratory. They provided me all the things I needed to spend good time in Osaka university at both home and work. Accommodations were perfect. Regarding laboratory environment, all the team was very kind and full of attention with me and also very pleased to teach me things about their culture and daily life. Working with Pr Hiroshi Miyasaka and co-workers was also a great opportunity for me to acquire some knowledge in various research fields. Their experience and expertise was more than appreciable. I am also very grateful for their daily help at works and beyond works.

RESEARCH REPORT

1. Name: Fabien PRIZIAC （ID No.: SP10210 ）

2. Current affiliation: University of Rennes 1

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Saitama University

5. Host researcher: Pr. Toshizumi FUKUI

6. Description of your current research

My current research is about the adaptation to the case of real algebraic varieties with group action of the weight filtration for real algebraic varieties, described in the eponymous article of C. McCrory and A. Parusinski. This filtration on the Borel-Moore homology of real algebraic varieties has additivity and acyclicity properties on the chain level, which can give us useful ways to compute the terms of the associate spectral sequence (called the weight spectral sequence) converging to the homology.

One other very noteworthy fact is that we can recover the virtual Betti numbers from some terms of the weight spectral sequence, which is an additive invariant which coincide with the classical Betti numbers on compact and non singular varieties.

The goal of my research is, basing on the work of McCrory and Parusinski, to develop an “equivariant weight filtration” on equivariant homology of real algebraic varieties with an action of a group. A wish would be to be able to recover the properties got in the non-equivariant case, and particularly to be able recover the equivariant virtual Betti numbers developed by G. Fichou, in order for instance to apply the equivariant weight filtration to theories using those and the equivariant virtual Poincaré polynomial. The equivariant zeta function for equivariant Nash germs that I tried to develop with Professor Fukui during my stay would be such theory.

7. Research implementation and results under the program

Title of your research plan:

Equivariant zeta function for equivariant Nash germs.

Description of the research activities:

The first and maybe the most important step was to define an equivariant zeta function. Indeed, in order to be able to define such a function which would have the same properties that the non-equivariant zeta function has, such as the Denef-Loeser formula and the invariance under blow-Nash equivalence, the questions about a good definition for a germ with action, and possibly restrictions on it or on the wished properties are arisen.

Consequently, this first step had to be done while working on the second one, that is a proof for a Denef-Loeser formula for the different tentatives of equivariant zeta functions in order to see what would be the differences with the demonstration of the non-equivariant cases and possibly the obstacles that we may encounter for the case with a group action.

One essential property for the proof of the Denef-Loeser formula is the so called Kontsevich formula, so it was necessary to study if the equivariant virtual Poincaré polynomial would allow us to get this property. And one result of that summer program is that indeed we have the Kontsevich formula with respect to this equivariant Poincaré polynomial.

It remains now to write down in black and white the proof of the equivariant Denef-Loeser formula now that we know that this fact is true.

8. Please add your comments (if any)

I would like to thank sincerely Professor Toshizumi Fukui for his great welcome, for the work he proposed me, for his great advice, suggestions, help, contribution on it and for all the knowledge this research has already brought and will bring me.

I thank of course very much JSPS staff for all the given support, and my thesis advisor Goulwen Fichou who gave me the opportunity to do this stay in Japan as well.

9. Advisor's remarks (if any):

Mr. Fabien Priziac gave talks six times in my seminar. His topic is equivariant weight filtration and equivariant zeta function. He was focusing to give the right definition of equivariant zeta function and to prove Denef-Loeser type formula (expression via resolution of singularities). He found that Kontsevich formula (for change of variables) may not hold, since equivariant virtual Poincaré polynomial is not multiplicative, and finally showed Kontsevich formula holds true by spectral sequence argument. This is very good job ! I am very happy of this progress.

RESEARCH REPORT

1. Name: ROUEN Mathieu （ID No.: SP10211）

2. Current affiliation: PhD Student

3. Research fields and specialties:

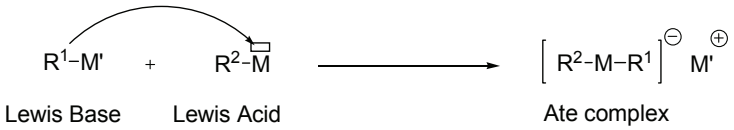
Chemistry

4. Host institution: Laboratory of molecular transformation, Graduate school of pharmaceutical sciences, Tohoku university, Sendai

5. Host researcher: Pr Yoshinori Kondo

6. Description of your current research

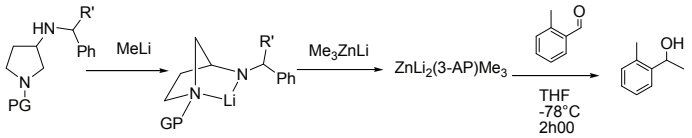
Mixing two organometallic species leads to “new reactants”, with their own reactivity. Combinig Lewis acid to Lewis base provides Ate complexes.



If Ate complexes have been widely studied as strong bases, less is known about their nucleophilic properties and in both field of application, no enantioselective version has been described.

We are interested in the combinations of zinc species with chiral lithium amides (based on 3-aminopyrrolidine) developed in Rouen for enantioselective nuceleophilic additions onto prochiral activated substrates.

We have engaged those resulting chiral Ate and ee’s up to 70% have been recorded (with Me_3ZnLi-3APLi complex).



Racemic : GP = Bn, R'=Ph Conversion 48% (up to 91% in toluene)
Chiral (S,R) : GP = Me, R' =Me Conversion 60% (ee up to 70%)

We are now focusing our attention on the extension of this methodology to other zinc species and determining the scope and limitation of those new reagents.

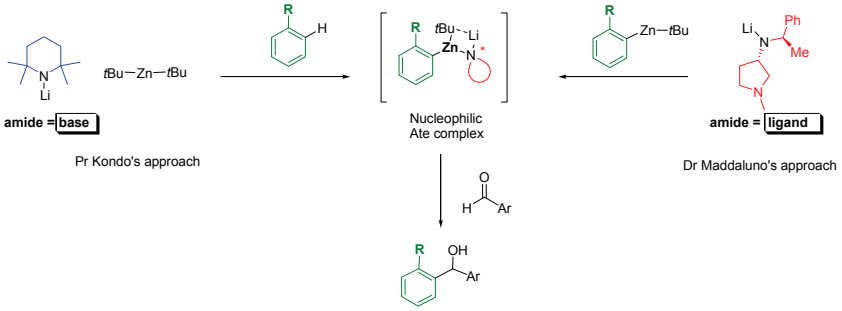
7. Research implementation and results under the program

Title of your research plan:

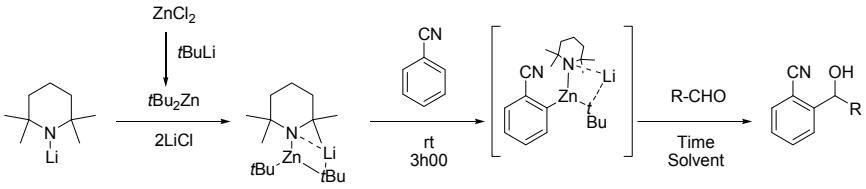
CHIRAL ATE COMPLEX FOR ENANTIOSELECTIVE NUCLEOPHILIC ADDITION

Description of the research activities:

This project was to combine the methodology concerning the ortho-directed deprotonation of aromatic substrate by zincate compound and our approach of enantioselective nucleophilic addition to get asymmetric sequence.



The first point studied various parameters of the reaction as time, solvent, aldehyde used in the racemic way.



After all thoses paramaters have been checked, we have focused our attention on the role of the generated LiCl in the reaction. Indeed, it has been shown by Knochel that LiCl can dramatically increase the reactivity of magnesiate compounds.

In order to check the influence of this metallic salt on the reaction, the preparation of salt free di-terbutylzinc is necessary. For this we have used the Charette's procedure and this sequence have been studied salt free.

To be sure of the influence of LiCl on this reaction, LiCl have also been added at various key steps (formation of the aggregate, with the aromatic compound or with the aldehyde).

Finally, we have tested chiral ligands developed in Rouen on this reaction, but unfortunately any positive results concerning the obtention of enantioenriched alcohol have been recorded.

But we experiments are also in progress to modify some parameters of the reaction.

8. Please add your comments (if any): Even if the results expected are not obtained, I think that it was a wonderfull experience for me, because I can exchange on many point with japanese people about culture or science. I would like to thank the JSPS for letting me the opportunity to join this program, and I would like also to mention that this work would be continued when I will come back to Rouen, so this is the beginning of a lot partnership. Finally, I would like to thanks the Professor Kondo for accepting me in his lab, and my supervisor doctors Maddaluno and Harrison-Marchand.

9. Advisor's remarks (if any): Mr Mathieu Rouen participated in various research activities in our group actively and he worked very hard for the JSPS summer program project. At this moment, the expected conclusion has not yet obtained, he will be able to continue the project after leaving Sendai. His presence in our laboratory was very important for our group members and most of our students made good friends with him. They exchanged their chemistry and also culture from various viewpoints. Mr Rouen showed strong interest in Japanese culture, history, and also education system. I am convinced his stay in our group with the JSPS summer program was very successful and I really appreciate JSPS for giving us this wonderful opportunity. I also would like to thank his adviser Professor Jacques Maddaluno for sending him generously to our laboratory.

RESEARCH REPORT

1. Name: Raphaël Trouillon （ID No.: SP10212）

2. Current affiliation: Department of Bioengineering, Imperial College London

3. Research fields and specialties:
Chemistry

4. Host institution: Department of Chemistry, Keio University

5. Host researcher: Professor Yasuaki Einaga

6. Description of your current research

Most of my PhD project was focused on the tissue-sensor interface. Electrochemical bio-sensing consists in inserting an artificial device into an active biological sample. This could harm the sample (cell culture, animal or human tissue) by triggering necrosis or massive immune response, but, on the other hand, we must also ensure the sensor still works properly in this very complex background matrix. Protein adsorption, enzymatic attack and fibrous encapsulation could lead to complete failure of the sensor. We have chosen to use membrane coating to address this problem. Solutions of albumin and homogenized chicken liver were used as fouling buffers. In particular, I have proven the good efficacy of fibronectin dry-coating, which allows good electrochemical measurements even in dramatically fouling samples. In addition, the high biocompatibility of the fibronectin membrane has been demonstrated using cultured pig aortic endothelial cells, thus showing that fibronectin is a very good candidate for sensor coating in cell culture measurements. Other membranes were tested (Nafion, chitosan, cellulose acetate) in order to get a wider range of sensor coatings and to fully characterize the performances of electrode membranes for bio-applications.

Furthermore, I have carried out an extensive study on the behavior of a new electrode material, boron doped diamond, in biological samples. This was the first piece of work showing the improved stability of this surface in presence of proteins, in comparison with other more common carbon electrodes (glassy carbon).

7. Research implementation and results under the program

Title of your research plan:

Biological stability of boron doped diamond electrodes

Description of the research activities:

Boron doped diamond (BDD) is a novel and exciting electrode material offering enhanced stability and reduced current background. Grain size, terminating atoms and sp2 content all affect reactivity and stability. Control of these factors is crucial to developing reliable sensors, especially for in-vivo applications. Due to its stability and low capacitance, this kind of electrode is perfect for biological experiments.

We have investigated and characterized the sensor-tissue interface of the BDD electrode and how it is affected by the BDD composition and structure. For this study, I have tested different types of crystalline BDD and in particular different types of doping levels. Electrochemical measurements in presence of biological interfering molecules (ie albumin) were performed for different types of redox systems and reactions.

My results show that low doped diamond electrodes offer enhanced biological stability, at the expense of chemical reactivity. Indeed, no or limited fouling have been noticed in biological buffers, and catecholamine fouling appears to be less problematic on this semi-conducting substrate rather than on metallic surfaces.

This study supports the use of this novel material as a candidate for biocompatible biosensors. Effects of other surface terminations (oxygen, amines) also have to be investigated. Similarly, impact of biocompatible membranes and behaviour of BDD microelectrodes are expected to be studied soon.

RESEARCH REPORT

1. Name: Frederic Thuaud （ID No.: SP10213）

2. Current affiliation: University of Strasbourg

3. Research fields and specialties:

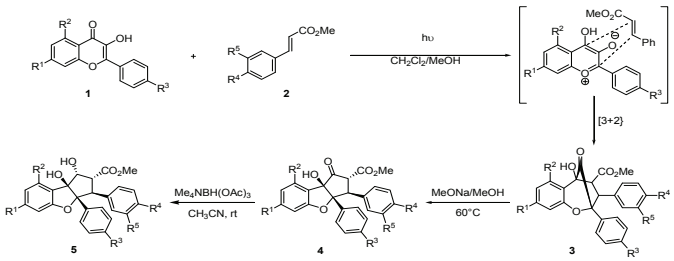
Chemistry

4. Host institution: RIKEN, Wako-Shi

5. Host researcher: Professor Mikiko Sodeoka

6. Description of your current research

My thesis project consists in synthesizing analogues of natural compounds which display promising anticancer activity. Currently, about 40 flavaglines derivatives have been synthesized and a structure activity-relationship was investigated and permitted to highlight pharmacophores and new analogues with unique scaffold are in preparation. However, the mechanism of action of flavaglines is unknown. Therefore, we synthesized pharmacological tools, like fluorescent probe, in order to identify it.

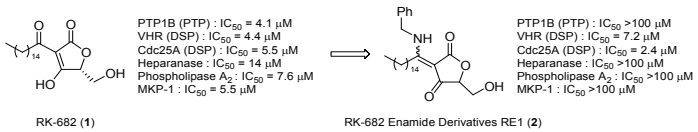


Scheme 1: Biomimetic synthesis of flavaglines derivatives

7. Research implementation and results under the program

Title of your research plan: Synthesis and biological evaluation of DSPs inhibitors.

Description of the research activities: Professor Sodeoka's laboratory is interesting in the synthesis of dual specificity phosphatase (DSP) inhibitors which can dephosphorylate both phosphotyrosine and phosphoserine/phosphothreonine residues within the one substrate. These phosphatases have an important role in cell growth regulation, in multiple signaling pathways and could display anticancer properties. RK-682 (**1**), which was isolated from *Streptomyces sp.* 88-682, inhibits various enzymes such as phospholipase A_2, heparanase, some dual-specificity phosphatases (DSP), and a protein tyrosine phosphatase (PTP). Professor Sodeoka's group found enamides derivatives of RK-682 which act as neutral phosphatase mimic and which specifically inhibit dual-specific phosphatase Cdc25 (A, B) and VHR (Scheme 2).



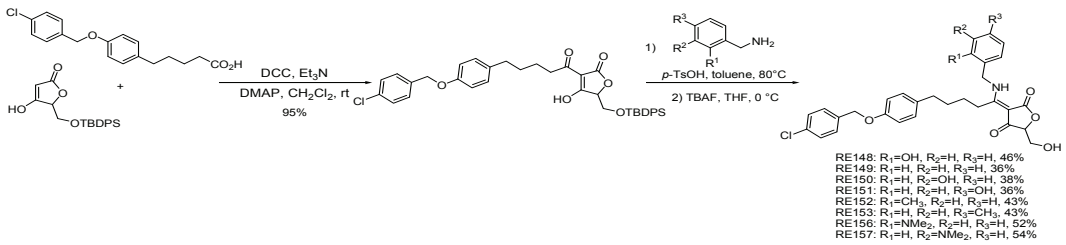
Scheme 2: RK-682 and its enamide derivative

During these 2 months, we planned to prepare new enamides analogues to improve the activity and the selectivity on Cdc25 and VHR. In order to introduce new functionalities, it was planned to develop a new synthesis of these analogues.

I. Synthesis of new analogues and biological activity evaluation

1) Synthesis of the new enamides derivatives

The tetronic acid enamides derivatives were synthesized in three steps (Scheme 3). The long alkyl chain was replaced by a chain which contained two aromatic cycles.



Scheme 3: Synthesis of new analogues

2) Biological activity evaluation

First these compounds were tested for the inhibition of Cdc25A, Cdc25B, Cdc25C and VHR. The introduction of hydroxyl and methyl groups on *para* and *ortho* positions did not improve the activity on Cdc25 and VHR. We can note that, in each series, best compounds were those with *meta* substitution. The introduction of a mesyl on the hydroxyl group improves the activity certainly thanks to the formation of a covalent bond with the active site of the phosphatases.

These derivatives were already tested on cells. When tsFT210 cells were incubated at the permissive temperature of 32°C, they had a normal cell cycle distribution. When cells were incubated at the nonpermissive temperature of 39°C for 17 h, they arrested at G2/M phase, because of Cdc2 inactivation. When G2-M arrested cells were cultured at 32°C for 4 h with dimethylsulfoxide (DMSO) alone, cells progressed into G1 phase. In contrast, nocodazole, a microtubule inhibitor, blocked cell passage through G2/M. One of the endogenous cellular substrates for Cdc25s is the Cdc2, which must be dephosphorylated to allow entry into mitosis. If RE derivatives inhibit Cdc25 phosphatases in tsFT210 cells, they can induce cell cycle arrest at G2/M phase. As shown in the figure, cells that were treated with increasing concentrations of RE derivatives were inhibited in their progression into G1 phase and remained blocked in G2/M phase as dose dependent manners.

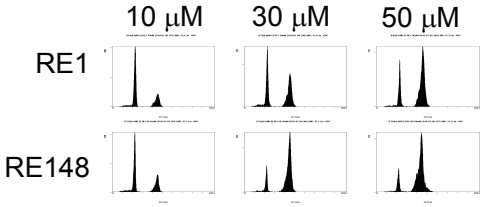
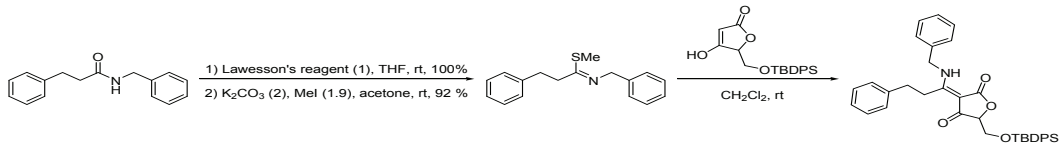


Figure 1: Effect of RE derivatives for cultured cells (done by Dr. A. Tsuchiya)

The replacement of the long alkyl chain and the introduction of hydroxyl group increase the cell permeability of compounds and the activity on cells was improved.

II. Development of a new synthesis

In order to introduce new functionalities, a new synthesis which involved the coupling between tetronic acid and a thioimidate was developed (Scheme 4).



Scheme 4: Development of a new synthesis on a model

The best results were obtained without activation. When we tried to use activators like silver triflate or nitrate, DMAP, yields decreased because of degradation. Then, this strategy was used to prepare RE147 which was obtained with a yield of 27 %.

To conclude, I could prepare 9 final compounds which were tested on enzymes and on cells. Introduction of polar substituent like hydroxyl group doesn't improve the activity on enzymes but improve the activity on cells. I already could achieve the development of a new synthesis of the enamides derivatives which will permit to introduce new functionalities. Finally, I want to thank Professor Sodeoka who accepts me in the laboratory, Dr Hirai who takes time to help me in and out of the laboratory and all the students for theirs welcome.

RESEARCH REPORT

1. Name: Emmanuel Combe (ID No.: SP10214)

2. Current affiliation: Laboratoire de Cristallographie et Sciences des Matériaux (CRISMAT)

CNRS UMR 6508 – 14050 CAEN

3. Research fields and specialties:

Engineering Sciences

4. Host institution: National Institute of Advanced Industrial Science & Technology, Research Institute for Ubiquitous Energy Devices, Ikeda, Osaka

5. Host researcher: Dr. Ryoji Funahashi

6. Description of your current research

My PhD project, in collaboration with the University of Caen (France) and the University of Liège (Belgium), is focused on the development of innovative process for the synthesis of oxides ceramics preparing for thermoelectric applications. The thermoelectric effect allows the direct transformation of a temperature difference into electric voltage (Seebeck effect), and vice-versa (Peltier effect). This direct conversion products no pollution and is promising as a new clean energy source. My study consists in the realization of thermoelectric materials containing doped indium oxide nanopowders which presents high thermoelectric properties. The final purpose of my subject is the integration of these materials in thermoelectric generators (also named "modules"). Thermoelectric generators are composed by an assembling of p and n-type semiconductors (named "legs" for the module) disposed between two ceramic substrates (Fig.1a)) and connected together via metal sheets. The p and n-type semiconductors are alternately connected electrically in series and thermally in parallel (Fig.1b)). The use of oxides as semiconductors presents advantages such as corrosion resistance and high thermal stability in air at high temperature (in fact the power conversion efficiency of thermoelectric materials is higher at high temperature difference).

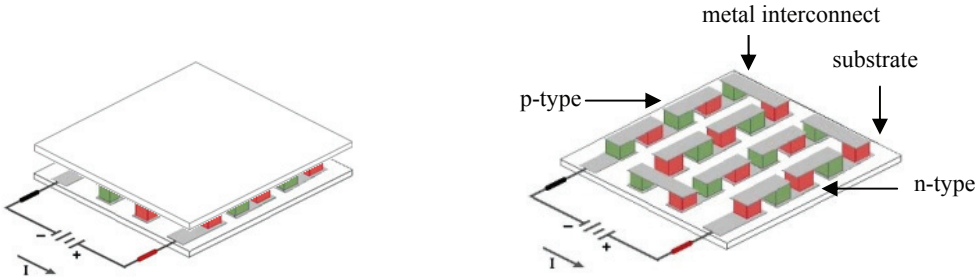


Fig.1a) and 1b): representation of a thermoelectric device

Due to their conception these devices have no moving parts and offer a high reliability. Due to their properties, thermoelectric generators can be used for generate electric energy by using waste heat produce by incinerators, boilers or cars for example.

My work in Japan is focused on the realization of a thermoelectric generator composed with $Ca_3Co_4O_9$ as p-type material and including doped In_2O_3 as n-type. The thermoelectric performances of this type of module, the power generation performances, will be investigated.

7. Research implementation and results under the program

Title of your research plan:

Realization of thermoelectric generators composed with oxide ceramics

Description of the research activities:

During my stay in Japan, two modules were realized and their thermoelectric characteristics were measured. First, our work was to manufacture the p and n-type legs from $Ca_3Co_4O_9$ and doped In_2O_3 bulks. Bulks are polished at first and then cut for obtaining legs with a cross-sectional area of 3.5mm × 3.5mm and a length of 5.0 mm. After

measuring the evolution of both electric resistivity and the Seebeck coefficient with temperature for each material (the Seebeck coefficient corresponds to the electric current produced by a thermal gradient), the p and n-type legs are connected with silver sheets. For this step, silver paste is used for connecting the legs to the silver sheets. The performance of a thermoelectric module is determined by the thermoelectric properties of the legs but it is also important to consider the resistance contacts at the junction which will decrease the electric power delivered by the module. For improving the electric current flow at the junctions it has been shown that the adding of a certain amount of p or n-type oxide powder to silver paste can decrease the resistance contact (the compositions of the oxide powder used is identical to those of the p or n legs). For that purpose, we prepared different batch of silver paste which include different amount (1, 3 or 6% in weight) of $Ca_3Co_4O_9$ or doped In_2O_3 powder. Then, by using the DC four-terminal method, we have determined that the resistance contact at junctions is the lowest for an amount of 6% of doped In_2O_3 powder in silver paste. But the contact resistance at p-type legs seems to be lower by using 6% of $Ca_3Co_4O_9$ powder in silver paste. Due to these results, we have finally decided to realize two modules: one with an amount of 6% of doped In_2O_3 powder in silver paste for both p and n-type legs (module 1) and an another module with 6% of $Ca_3Co_4O_9$ in silver paste for p-type legs and 6% of doped In_2O_3 powder in silver paste for n-type legs (module 2). We will after compare the electric internal resistance and the power generation performances of both modules.

After connecting the legs and the substrate, the modules are solidified by “Hot Pressing” step: the modules are heat at 1123 K under a uniaxial pressure of 6.4 MPa for 5 hours in air. A module after the “Hot Pressing” step is shown in Fig.2.

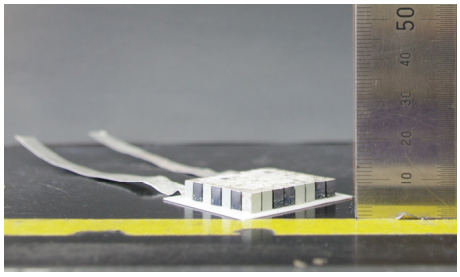


Fig.2): thermoelectric module composed with $Ca_3Co_4O_9$ *and doped* In_2O_3 *legs*

Finally, the power generation performances at different temperatures for both modules were investigated. The measurements show that both modules can generate up to 1.0 V at 873K for the open circuit voltage. The maximum power output is 0.6 W for 1.18 A for module 1 and 0.49 W for 0.9 A. The electric internal resistance is 1,007 □ for module 1 and 1,645 □ for module 2. As a conclusion, the different results of this study show that these module show promising thermoelectric performances. But other studies have to be carried out in order to determine the stability of these modules at high temperatures.

8. Please add your comments (if any):

The JSPS Summer Program gives me a great opportunity for having an international research experience which will be very useful for my future. My stay in the team of Dr Ryoji Funahashi was very enriching for me. My stay in Japan allows me not only to have new scientific knowledge but it also offers me to discover the Japanese culture. It also permits me to visit very interesting places all around Osaka.

I finally would like to thank Dr. Ryoji Funahashi and all the members of his team for their welcome and their help during these two months. I want to thank also the CNRS and the JSPS for giving me this opportunity.

9. Advisor’s remarks (if any):

Mr. Combe is succeeded to fabricate $In_2O_3/Ca_3Co_4O_9$ based modules. Although his staying is not long for this, he prepared oxide legs, discovered good paste for junctions between electrodes and oxide legs and fabricate modules. Power generation property of the modules is comparable to simulated values.

I hope his staying in my laboratory is not only significant for his research but also fruitful for his future. I would like to appreciate JSPS and CRISMAT.

RESEARCH REPORT

1. Name: Nora Friedemann （ID No.: SP10301）

2. Current affiliation: Johannes Gutenberg-Universität Mainz, Duesbergweg 10-14, 55128 Mainz, Germany

3. Research fields and specialties:

Chemistry

4. Host institution: University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

5. Host researcher: Prof. Shu Kobayashi

6. Description of your current research

The group 2 elements, Mg, Ca, Sr and Ba, are widely distributed in the earth's crust and in the sea. In the last years, Prof. Kobayashi and co-workers have investigated the reactivity of barium catalyst and have reported that barium aryl oxides are excellent catalyst in direct-type aldol and Mannich-type reactions of imides. The alkaline earth metals`s high coordination number enables its use as chiral complexes in asymmetric organic synthesis.

Within my research I focused on the aldol reaction with subsequent cyclization of different enones with benzaldehyde to afford hetero Diels-Alder products catalyzed by alkaline earth metal alkoxides (**Figure 1**). The catalyst is needed as a base and will coordinate both carbonyl-groups in a defined transition state. The enone needs a leaving group OR^1 to make the cyclization via addition-elimination mechanism irreversible. This topic is challenging because no successful example has been reported using those substrates.

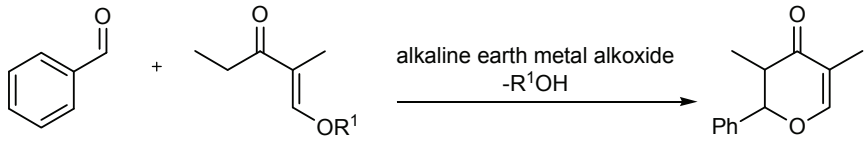


Figure 1

The desired reaction occurred when I used the alkaline earth metal catalysts, however the yield of this reaction is still poor and needs to be improved. From our expectations a more acidic substrate may follow the catalytic cycle without undergoing as many side reactions.

7. Research implementation and results under the program

Title of your research plan: Aldol reaction with subsequent cyclization

Within my research I focused on an aldol reaction with a subsequent cyclization of different enones with benzaldehyde catalyzed by alkali earh metal complexes.

Description of the research activities:

First the substrates[1] (R^1 = Methyl and R^1= *tert*-Butyl (**figure 1**)) were synthesized as starting materials for the reaction. With these substrates the reaction of interest was conducted at several different reaction conditions: The following parameters were changed according to **table 1**. The solvent was changed from tetrahydrofurane to dimethylformamide. Several different catalyst were used: $Ba(O\textit{t}\text{-}Bu)_2$, $Ba(HMDS)_2$, $Ba(O\textit{i}\text{-}Pr)_2$, $Ba(PMP)_2$, KHMDS and CsHMDS. And the reaction temperature was varied from room temperature to 50°C. Despite all the efforts the reaction`s yield could not be improved reasonably.

No.	R^1	catalyst	solvent	T	result
1	Me	$Ba(PMP)_2$ (10mol%)	THF	RT	No reaction
2	Me	$Ba(PMP)_2$ (10mol%)	THF	50°C	No reaction
3	Me	$Ba(O\textit{t}\text{-Bu})_2$ (10mol%)	THF	50°C	4.9 mg pure (8.1%)
4	Me	$Ba(O\textit{t}\text{-Bu})_2$ (10mol%)	DMF	50°C	2.8 mg (4.6%) impure
5	Me	Ba(HMDS), (10mol%)	THF	50°C	13.0 mg (21.4%) impure
6	Me	$Ba(O\textit{i}\text{-Pr})_2$ (10mol%)	THF	50°C	5.6 mg (9.2 %) impure
7	Me	$Ba(O\textit{t}\text{-Bu})_2$ (50mol%)	THF	50°C	Only many side products
8	Me	$Ba(HMDS)_2$ (50mol%)	THF	50°C	Only many side products
9	Me	$Ba(O\textit{t}\text{-Bu})_2$ (10mol%), $Sc(OTf)_3$ (10mol%)	THF	50°C	No reaction
10	Me	$Ba(O\textit{t}\text{-Bu})_2$ (10mol%), MeOH (100mol%)	THF	50°C 48h	2.1 mg (3.5%)
11	*t*-Bu	$Ba(O\textit{t}\text{-Bu})_2$ (10mol%)	THF	50°C	No reaction
12	*t*-Bu	$Ba(HMDS)_2$ (10mol%)	THF	50°C	Many side products
13	*t*-Bu	KHMDS (20mol%)	THF	50°C	Many side products
14	*t*-Bu	CsHMDS (20mol%)	THF	50°C	Many side products

Table 1

As the reaction`s yield (with one exception) did not exceed 10% it seems as the catalytic cycle did not occur. But even as the amount of catalyst was raised to 50% only side products could be observed.

To check whether the protonation – deprotonation equilibrium lacks catalysis the reaction was conducted in the presence of one equivalent methanol but no increase of yield could be observed.

The change of substrate (R^1= *t*-Bu) is supposed to improve the catalytic cycle because the basicity of the catalyst is not diminished during the catalytic cycle. Despite this expectation no product could be observed but many different side products.

With some experiments (which are not shown in **table 1**) the benzaldehyde was exchanged by an imine but even with the change from aldol to Mannich reaction no occurring reaction could be observed.

For the perspective the substrate probably needs to be more acidic and therefore needs an electron withdrawing group next to the α-methylene group.

[1] *Organic Synthesis Coll. Vol. 9,* **1998**, 548. Danishefsky et al. *J. Org. Chem.* **1984**, *49*, 2290-2292.

8. Please add your comments (if any): At this point I want to thank Prof. Kobayashi for giving me the opportunity of research with his group and providing me the interesting topic to work on. Then I need to thank ass. Prof. Yamashita for teaching me experimental methods and all his support throughout my stay. Finally I want to thank JSPS for the financial support and the informative and revealing introduction week. I really enjoyed my stay in Japan.

9. Advisor's remarks (if any): It is our pleasure to accept Nora Friedemann in this laboratory. She is very friendly and has worked very hard. Her research topic may be a little bit difficult to complete during her short stay, but I believe that Nora had many valuable experiences through the research work. Finally, I hope that this JSPS summer program is helpful for her brilliant future.

RESEARCH REPORT

1. Name: Simone Anke Hamerla (ID No.: SP10302)

2. Current affiliation: Technische Universität Dortmund

3. Research fields and specialties:
Mathematical and Physical Sciences

4. Host institution: Department of Physics, Kyoto University

5. Host researcher: Prof. Dr. Norio Kawakami

6. Description of your current research

My research focuses on the behavior of strongly correlated electron systems in non-equilibrium situations.

Correlated electron systems are systems in which the interaction of electrons with each other plays an important role for the properties of the system. In this way the interplay of the electrons leads to many interesting phenomena which have been observed in the context of solid state materials.

The evolution of interacting quantum systems in real time has been attracting enormous attention in the last years. This is due to the impressive advances in the controllability of atoms in optical lattices. Optical lattices are formed by a superposition of counter-propagating laser beams. These laser beams interfere thus forming an artifical lattice with almost arbitrary properties. These artifical lattices are then used to model the physics of the lattice systems found in real solids.

Due to the advances in the controllability it became possible to design lattice models of bosons and fermions with variable and time-dependent interactions.

As we are now able to control intrinsic properties of the system itself, optical lattices can be used to study systems out of equilibrium. The crucial point of these systems is that quantum systems out of equilibrium are prepared in highly excited states.

To describe these systems many degrees of freedom, which develop on short time scales, have to be considered. As a consequence of this the methods used to describe equilibrium processes fail to describe the physics of non-equilibrium systems.

There are several ways to prepare the system in a highly excited state. For example the system may be changed on long or on short time scales.

I focus on the behavior of interacting quantum systems after a so-called quench. A quench is an abrupt change of intrinsic system parameters. This change alters the properties of the system and creates a non-equilibrium situation.

Thus a quench is used in my work to prepare the system in a highly excited state and observe the relaxation of such a system. The quench is designed in such a way that it transforms a non-interacting system into an interacting one which allows to observe the buildup of correlations in the system. I study these quenches in one and two dimensions, with the focus being on two dimensional models.

7. Research implementation and results under the program

Title of your research plan:

Real-time evolution of quantum systems after an interaction quench

Description of the research activities:

During my stay at the Kyoto University I started my studies by considering such quantum systems in one dimension. The model used in this context is a fermionic Hubbard model on a linear chain, which is a commonly used model in the context of strongly correlated systems as it contains the kinetics as well as the interaction of electrons.

In a first step the influence of the interaction quench on the momentum distribution is studied. Therefore one-particle-correlations have to be determined which are given by a Greenfunction in real space. Having calculated this function a Fourier transform is applied, which leads to the wanted momentum distribution.

In a first approach only terms with a limited extension were considered. Within this approach I received first analytical results for the time evolution of the operators.

In calculations with more extended terms many processes on many energy scales contribute. Thus these calculations rely on the use of a computer. The calculations can be split up into two parts. The first part consists of the calculation of a system of

differential equations by the use of the Heisenberg time evolution.

For this part I derived a scheme to split the calculation of the commutator of two complicate terms consisting of many operators into many calculations of anticommutators of simple terms. This allows to use the computer for these calculations. Although a computer is used in this step the calculations remain analytical.

The second part deals with solving these high-dimensional differential equations. For this part of the calculation I wrote a program based on numerics.

For the first part of the calculation I started to implement a program based on C++, which applies translational symmetries, calculates the commutator and derives the differential equations.

This program now has to be extendet to be able to calculate the observables we are interested in.

A next step will be to determine the limitations of the presented approach before it will be used to calculate several types of observables and finally to describe two dimensional models.

RESEARCH REPORT

1. Name: Ina Klinke （ID No.: SP10 303 ）

2. Current affiliation:

Institute of Neurobiology, Freie Universität Berlin, Berlin, Germany

3. Research fields and specialties:

Biological Sciences/Neuroscience

4. Host institution:

Laboratory of Statistical Neuroscience, Brain Science Institute, RIKEN, Japan

5. Host researcher:

Dr. Sonja Gruen

6. Description of your current research

Neuronal representations of olfactory and visual associative learning in mushroom body extrinsic neurons of the honeybee (Apis mellifera)

In order to elucidate the role of higher-order feedback neurons at the output region of the honeybee`s mushroom body, I apply extracellular electrophysiological recordings while the bee performs a classical conditioning task. The aim is to detect correlated changes of spike rate, spiking patterns and spike timing among different neurons measured simultaneously, and collect these activities for longer periods of time (up to three days and nights) searching for neural correlates of learning and memory consolidation.

The learning task is composed of compounds of odors and colors in order to study especially the multisensory features and context dependencies of feedback neurons during classical conditioning and memory retrieval. The combination of behavioural and electrophysiological methods in the honeybee gives us a unique tool to study brain functions on the single cell level in a small but smart brain.

7. Research implementation and results under the program

Title of your research plan:

Correlated changes of spike rate, spiking patterns and spike timing among different mushroom body extrinsic neurons of the honeybee (apis mellifera) during long-term multisensory learning

Description of the research activities:

In the research group of Dr. Sonja Gruen, neural mechanisms of higher-order brain functions are studied by the analysis of coordinated activity of populations of neurons.
I began my work in the lab with a talk about my research project that build the basis for discussions about possible approaches for data analysis.
Subsequently, in order to analyze my data with respect to rate change, correlations among single cell activity, local field potentials (LFPs) and locking of single spikes to LFPs during learning and memory consolidation I was able to write analysis programs in matlab. Therefore, I worked intensely together with Nicole Cichon, also currently affiliated in Dr. Gruen`s Lab, and Johanna Derix, Laboratory for advanced brain signal processing, Brain Science Institute, RIKEN.
We were able to detect LFPs in the high gamma frequency band (70-250 Hz) as soon as bees perceive a learned color that primes an odor that was previously associated with a sugar reward. The next step is to study LFPs subsequently throughout the whole learning procedure during 3 days. High gamma activity is associated with cognitive processes in humans.

I gained fundamental insight in computational neuroscience by attending the lab meetings, journal clubs and through fruitful discussion with the lab members.

RESEARCH REPORT

1. Name: Elnaz Mazandarani （ID No.: SP10304）

2. Current affiliation:
University of Applied Sciences Berlin

3. Research fields and specialties:
Engineering Sciences

4. Host institution:
Kyushu Institute of Technology

5. Host researcher:
Prof. Dr. Mario Köppen

6. Description of your current research

Recently, the interest on recommendation systems has been strongly increasing. This is due to corresponding developments in new web technologies, esp. social networking. Basically three main principles for recommendation systems are currently most intensively studied:

- classification based on single user information
- mapping newer users to known users, and derive from known preferences
- mapping users to prototypes and elaborating on the prototypes

None of these approaches could be shown to be superior, so commonly various information sources are fused together by ad hoc formulas. In such a fusion formula, several measurements according to user matching, prototypes or user preferences and user situation are numerically put together in an analytic expression.

My current research follows an approach based on the evolution of the ad hoc fusion formula. The means for evaluation come from the user itself: recommendations will be given following different fusion formulas. The selection of one recommendation thus gives feedback on the better suitability of that formula, and the base for presenting recommendations selected by slightly modified expressions next time to another user. This is the base for a multi-user interactive evolutionary approach used for steadily improving the recommendation system.

7. Research implementation and results under the program

Title of your research plan:
Web-based Recommendation Systems

Description of the research activities:

The research activities have focused on the design and implementation of an experimental recommendation system with competing recommendation algorithms.

The list of activities performed during the research tenure:

- survey on existing recommender systems, their classification and basic methologies
- detailing of own methodology
- design of an experiment to test and validate the approach: dinner choices suggestions
- selection of the usable web and database technology for such a system
- draft implementation and web design of the experimental system, incl. user, product and usage history management
- specification of competing procedures for recommendation derivation from database information: unbiased (random) selection, modified PAF* with regard to most similar average, modified PAF with regard to highest frequency (**PAF: select most similar among random selection of users, and then the most similar product among them as recommendation*)
- prototype implementation of these recommendation methods and of the framework for their parameter supervision

performing first experiments with encouraging results

8. Please add your comments (if any):

The experimental system will be operated on-line over some period with voluntary users from Kyutech. Interesting and relevant findings of the experiments are planned to be reported in a scientific publication.

9. Advisor's remarks (if any):

During her stay in our laboratory, Mr. Masandarani worked very hard on the progress of the research theme. We had numerous discussions on the system design and implementation, and she always contributed with a lot of inspiring ideas and observations. The further development of the research on this topic is of greatest interest.

RESEARCH REPORT

1. Name: Marcus Meyer （ID No.: SP10305）

2. Current affiliation: Chemnitz University of Technology, Chemnitz, Germany

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: The University of Tokyo, Graduate School of Mathematical Sciences

5. Host researcher: Prof. Masahiro Yamamoto

6. Description of your current research

As a member of the group for inverse problems in Chemnitz, which is led by Prof. Bernd Hofmann, my current research is focused on material parameter identification problems in structural mechanics, in particular with applications in a nonlinear elasticity framework allowing large deformations. Such problems are important e.g. for the determination of not directly observable material properties or for nondestructive material analysis by deformation experiments. The deformation of the material under consideration is modeled by the nonlinear elasticity partial differential equation (PDE), whereas the material properties are quantified by some material parameters arising as real constants or real-valued functions. The aim of parameter identification is to reconstruct unknown material parameters from given measurements of the deformation.

For calculating a solution, such identification problems are usually formulated as PDE-constrained optimization problems, which are highly nonlinear due to the crucial nonlinear structure of the nonlinear elasticity PDE. Consequently, numerical solutions are affected by considerable numerical costs and therefore the development of efficient algorithms is of particular interest. Additionally, for inverse problems – as identification problems are – the stable and unique solution of the problem needs to be verified. Typically, the solution of an inverse problem cannot be expected to depend stably on the measurement data and therefore so-called regularization methods need to be applied.

7. Research implementation and results under the program

Title of your research plan:

Parameter Identification Problems in Mechanical Models

Description of the research activities:

Throughout the research stay in Tokyo, I considered several delicate problems arising in parameter identification for the nonlinear elasticity partial differential equation. In three dimensions the nonlinear elasticity PDE is a quasilinear system of three partial differential equations of second order. In the following we list some serious questions among this topic:

1. Existence, uniqueness, and regularity of the solution of the direct problem
2. Existence and uniqueness of the solution of the inverse problem
3. Numerical costs and implementation of adaptive FEM methods
4. Verification of results by sophisticated numerical studies

Basing on extensive literature studies, in several discussions and seminars with Prof. Yamamoto and other guest researchers at The University of Tokyo I specified ideas how to overcome these problems. The main ideas are the following:

1. Analysis for the direct problem (i.e. finding the solution of the elasticity PDE for known material parameters) is not solved satisfactorily up to now since well-known general results on quasilinear systems do not fit some details of deformation physics. From the inverse point of view, we therefore may assume existence and sufficient regularity of solutions a priori for introducing analysis on the inverse problem.
2. Despite uniqueness results for parameter identification problems are of high importance, only few such results exist in nonlinear elasticity. We discussed the application of techniques involving Carleman estimates for a non-stationary elasticity system, which in recent studies was used by Prof. Yamamoto and Prof. Emanouvilov (Colorado State University, USA) for proving some uniqueness results in linearized elasticity inverse problems.
3. Due to nonlinearities in the direct and in the inverse problem, the application of iterative nonlinear optimization methods involves the solution of many FEM subproblems. Thus, for an efficient solution of identification problems with distributed parameters it is essential to implement adaptive methods. Several results on adaptive parameter estimation can be found in literature and adjusting these techniques for the nonlinear elasticity problems may result in a considerable increase of efficiency for the numerical solution.
4. A number of ingenious FEM software tools exist, which can be used for the solution of the nonlinear elasticity PDE. We developed a numerical implementation of a test problem with nonlinear Neo-Hook material by using COMSOL with MATLAB, which can be used for later numerical studies.

Some results of the research will be presented at the Chemnitz Symposium on Inverse Problems 2010, held on September 23 and 24 in Chemnitz, Germany.

8. Please add your comments (if any):

Besides the research mentioned above there were other fruitful occasions for scientific experience. In discussions with Matthias Kaiser, another JSPS-fellow (Cottbus University, Germany), we considered the implementation of optimization algorithms for clustering methods in multiple scenario analysis for future approaches. Furthermore, during a visit of Nippon Steel Kimitsu Works I got very interesting insight into the process of steel-manufacturing and related mathematical problems. I want to thank JSPS for offering me the opportunity of getting this wonderful experience of Summer Program 2010 and in particular I thank Prof. Masahiro Yamamoto for his kind assistance in scientific and daily life questions. The fruitful discussions with him gave me a deeper insight into the mathematical theory of identification problems and I think the collaboration of our research groups in Tokyo and Chemnitz was enriched within the 10 weeks in Japan.

9. Advisor’s remarks (if any):

Mr.Meyer has worked well with members of my teams and other visitors from USA, France,

Germany about his specialty. He and I have been working for mathematical analysis for inverse problems for the nonlinear elasticity. This subject is important from both theoretical and practical viewpoints, but there are very few mathematical works. We have tested several techniques such as Carleman estimates and the multiplier method and we will establish the uniqueness and the stability in the inverse problem. I can strongly expect that his stay is meaningful not only for his individual researches, but also for developing my existing collaboration with the group directed by Prof. Bernd Hofmann where he belongs. Moreover Mr. Meyer has been interested in the Japanese cultures and life styles, and I believe that his stay is very useful for better general understanding in Germany about Japan.

RESEARCH REPORT

1. Name: Katharina Mueller （ID No.: SP10306）

2. Current affiliation:

Institute of Radiochemistry, Forschungszentrum Dresden-Rossendorf e.V.

3. Research fields and specialties:

Chemistry

4. Host institution:

Department of Nuclear Engineering, Kyoto University

5. Host researcher:

Prof. Takayuki Sasaki

6. Description of your current research

The migration behavior of actinides and other radioactive contaminants in the environment is controlled by prominent molecular phenomena such as hydrolysis and complexation reactions in aqueous solutions. These reactions significantly influence the mobility and bioavailability of the metal ions in the environment.

Neptunium (Np) is one of the most important actinide components of nuclear waste. In the long-term safety assessment of underground disposals, great attention must be paid to its geochemistry and migration behavior. Geochemical reactions are primarily defined by the oxidation state and the distribution of appropriate aqueous species of Np.

Accurate thermodynamic data are the key to reliable modeling of the geochemistry of natural aqueous systems. Despite numerous reviews of actinide chemistry, few studies focus on Np geochemistry and thermodynamic data. The current knowledge of Np species is based on very few data from the seventies arising from individual techniques, performed at differing experimental conditions and at Np concentrations in the millimolar range. A structural characterization of the found species is still insufficient, in particular at low concentrations, which are relevant in the environment.

In the previously performed studies at the Institute of Radiochemistry at the Forschungszentrum Dresden-Rossendorf e.V. (FZD), spectroscopic techniques, mainly attenuated total reflection Fourier-transform infrared (ATR FT-IR) spectroscopy and near-infrared absorption spectroscopy have been applied to characterize the aqueous species of pentavalent and hexavalent actinide ions [1, 2]. Therefore, the hydrolysis reactions and the complexation of actinide ions, namely, Np(V/VI), with inorganic ions (e.g. carbonate) and organic molecules (e.g. humic substances) has been the focus of current research.

For a trustworthy data evaluation a combination of several techniques under comparable conditions is of urgent need and is the aim of this collaboration research project.

7. Research implementation and results under the program

Title of your research plan:

Study of the interaction of Np(V) with different humic substances by solvent extraction

Description of the research activities: The interaction of humic substances with Np(V) has been investigated by a solvent extraction method at very low Np concentration level (10^{-13} M), that is of high environmental concern. Humic substances in soils and sediments can be divided into three main fractions: humic acids, fulvic acids and humin. In this study, the complexation of Np(V) onto different samples of humic and fulvic acids has been comparatively studied.

In the experiments the gamma emitting isotope ^{239}Np was used, since very low concentrations can be detected by gamma-spectrometry using a Ge detector. For the determination of formation constants the following back-extraction procedure was applied. First, Np(V) was extracted into the organic phase, i.e. isoamyl alcohol containing a defined concentration of thenoyltrifluoroacetone (TTA) and 1,10 phenantroline (phen). Then, a defined aliquot of this organic solution was shaken overnight with the same volume of an aqueous solution, containing a variable concentration of humic substance. After phase separation, gamma activities of both phases were measured. In addition pH of the aqueous solution was determined. From the distribution coefficient of Np(V) between both phases the formation constants were determined by the equations, given in [3]. The experiments were performed at weak acidic conditions (pH 6) and at ionic strength of 0.1 M, adjusted by $NaClO_4$.

The obtained formation constants, log β_{app} were found to be in the range from 5 to 6 with decreasing concentration of humic substance. These values are in accordance to other experimental studies of Np(V) complexation with humic substances.

The performed study contributes to the comprehension of the geochemical interactions of Np in the environment. Consequently, more reliable predictions of actinides migration which are essential for the safety assessment of nuclear waste repositories can be performed.

Furthermore, the cooperation itself created added values in a way that the exchange of ideas and expertise between institutes working in different countries but on similar scientific fields is strengthened. This will hopefully translate into further joint efforts.

1. Müller, K., V. Brendler, and H. Foerstendorf, *Aqueous uranium(VI) hydrolysis species characterized by attenuated total reflection fourier-transform infrared spectroscopy.* Inorganic Chemistry, 2008. **47**(21): p. 10127-10134.
2. Müller, K., et al., *Direct spectroscopic characterization of aqueous actinyl(VI) species: A comparative study of Np and U.* Journal of Physical Chemistry A, 2009. **113**(24): p. 6626-6632.
3. Tochiyama, O., et al., *Complex formation of Np(V) with humic acid and polyacrylic acid.* Radiochimica Acta, 2000. **88**(9-11): p. 547-552.

8. Please add your comments (if any): The stay in Japan was very intense and fruitful in all respects. I was cordially received by my working group and besides scientific discussions and experience I also got the opportunity to learn much of Japanese life and culture and have met many interesting people.

Finally, I want to thank JSPS and express my sincere gratitude to my host researcher Prof T. Sasaki and his group for making this wonderful and unforgettable experience possible.

RESEARCH REPORT

1. Name: Robert Piskol (ID No.: SP10307)

2. Current affiliation: Ludwig-Maximilians-University Munich

3. Research fields and specialties:

Biological Sciences

4. Host institution: The Graduate University for Advanced Studies (SOKENDAI)

5. Host researcher: Prof. Dr. Hideki Innan

6. Description of your current research

miRNAs are small non-coding RNA molecules that play critical roles in various developmental, stress, and signaling responses. Their most important function is the post-transcriptional regulation of target genes through the process of RNA interference. In thale cress (*Arabidopsis thaliana*) miRNAs have a length of 21-22 nucleotides and are processed from longer precursor-miRNAs of distinct 2-dimensional structure. miRNAs perform their function in regulatory systems which are based on the principles of multiplicity (one miRNA can target more than one gene) and cooperativity (one gene can be controlled by more than one miRNA). *A.thaliana* for instance contains 14 miRNA genes (encoded at different locations in the genome) that produce the mature miR169 sequence which in turn is known to target 8 different protein coding genes.

The biogenesis of miRNAs and their involvement in regulatory processes have been extensively studied. However, little is known about their evolution. My graduate studies mainly focus on the uncovering of evolutionary processes in non-coding RNAs. Thereby, the primary goal is the identification of structural features of the RNA molecule and their influence on patterns of nucleotide variation. During my stay at the host institute I will focus my attention on miRNAs in *A.thaliana* as a special class of non-coding RNAs. The main goal will be the identification of the effect of structure-disrupting mutations on the fitness of the molecule, while accounting for the number of copies of a certain miRNA and the number of target gene families this miRNA regulates.

7. Research implementation and results under the program

Title of your research plan:

The Analysis of Mutational Patterns and Selective Constraints in miRNAs of *Arabidopsis thaliana* and *Arabidopsis lyrata*

Description of the research activities:

The genome of *Arabidopsis thaliana* was the first plant genome to be completely sequenced in the year 2000 and was extensively studied since then. However, it was not until recently that the genetic information of a close relative (*Arabidopsis lyrata*) was made available to the public which allowed thorough comparative analyses between these two species.

My project makes use of the genetic information of these two genomes to study the molecular evolution of miRNAs and in particular the negative effects on miRNA function that are conferred through mutations in the miRNA sequence. To determine the detrimental effect of mutations in a sequence of interest (in this case the miRNA), it is necessary to understand how fast mutations accumulate in neutrally evolving regions (regions that are free from the constraint to perform a certain function) and relate that speed of evolution to the evolution in the sequence of interest. Therefore, my research plan included (1) the identification of neutrally evolving regions, (2) characterization of nucleotide variation in miRNA sequences of *A.thaliana* and *A.lyrata*, and (3) calculation of detrimental effects of nucleotide mutations on the fitness of miRNAs. During my stay in Japan I was able to perform work on the first two parts of the project, while the last part unfortunately remained untouched due to the limited amount of time.

1.) Identification of neutrally evolving regions

Sequences that evolve most closely to neutral expectations may differ between species. In hominids (human and chimpanzee) repetitive sequences in introns (untranslated regions within genes) and intergenic regions are assumed to be subject to the lowest selective restrictions. In fruit flies

nucleotides 8 to 30 of short introns (<65nt) show patterns of evolution that are most similar to the expectations under neutrality. A study in rice (the closest relative of *A.thaliana* which was studied in that respect) also suggests that introns are evolving most closely to neutral expectations.

Therefore, we investigated how fast substitutions (nucleotide replacements which lead to differences in sequence between two species) are accumulated at various positions of short introns (45nt - 110nt) of *A.thaliana* and *A.lyrata*. We aligned the complete genomes of these two species, determined genes in both species that are similar by descent (orthologs) and analyzed their introns for substitutions. We find that positions 10 to 50 of introns show the highest substitution rates (with smallest CIs) and are hence the least constrained ones (fig.1a), while regions towards the end of introns exhibit reduced numbers of substitutions (fig.1b) which suggests higher constraints on evolution.

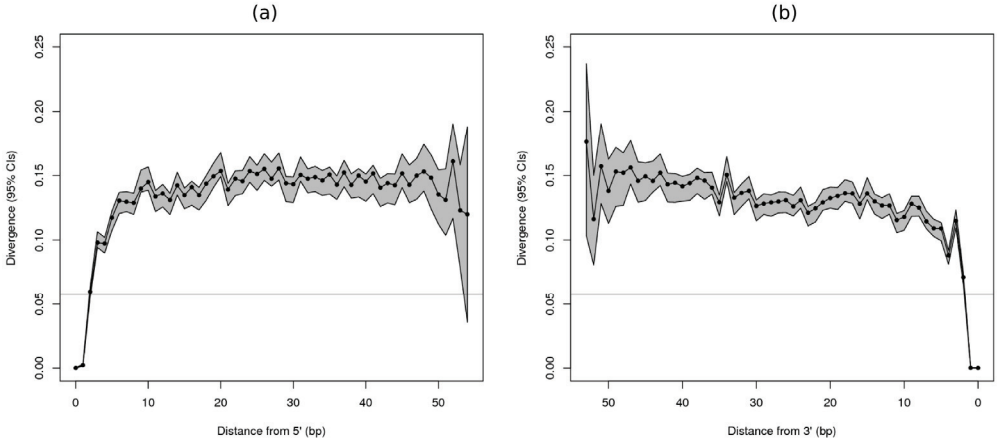
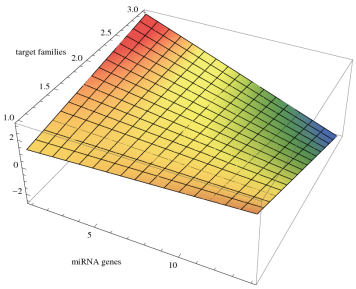


Figure 1: Mean divergence (95% confidence interval as a gray box) in short Arabidopsis introns plotted as a function of distance from the 5'- and 3'-ends of the intron

2.) Characterization of nucleotide variation

The subsequent logistic regression analysis of nucleotide variation in miRNAs revealed the significant influence of several factors on the presence of nucleotide substitutions. While some of these factors were already known before, we were able to show a new link between the substitution rate and (1) the number of miRNAs in a family and (2) the number of target gene families that are being regulated by the miRNA. These two determinants shape nucleotide variation through a complex interaction leading to an increase (or decrease) in substitution rates depending on the levels of the two parameters (fig. 2).



8. Please add your comments (if any):

I am very grateful to Professor Innan for hosting me during the summer program. The two-month period of the program was very inspiring and productive and allowed me to establish a project which we are planning to continue in a long lasting collaboration. While parts of that research can be accomplished independently, especially the final phase of the project will largely benefit from direct communication during a repeated stay in Japan which I hope to conduct. Apart from the research aspect of the program, the communication and interaction with other students and postdocs at SOKENDAI and learning about Japanese history, culture and habits were invaluable experiences I wouldn't have been able to make without the support of JSPS. Thank you for an amazing time!

RESEARCH REPORT

1. Name: Carsten Röcker （ID No.: SP10308）

2. Current affiliation:

Human Technology Centre (HumTec), RWTH Aachen University,
Theaterplatz 14, 52056 Aachen, Germany

3. Research fields and specialties:

Interdisciplinary and Frontier Sciences

4. Host institution:

Yoshimi Shunya Laboratory
Interfaculty Initiative in Information Studies
Graduate School of Interdisciplinary Information Studies
The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
Social Science Building, 8. Floor, Office 803

5. Host researcher:

Prof. Shunya Yoshimi

6. Description of your current research

Recent statistics show that approximately 30% of the people over 65 years and 50% of the people over 80 years fall at least once a year. In 20 to 30% of the cases, people suffer serious injuries with sustaining effects on mobility and independence. As many of these falls happen, when people are alone at home, several companies started to develop mobile emergency systems, which should enable users to call for help in an emergency situation. While this seems to be a promising approach at first sight, empirical evidence shows, that patients often do not carry those devices with them or are simply not able to operate them when medical problems have occurred. As a consequence, people lie on the floor for hours, sometimes even days, with lethal outcomes not being unusual.

In our current research we follow an alternative approach, in which information, communication and sensor technologies are integrated into the environment, so that physical objects, like chairs, tables or walls, can be used to offer context-adapted medical services in different areas of life. While such intelligent environments bear the potential to revolutionize medical home care, the interaction between the user and the environment plays a crucial role in the design process. Compared to traditional computer users, most older or handicapped people have very specific needs, which require the input and output devices to be individually adapted for each user. Besides these individual user characteristics, cognitive as well as motor skills of older users are not constant over the years, which makes an additional adaption over time necessary. Those dynamically changing requirements are reflected by integrating various interaction devices into our system, which enable the combination of different input and output modalities,

like speech or gesture, in order to individually support different types of users. But experiences with previous systems show, that the preferred interaction modalities do not only depend on the physical abilities or the personal preferences of users, instead they are also likely to be influenced by a variety of other factors, including the social situation, societal norms, and individual needs regarding privacy and intimacy. In order to analyze the influences of these factors, we recently set up a living lab environment, which enables us to observe different target user populations in realistic usage situations. We are currently conducting several formative studies, in order to analyze personal and medical needs of potential end users, as well as the habits they have in dealing with their illnesses. The insights gained in these studies will be used to define fundamental requirements for the design of Ambient Assisted Living environments.

7. Research implementation and results under the program

Title of your research plan:

A Multi-Disciplinary Approach toward Ambient Assisted Living.

Description of the research activities:

The overall goal of the research visit to Japan was to meet fellow researchers and industry practitioners from different academic fields in order to share research positions and practical experiences, and discuss new ideas, innovative approaches and challenging research questions, which have the potential to motivate future research activities within the field of Ambient Assisted Living. There are several reasons why an investigation into the Japanese society and research community was highly valuable for our ongoing research activities.

The most important was probably the discussion of inter-cultural differences regarding the adoption of new information and communication technologies. For the large-scale diffusion of Ambient Assisted Living technologies it is important that the underlying technologies and concepts are accepted by potential end users. Over the last two decades, several independent theories for the acceptance as well as adoption of information technology have been developed and were tested in numerous studies. A variety of these studies showed significant differences in the adoption process among different groups of users. Besides factors like gender and computer literacy, especially cultural differences played a crucial role in the adoption process. The JSPS summer program allowed to discuss different concepts and technical approaches with local researchers and developers in order to identify the factors, which contribute to potential differences in the adoption behavior between Japanese and Western users. While it is relatively well known that aging and housing concepts differ between Japan and most Western countries, other factors are far less studied. The stay in Japan enabled an exploration of the Japanese culture and society and thereby contributed to a deeper understanding of the different factors affecting the adoption behavior.

By identifying potential collaborators and establishing personal contacts with like-minded Japanese researchers, it was also possible to lay the groundwork for long-term collaboration activities with Japanese partners. The Interfaculty Initiative in Information Studies at the University of Tokyo offered a highly interdisciplinary research environment and turned out to be a very suitable host organization to conduct the envisioned research activities.

RESEARCH REPORT

1. Name: Felix Roesch （ID No.: SP10309）

2. Current affiliation: Doctoral candidate in Politics, Newcastle University/UK

3. Research fields and specialties:

Humanities, Social Sciences

4. Host institution: Faculty of Law, Kansai University, Osaka

5. Host researcher: Prof. Dr. Chieko Kitagawa Otsuru

6. Description of your current research

My current research focuses on the elaboration of Hans Morgenthau's world-view. Morgenthau is considered to be the doyen of International Relations and established the still important, but often misunderstood Realism.

The elaboration of his world-view will be elaborated by a contextualization of him into intellectual debates of German humanities during the *fin de siècle*. Morgenthau's major principles of his world-view – anti-ideologism, alienation, and 'conscious pariah' (Hannah Arendt) – happened in the wake of the 'cultural crisis' intellectuals perceived themselves to be in. This shows, other than it is often claimed, that Morgenthau's thought was characterized by a striking continuity throughout his life. The world-view itself is subdivided into Morgenthau's ontology, epistemology, and political agency. This research project is the first thorough elaboration of Morgenthau's life and work which will allow it to be considered as a fundamental study enabling further engagement with Morgenthau and re-consider his thought for the analysis of current international affairs.

The methodology applied to analyze Morgenthau's world-view is based on Karl Mannheim's world-view analysis, but especially draws upon Pierre Bourdieu's field and habitus theory and on Reinhart Kosselleck's conceptual history. For Bourdieu the world-view, or habitus as he called it, refers to thought, beliefs, and action and require to be contextualized into the respective time and place. In order to avoid relativism, my knowledge constitutive interests will be considered as well in the process of my knowledge construction.

7. Research implementation and results under the program

Title of your research plan: Politics is art, not a science – Hans J. Morgenthau's epistemology

Description of the research activities:

During my time at the Kansai University I was very much involved in its academic life. Not only was I able to participate at undergraduate courses and give tutoring to some students, but I also participated at various workshops. This included a workshop on multiculturalism and another one on intellectual property rights. Finally, I was also able to present a paper of mine on 'Styles of Thought in International Relations' at a

joint-seminar of the Kansai University and Kwansei Gakuin University on 31st July 2010. This presentation was very fruitful for me since I could get valuable insights from the participants of this seminar to further strengthen my argument.

However, to further my research, I devoted my time at the Kansai University particularly to analyze Morgenthau's epistemology. Epistemology can be defined, following the Stanford Encyclopedia of Philosophy as '… the study of knowledge and justified belief … which is concerned with the following questions: What are the necessary and sufficient conditions of knowledge? What are its sources? What is its structure, and what are its limits?' The results were the following:

Hans Morgenthau's epistemology was characterized by a strong rejection of positivism which dominated his thought throughout his career. In the time before the World War II, while being still in Europe, he contradicted legal positivism of the Vienna School, particularly of Hans Kelsen. This was the case, although he remained thankful to Kelsen for his positive intervention of his *Habilitation* and he had sympathy for his approach since he considered it as a viable approach to safe *Staatslehre* from the deprivation of metaphysics during the cultural crisis of the early 20th century. After his emigration the USA in 1937 Morgenthau faced another kind of positivism, behaviouralism. In several books and articles, he argued against this kind of scholarship for the simplistic belief in rationalism and empiricism of behavioural approaches and their reaffirmation of the status quo. Therefore, he believed behavioural approaches would not even achieve the standard requirements of good scholarship.

Morgenthau's epistemology found its source in alienation. Not only did he suffer from it throughout his life – double emigration from Germany and Spain, being a Jew in a particular anti-Semitic environment, and living in the USA whose academic life is based upon very different intellectual premises –, but he also get acquainted with it as an epistemological source which was then largely discussed in German humanities, amongst others by Georg Simmel, Mannheim, and Alfred Schütz.

Morgenthau based his own epistemology on the belief that knowledge is a spatial and temporal construct and can, therefore, not be universalized. For Morgenthau this meant that both, the knowledge of the observer and the one being observed are situationally determined. In order to avoid claims of relativism, he, therefore, argued it is not only necessary to contextualize the research object, but also the researcher as well. Only then would it be possible to produce viable knowledge constructs which are of an objective truth tied to the particular situation of the researcher.

Finally, it was elaborated that Morgenthau followed a conceptual history approach to implement his epistemological guidelines. This allowed him to establish general concepts to analyze and distinguish politics from other fields, while being aware of the different contexts which led to different understandings of these concepts.

RESEARCH REPORT

1. Name: Fabian SCHMELING (ID No.: SP10310)

2. Current affiliation: Philipps-University Marburg

3. Research fields and specialties:
Biological Sciences

4. Host institution: Sokendai University

5. Host researcher: Prof. Dr. Kentaro Arikawa, Dr. Michiyo Kinoshita

6. Description of your current research

Many insects like locusts are able to detect polarized light and use it for compass orientation. The locust *Schistocerca gregaria* possesses specially modified photoreceptors in a dorsal rim area (DRA) of its compound eyes to detect the polarization pattern of the sky (Peach and Homberg 2002: Ultrastructure and orientation of ommatidia in the dorsal rim area of the locust compound eye. *Arthropod Structure & Development* 30:271-280). During my current research I will determine the physiological characteristics of single DRA photoreceptors, including measurements of spectral and absolute sensitivities, polarization sensitivity and size and orientation of their receptive fields. Tracer injections will reveal their central projections into the lamina and medulla of the optic lobe. To achieve this, electrophysiological (intracellular recordings) and histological (retrograde mass cell staining) methods are used. Current efforts are aimed to assemble a set up for intracellular recordings from locust photoreceptors. In parallel, backfill experiments in progress are aimed to label and identify DRA photoreceptors with terminal projections in the dorsal rim area of the medulla.

7. Research implementation and results under the program

Title of your research plan:

Electrophysiological examinations on the compound eyes of several butterfly species

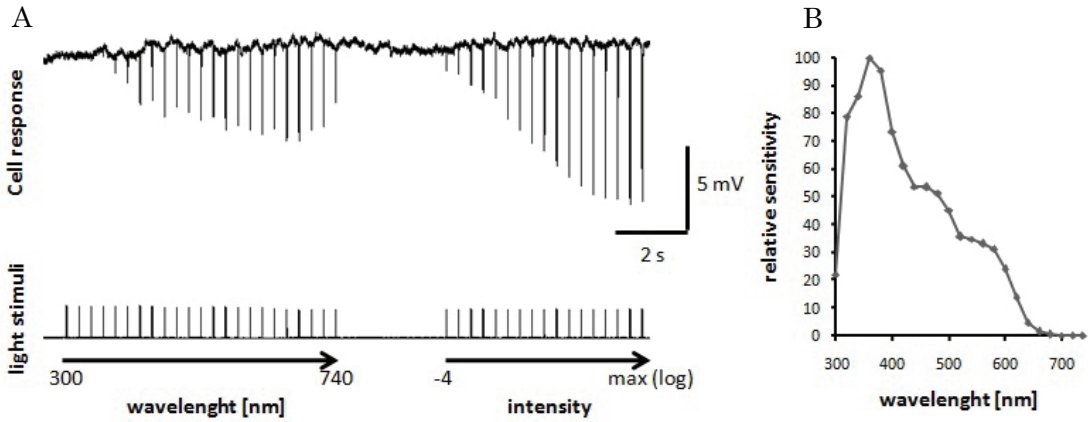
Description of the research activities:

In the Sokendai Laboratory of Neuroethology one of the main research topics is insect vision with special regard to several butterfly species. During my time here I determined the physiological characteristics of single photoreceptor cells in butterfly compound eyes. Elekctrophysiological methods like electroretinography (ERG) and intracellular recordings were used. Mainly the two species *Pseudozizeeria maha* and *Parantica sita* were examined. The procedure for electrophysiological recordings were as follows:

The body and head of the butterfly were fixed with wax on a small plastic platform. A small hole was cut in the cornea (surface) of the compound eyes. For ERG recording a silver wire electrode was inserted in the eye to measure the electrical activity of the photoreceptors without penetrating them. A glass microelectrode filled with a fluorescent dye was used for intracellular recording. This way a single receptor cell could be penetrated and its activity recorded. Signals recorded by the electrodes were received by an amplifier which was connected to an oscilloscope and a computer for data saving.

Light flashes of different color, intensity and polarization were presented to the animal to cause reactions of the receptors. If an interesting cell could be penetrated the dye was injected to stain the cell for further examination under the microscope.

Fig.1



The ERG recordings provide information about the full range of spectral sensitivity (which colors does the animal see) of the compound eye. Electrical activity of the receptor cells can be measured in volt as is shown in fig. 1 (recording from the butterfly *Pseudozizeeria maha*).

In fig.1 A a change from the basic volt level indicates that the cell is responding to the stimulus. The bigger the amplitude of the response the more sensitive is the cell for this specific stimulus considering wavelength and intensity. Using these data the relative sensitivity of the whole compound eye can be evaluated, as in Fig.1 B. The maximum peak is in the UV spectrum, so this butterfly is most sensitive to UV light. Furthermore there are two more sensitivity peaks in this graph indicating that in total there are three types of photoreceptors involved, each having its strongest sensitivity at a different wavelength (UV, blue and green). Together these tree photoreceptor types provide color vision in the range of at least between 380 to 680 nm. To examine details of the sensitivity of single photoreceptors intracellular recording in single cells is necessary.

Intracellular recordings where performed in the butterfly *Parantica sita* (which means this recordings cannot be set into relation with the ERG of *P. maha*). Three types of photoreceptors were found. One most sensitive to UV light, one to blue and one to green. So these photoreceptors are similar but not necessarily identical with those of *P. maha*. In conclusion *P. sita* and *P. maha* do have a similar ability for color vision. Testing with polarized light showed that the blue receptors of *P. sita* are also able to detect the polarization of light. This could enable *P. sita* to see the polarization pattern in the sky. *P. sita* is a seasonal migrating species and such sky compass could provide sufficient help for orientation.

Anatomical examination if the single photoreceptor cells is in progress and will provide information about the neuronal processing of visual information in the butterfly brain.

RESEARCH REPORT

1. Name: Julia Katharina Wagner (ID No.: SP10312)

2. Current affiliation: University of Augsburg, Institute of Physics

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Center for Frontier Science and Graduate School of Advanced Integration Science, Chiba University

5. Host researcher: Professor Hisao Ishii

6. Description of your current research

My current PhD research addresses charge carrier transport and the relation between morphology and device performance in organic solar cells based on small molecules. The huge interest in organic devices is based on the possibility to apply simple and low-cost fabrication techniques combined with good mechanical properties such as flexibility and robustness. In spite of great efforts concerning the fundamental understanding of the electronic structure and charge carrier transport mechanisms, many details are not yet fully understood. One reason for this fragmentary understanding is the insufficient knowledge of basic processes concerning the interfaces within the device. However, as these interfaces have a strong effect on charge carrier injection and charge flow, a detailed understanding of the interfacial electronic structure is essential to improve the performance of the devices.

One of the characteristic parameters describing the quality of a solar cell is the fill factor, which is defined as the ratio of the actual maximum obtainable power to the theoretical power. Typical commercial inorganic solar cells have a fill factor of around 80%, while organic solar cells often suffer from low fill factors not exceeding 50%. The reason for this may often be found in the appearance of so-called “s-shaped” device characteristics, i.e. a low current density near and above the open circuit voltage. This undesired feature has recently gained more and more attention in literature, while the origin is not yet fully understood. Possible explanations may be found in extraction barriers caused by insufficient energy level alignment inside the device.

7. Research implementation and results under the program

Title of your research plan:

Investigation of Interfaces in Organic Semiconductor Devices

Description of the research activities:

My research activities in the course of the JSPS summer program can be separated into two parts: The major part comprises measurements on organic solar cells while the second part is based on simulations of organic field effect transistors.

The goal of my research on organic solar cells was to extend the measurements on devices made in Augsburg to the measuring techniques available at my host institution. Due to their extensive experience in the field of organic electronics, the stay offered me a wide range of possibilities to investigate the interfaces inside the organic solar cell by means of different measuring techniques.

The electronic structure of the neat organic films and their interfaces can be investigated by photoelectron yield spectroscopy (PYS) and ultraviolet photoelectron spectroscopy (UPS). Moreover, the displacement current method (DCM) offers the possibility to monitor degradation mechanisms and charge carrier extraction barriers in organic solar cells. UPS data was carried out at the synchrotron UVSOR II in Okazaki and is used to determine the molecular energy levels in the valence region of the investigated material by detecting the kinetic energy spectra of the photoelectrons emitted by the ultraviolet radiation. The results of the measurements enabled us to develop an energy diagram of the electrode/semiconductor interface - both for heated and unheated substrate (see Fig.1).

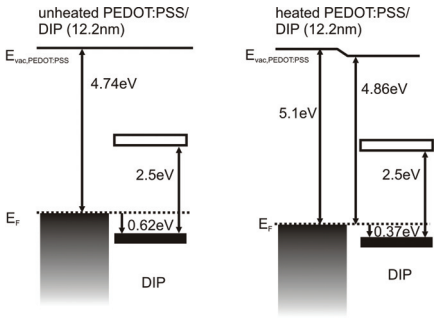


Fig. 1: Energy diagram of the relevant electrode/semiconductor interface in an organic solar cell. Values are obtained by UPS measurement.

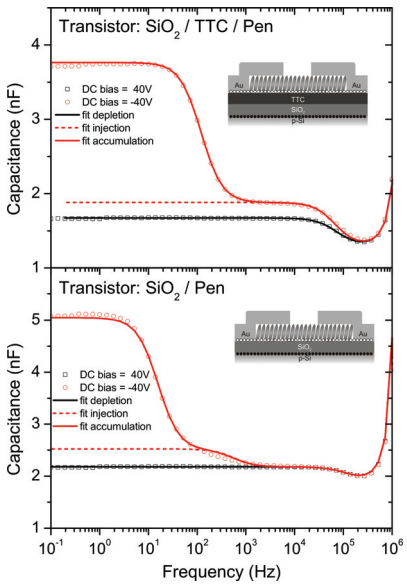


Fig. 2: Impedance data of two different transistors showing the influence of the spreading effect.

In addition to the concrete measurements carried out on solar cells and molecular films used in photovoltaic devices, I could apply my experience in simulating impedance data on devices measured by a member of my host research group in our laboratories in Augsburg. By means of extensive discussion we were able to develop an equivalent circuit for two organic field-effect transistors based on Pentacene which enabled the successful simulation of the measurement data. The crucial point in these experiments is the spreading effect of charge carriers taking place during accumulation and the effect of an additional layer of the semiconductor tetratetracontane. The simulated data fits well to the measured curves as can be seen in Fig.2. The most prominent difference between the two systems seems to be the relaxation frequency for the injection. Thus, it seems as if the change in the Pentacene film – probably induced by different morphology and structure - mainly affects the mobility in the direction perpendicular to the substrate.

8. Please add your comments: I would like to give my sincere thanks to the JSPS for giving me the opportunity to spend an enriching and unforgettable summer in Japan. I am truly grateful for the cordial integration and constant help by my host researcher Prof. Hisao Ishii and the entire work group. I learned a variety of new experimental techniques that will be beneficial for my future research. The successful application of the available measurement techniques to the field of organic solar cells provides a basis for intensifying and expanding our ongoing collaboration.

9. Advisor's remarks: Mrs. Julia Wagner was so positive to learn new experimental techniques. Actually, she performed both electron spectroscopy and electric measurement in our lab. Her data obtained by the techniques was very new and impressive, and demonstrated that the methods are very useful to investigate organic solar cells. So, I have decided to extend this work as a joint research program with her group, and I would like to invite her to come again in near future. She also gave good atmosphere to encourage our students. Now my students become able to communicate in English to some extent and understand the importance of international activity. Finally, I very much appreciate this summer program for supporting her stay.

RESEARCH REPORT

1. Name: Christina Zimmermann （ID No.: SP10313）

2. Current affiliation: Doctoral Student at Bauhaus-University Weimar, Germany

3. Research fields and specialties:

Humanities

4. Host institution: Tokyo Politechnic University (Tokyo Kougei Daigaku)

5. Host researcher: Prof. Keiji Hirayama

6. Description of your current research

Film and Ambiguity

Within the framework of my doctoral thesis I pursue research on different phenomena of ambiguity in film. The objective of this research is the formation of an alternative dramaturgy, concentrating on the cognitive and contemplative qualities of narrative film.

Prevalent dramaturgies focus on the organization of the plot within the audiovisual experience, taking an empathic relationship to the film characters as sine qua non. This concept of narration arises out of an essentially homocentric spirit and is usually based on the representational quality of the audiovisual medium.

Films, which exceed this representational, realistic mode and make, for example, use of different forms of stylization, are often perceived as symbolic, ambiguous or indetermined. They stimulate associative comprehension and detach the viewer from his empathic captivation. In my research, I focus on these cognitive and emotional processes to inspire future storytelling for film.

7. Research implementation and results under the program

Title of your research plan:

Film and Ambiguity

Description of the research activities:

Ambiguity in the sense of an indetermined, potential meaning of things, situations or language is very common in Japanese culture. During my stay in Tokyo I had not only the chance to discuss this topic with experts from different fields, such as social psychology, aesthetics and film theory, but I experienced it also in everyday life. When I was preparing questions for an interview with Naoko Ogigami on one of my last days in Tokyo, I suddenly recognized that I was trying to imply questions rather than asking them. In Japan “implying” and understanding the implications is maybe at least as important as the knowledge of the Japanese language.

During these two months in Tokyo I tried to build the fundaments for one chapter in my thesis. I am concentrating on Asian filmmakers, who design the experience of their films as meditative acts. Contemplation and meditation serve in these cases as alternative to character-centered absorbing narrations. Apitchatpong Wheerasethakul from Thailand and KimKi-duk from South Korea are contemporary directors, who successfully worked in this way. In Japanese Cinema I knew Yasujiro Ozu and Hiroshi Teshigahara, who created atmospheres of ambiguity in their films. Studying the cinematographic principles of Ozu, I came across two concepts that provide much insight for the theoretical foundation of my research. Noel Burch, and successively also Donald Richie, stressed the

"presentational" tendency in Japanese film. They related this tendency to the influence of Classical Japanese Aesthetics and to the tradition of Noh-and Kabuki-Theatre. I saw a Noh-Play at the National Noh Theatre in Tokyo and was deeply impressed by the performance with masks. I deepened my understanding in exhibitions of Noh masks and costumes and read the Major Treatises of Zeami Motokiyo. But although - at a first glance - some of the stylization strategies in young Japanese cinema might remind one of the Noh-tradition, in my conversations with young Japanese directors I couldn't find any conscious reflection of this cultural tradition.

The second concept, which was defined by Aaron Gerow, is for the understanding of ambiguity in contemporary Japanese cinema maybe more fruitful. Gerow observed a tendency in Japanese film that he called the "detached style". „Many contemporary filmmakers no longer accept the humanist assumption that people are at the heart all the same and can easily communicate based on that shared essence. [...] The detached style rejects the emphasis on explanation and thus creates a world that is, on one hand, more opaque and uncertain and, on the other, populated with people who gain a certain freedom from their detachment from others." Both concepts independently try to explain the inherent distance to the characters, which the authors found so typical in Japanese films.

Prof. Keiji Hirayama, my mentor during this summer program, suggested another explanation. Drawing back on the philosophical concept of „Fudo" by Tetsuro Watsuji, he described cultural differences as determined by the characteristic climate conditions in the respective regions. Homocentrism is thus a typical attitude in regions, where humans feel superior to nature, whereas in "Monsoon-regions" and subtropical countries, people tend towards cosmocentrism and polytheism/animism. Watsujis theory inspired a videoinstallation that I started to work on in Japan, and which will be edited, as soon as I am back to Germany.

Still, yet I hadn't found a contemporary Japanese director, whom I could fruitfully combine with Apitchatpong Weerasethakul and Kim Ki-Duk, to write about the ambiguity that arises in films, which apply a cosmocentric contemplative spirit.

From July 16th to 30th I had the chance to attend this years' PIA Film Festival at the National Film Center. The director of this festival, Keiko Araki, gave me the crucial hint to see "Megane" by Naoko Ogigami. This was the missing piece in my puzzle. I saw two other films by Naoko Ogigami - "Kamome Diner" and her new film "Toilet" in a preview screening - and had the chance to do an interview with her.

8. Please add your comments (if any):

I have been discussing the topic of my doctoral thesis with many film experts in Tokyo and I owe a deep gratitude to them for their valuable hints: Prof. Kyoko Hirano (Temple University), Tatsuja Kimura, Prof. Yasuhiro Nishimura (Tokyo Kougei Daigaku), Prof. Keiji Asanuma, Prof. Ryuichi Takayama (Tokyo Kougei Daigaku), Prof. Dr. Helmut Morsbach, Eija Niskanen, Dr. Roland Domenig, Karl Neubert, Reinhild Dettmar-Finke, Fumiaki Itakura (National Film Center) and many more.

RESEARCH REPORT

1. Name: Matthias J. Kaiser （ID No.: SP10314）

2. Current affiliation: Brandenburg University of Technology Cottbus, Germany
Department of Economics (Marketing and Innovation Mgt.)
Prof. Dr. Daniel Baier

3. Research fields and specialties:
Economics

4. Host institution: Tama University, Tama Campus, Tokyo, Japan
School of Management and Information Sciences

5. Host researcher: Professor Tadashi Imaizumi

6. Description of your current research

In general the current research work is related to economical questions like: "How will the future develop and which follow-up strategies are necessary to avoid future uncertainties and risks, e.g. in companies or organisations?" – Dealing with future studies in economical context is of interest to companies, the society and also marketing scientists.

The research field concentrates on the methodical validation of the combination of Multiple Scenario Analysis (MSA) as one appropriate future method and Two-Mode Clustering Procedure (innovative scenario selection process) in the context of developing perspectives (scenarios) for eLearning at universities as an example of use. It concerns research core areas like "New Media" and "Operations Research".

Several experiments are in progress to identify optimal preferences, properties and dependencies of the new framework and to select appropriate key factors and their projections determining the future of eLearning at universities. A statistical software program (SAS) is set up for testing the ideas of the framework.

7. Research implementation and results under the program

Title of your research plan:

Developing Future Scenarios of eLearning at Universities via Multiple Scenario Approach including Two-Mode Clustering Procedures

Description of the research activities:

During the JSPS Summer Program 2010 the ideas of a new conceptual research framework (combination of MSA and Two-Mode Clustering Procedures) to access and select multiple future scenarios have been presented in several science meetings and a special "Symposium of the Japan Classification Society (JCS)". The innovative methodological approach was discussed by statistical experts, reviewed in brief discussions at various universities in Tokyo and new ideas were gained with the help of the supervisor or participants of the JSPS Summer Program 2010 with mathematical background. Besides the conceptual research work the new approach was tested with the help of specific statistical software (SAS).

Furthermore, a new approach was developed to enter several dimensions of nearby and vague future aspects of eLearning at universities as an example of use. Key factors and related projections of the eLearning future were identified by analysing actual scientific literature, previous experts´ interviews and discussions from eLearning conferences. Current results show a model to approach the future of eLearning at universities in different time periods (nearby, middle-term and vague) and several influencing areas (e.g. core areas like changes in society, technology and economy). New insights to the field of eLearning at universities were obtained.

The scholarship has ensured that the research work underwent a brief international reflection process, important eLearning key factors as input factors for the scenario generation process were found and the whole idea of the research activities have been concretised.

8. Please add your comments (if any):

Beside the research activities mentioned above I would like to thank JSPS, the responsible staff at Tama University and several statisticians, Marcus Meyer (another JSPS fellow from Chemnitz University, Germany) as well as my host Prof. Tadashi Imaizumi for his kind assistance in scientific and daily life questions during my stay in Japan. I finished my research work and got new insights from different point of views for the ongoing research activities in Germany. I could also strengthen scientific cooperation between Japanese and German researchers. Thank you very much!

From the personal point of view it was an incredible and fruitful experience to get in touch with the Japanese culture and society. I really appreciate that I am always cordially welcome in the family of my host.

9. Advisor’s remarks (if any)

Matthias J. Kaiser has engaged in this JSPS Summer Program 2010 very well. I think he got the new insight of his current MSA by several discussions with my colleagues and me at Tama University and others.

He also has looked over his MSA method thought his talk of MSA at the JCS (Japanese Classification Society) meeting and at other scientific meeting with Japanese mathematical statisticians, respectively. He understood the different point of view, especially Japanese point of view about MSA and made his research goals more clearly by constructive discussion with many researchers from economic, sociology, operations research, statistics and engineering etc.

He is a very polite in his manners for every person and has a communicative skill with other person. It was a pleasant period for my colleges, my family and me.

RESEARCH REPORT

1. Name: Sandra Annett （ID No.: SP10401 ）

2. Current affiliation: University of Manitoba, Canada

3. Research fields and specialties:
Humanities, Social Sciences

4. Host institution: Wako University

5. Host researcher: Dr. Toshiya Ueno

6. Description of your current research

The global spread of media is often considered one of the major factors shaping cross-cultural interaction today. My current research, the topic of my PhD dissertation, focuses on an especially visible example of such interaction: transcultural fan communities. A "transcultural fan community" is a group in which members from many national, cultural and ethnic backgrounds experience a sense of connection across difference, engaging with each other through a shared interest while negotiating the frictions that result from their differing social contexts. My main research goal is to explore how the global distribution of Japanese animation through new media technologies affects transcultural community formation by providing new means for virtual and face-to-face communication.

In order to investigate how media technologies and global communities intersect, I have developed an interdisciplinary, international research program. My disciplinary approach combines the practices of close textual and theoretical analysis found in film studies with ethnographic fieldwork methods more commonly used in the social sciences.

In the first stage of my fieldwork, running roughly from August 2009 to February 2010, I conducted a survey of English-speaking animation fans between the ages of 18-30. This survey was composed of 34 open-ended and multiple choice questions on four topics: animation viewing habits, fan experiences, consumption of related media products, and demographic information about the respondent. I recruited respondents online through English-language email lists and blogs devoted to anime, and in person at anime fan conventions in Canada and the United States. By joining in these lists and events, I was also able to conduct participant observation by myself engaging in the fan practices of textual debate and embodied performance I studied.

In the second stage of my research, running from March to September, I aimed to gain a truly transcultural perspective on anime fan community by pursuing a similar course of fieldwork in Japan, using a Japanese-language version of my survey. This is the work that JSPS has enabled me to conduct throughout the summer of 2010, as is described below.

7. Research implementation and results under the program

Title of your research plan:

Animating Transcultural Communities

Description of the research activities:

Because my project encompasses both film studies and ethnography, my research activities in Japan fell broadly into two categories: archival research and fieldwork.

Archival research consisted of locating Japanese-language resources related to the history and current state of Japanese animation. I worked mainly at Wako University's Umene Memorial library,

with additional research at the library of the Suginami Animation Museum in Tokyo and the International Manga Museum in Kyoto. Some of the resources I was able to access included films and writings by one of Japan's most important pre-war animators, Ofuji Noburo, whose works are difficult to find in the West despite his historical contributions. I also took the opportunity to familiarize myself with contemporary critical theory on anime and its related cultures today, including studies of anime fan, or "*otaku*," subculture. The documents I gathered and the bibliography I prepared during this stage of my research will be invaluable for writing a PhD thesis that takes into account multiple cultural perspectives, in scholarship as well as in fan practices.

For the fieldwork portion of my program, I visited various sites where I was able to observe and to some extent participate in the cultures of Japanese anime. These included: 1) permanent sites such as established *otaku* hangouts and shopping areas, 2) temporary sites such as fan conventions, and 3) virtual sites such as anime club websites and message boards.

The key permanent sites in my study were Tokyo's two anime-oriented shopping districts: the "Electric Town" in Akihabara and "Otome Road" (or, Maiden Road) in Ikebukuro. Comparing these two locales enabled me to see different facets of anime fan culture within Japan, as Akihabara largely caters to male *otaku*, while Ikebukuro attracts female fans, known as *fujoshi*. Informal interactions with fans and close observations of the kinds of anime imagery present in each district gave me new insight into the role of gender in Japanese anime fandom, particularly how it is played out in local urban spaces.

Besides visiting permanent sites, I also had the opportunity to attend Japan's largest anime fan convention, Comic Market. "Comike," as it is called, is a biannual event where male and female fans buy and sell self-published fan-works related to anime, manga, games, etc. This year's Summer Comike was held August 13-15, and proved to be my main recruiting opportunity. Here alone I handed out approximately 110 recruiting cards directing those who showed an interest to my survey website. Since I attended in costume as well, people often recognized the character my costume portrayed and called out to me spontaneously by "name," generating conversational openings which lead naturally into discussing my work. Such invested personal interactions were my most effective way of reaching Japanese fans across our differences in background.

In contrast, and contrary to my expectations, virtual sites out of all three recruiting locales were the most closed to me. My Japanese-language posts to public anime message boards went unanswered, as did my emails to selected university clubs. Many online-recruiting returns I received were blank, and as a result completion rates for the Japanese survey currently stand at 36.4%. This differs sharply from my English survey results, where online recruiting was generally effective, with a completion rate of 61.3%. My most successful ongoing email exchanges with Japanese fans and publishing circles have all been based on previous face-to-face meetings at social gatherings. I have thus found that virtual relationships in Japan tend to "link" to physical ones –a realization that is itself important to gaining an accurate portrait of media and community.

I am still collecting survey responses and will continue to do so until the end of September in order to match the timespan of the English-language survey. However, my experiences researching in Japan and the initial survey results point strongly to the need to consider the *frictions* -the unavoidable yet productive local differences- that make up transcultural communities as well as the flows of global media.

8. Please add your comments (if any):

Research in Japan was a planned element of my thesis project from the start. However, the JSPS summer program (co-sponsored, for me, by the Social Sciences and Humanities Research Council of Canada) opened so many doors that I now believe my project would have been incomplete without it. The Wako University library staff was a great help in locating documents and ordering materials I needed. The lectures and fieldwork events Dr. Ueno invited me to were always enjoyable and informative. (I wish we could have done more!) And the friends I made while here, from Japan and from all around the globe, really supported me during my fieldwork, right down to attending Comike with me and helping me improve my verbal recruiting scripts. This was more than research: it was a new way of living in the world. For that experience, I am profoundly grateful.

RESEARCH REPORT

1. Name: Mélanie Cousineau （ID No.: SP10403）

2. Current affiliation: Department of Earth Sciences, University of Ottawa, Ottawa, Ontario, Canada

3. Research fields and specialties:

Interdisciplinary and Frontier Sciences (geochemistry)

4. Host institution: University of Tsukuba, Tsukuba, Japan

5. Host researcher: Professor Teruyuki MARUOKA

6. Description of your current research

My current research at the University of Ottawa focuses on a metabolic process, "bacterial sulfate reduction" or BSR, used by many groups of bacteria, and on its use to understand past environmental conditions on the planet. Evidence of BSR can be found in mineral deposits as old as 3.47 billion years, making it one of the oldest metabolisms on Earth. During the metabolic reduction of sulfate (oxidized sulfur) to sulfide (reduced form), the heavy isotope, ^{34}S, becomes concentrated in the reactant, while its light counterpart, ^{32}S, becomes concentrated in the product. This separation of the different isotopes is termed "fractionation" and is often used as a proxy for biological activity in reducing conditions. Biogenic sulfide deposits of Archean age (3.8-2.5 billion years) typically present moderate depletions in ^{34}S, whereas modern deposits are depleted by up to 70‰ (per mil). Many studies have investigated the fractionation of sulfur isotopes during BSR and many factors have been investigated to explain the fractionation observed in modern deposits. However, the full range of fractionation has not been reproduced; maximum depletions are in the order of 46‰. Because BSR is a proton-consuming reaction, acidophilic and acid-tolerant sulfate reducers possess an energetic advantage at low pH. I hypothesize that pH, which has not been investigated as a controlling factor, has the potential to affect fractionation, due to the necessity of cells to expend energy to maintain optimal conditions in the cytoplasm. My research thus focuses on determining the role of pH as a controlling factor of sulfur fractionation during BSR. I am testing this hypothesis through a series of closed-system, time-series, experiments in which sulfur isotopic fractionation is investigated as a function of changing pH, a natural consequence of BSR in closed systems. Major (^{34}S, ^{32}S), as well as minor (^{33}S, ^{36}S), isotopes of sulfur are being considered. Additionally, bioreactor open-system experiments will be conducted to investigate fractionation at various (fixed) pH conditions. This research has implications for understanding geochemical conditions prevailing in ancient oceans, namely during the Archean, as Archean oceans, which supported the beginning of life on Earth are believed to have been acidic. Additionally, as sulfate-reducing bacteria have the potential to remediate the environmental problem of acid mine drainage (AMD), understanding the metabolism of these organisms at low pH conditions may benefit research into large-scale bioreactor applications for remediation. Moreover, the experiments will complement the current database on sulfur isotope fractionation for sulfate reducers, as there are currently no data on acid-tolerant or acidic strains.

7. Research implementation and results under the program

Title of your research plan: Investigating paleoenvironmental conditions at two terrestrial Cretaceous-Tertiary boundary sections in Alberta, Canada, using sulfur isotopes

Description of the research activities:

Mass extinction events are a common feature of Earth's history. Several mechanisms have been identified to explain these events, including meteorite impacts, and many geochemical signals can help elucidate the conditions prevailing on Earth during these events. Sulfur isotopes are such a tool, as most sulfides in sediments originate from BSR, which is influenced by environmental conditions and leads to

significant sulfur fractionation. The extinction of the dinosaurs 65 million years ago, represented by the Cretaceous-Tertiary boundary, is thought to have occurred as a result of the impact of the Chicxulub meteorite, which would have generated large amounts of dust and sulfur aerosols, preventing sunlight from reaching the surface and producing acid rain. Sections of this boundary, one of the northernmost in terrestrial settings, can be found in south-central Alberta. My research activities at the University of Tsukuba focused on determining the sulfur content and sulfur isotope ratios in sedimentary rocks sampled at high resolution to understand the paleoenvironmental conditions prevailing in these terrestrial successions across the boundary. The main objective during the JSPS summer program was to conduct the analysis of sulfur content and sulfur isotope ratios in the samples from the K-T boundary in Alberta. This implied homogenizing the samples and preparing them for analysis using an isotope ratio mass spectrometer. Because of the very small amounts of sulfur in the samples (sometimes <0.1%) and limitations on total sample size for the instrument used (<10 mg), special consideration was given to avoiding cross-contamination and optimizing the ratio of sulfur in the standards to sulfur in the samples. The samples were first crushed and homogenized by hand using an agate mortar and pestle. They were then weighed accurately in tin capsules and analyzed for sulfur content and isotopic composition. This initial assessment was aimed at providing an estimate of sulfur content and composition to optimize operation parameters, as analysis of sulfur in sediments can present many difficulties. First, the often high carbon content causes the oxygen to become rapidly depleted, resulting in a low signal and a consequently high measurement error. Second, the gas formed by oxidizing the sulfur, SO_2, tends to "stick" to the tubing of the instrument, often causing the sulfur from one sample to mix with the sulfur from the subsequent sample. Conducting an initial assessment enabled us to tailor the instrumental parameters to our specific needs. Once sulfur content was known, the samples were analyzed in triplicate. With the sulfur content and composition data now in hand, an in-depth look can be given at understanding the changes in environmental conditions in the terrestrial environment of what is now south-central Alberta, before and after the meteorite impact. This next step will be accomplished in the coming months, in collaboration with Dr. Maruoka, and Dr. François Therrien (Royal Tyrell Museum, Alberta, Canada).

8. Please add your comments (if any): I was deeply impressed by the quality of the JSPS summer program, not only in the orientation activities, which were simply amazing and extremely well orchestrated, but also during the course of the summer, with the staff always helpful and knowledgeable. I particularly enjoyed my experience with my host family in Yokosuka. This part of the program was a definite highlight, and proved to be a very enjoyable introduction to Japanese culture and customs.

My research activities at the University of Tsukuba with Dr. Maruoka were fulfilling, and have provided me with an opportunity to experience scientific research in a different professional and cultural setting and to make connections that I hope will be lasting friendships. I have indeed learned a great deal, but wish I had had more opportunities to become familiar with the equipment itself and its technical intricacies.

9. Advisor's remarks (if any): Ms. Cousineau conducted d34S analyses of the low sulfur samples during her stay at our university. As sample sizes were limited by the size of tin capsule and high-temperature furnace, we cannot use usual size of sulfur (30 micrograms). So, we decided to reduce sulfur size for measurements to 1-3 micrograms. We must think about more factors when using smaller size of sulfur for avoiding contamination. Ms. Cousineau carefully conducted experiments; then, we could overcome some of the critical problems. During her stay, I got valuable knowledge for analyses of low sulfur samples. This knowledge should be useful for my future researches.

RESEARCH REPORT

1. Name: Christopher P. Garnham (ID No.: SP10404)

2. Current affiliation: Ph.D. Candidate, Department of Biochemistry, Queen's University, Kingston, ON, Canada, K7L3N6

3. Research fields and specialties:

Biological Sciences

4. Host institution: National Institute of Advanced Industrial Science and Technology (AIST), Sapporo, Hokkaido

5. Host researcher: Dr. Sakae Tsuda

6. Description of your current research

My research focuses on the structure/function relationship of antifreeze proteins (AFPs). Many organisms that inhabit ice-laden environments (including fish, insects, plants, bacteria, and fungi) produce AFPs to enhance survival. AFPs stick to the surface of ice crystals and prevent their growth, therefore lowering the freezing point of the solution. Several different types of AFPs are known to exist, and they all display large variation in both amino acid sequence and three-dimensional structure. Despite this variation, all AFPs have evolved the ability to bind ice, the result of ice being a 'heterogeneous ligand'. Due to nature in which water freezes, several distinct surfaces (planes) are present within an ice crystal, any one of which an AFP may interact with. One technique previously employed to determine the specific plane(s) of ice to which an AFP may bind is termed 'ice-etching'. In this technique, a large, single ice crystal of known orientation is attached to the end of a temperature-controlled brass rod and allowed to grow in the presence of a specific AFP. Bound AFPs are revealed as patches on the surface of the ice crystal after it is allowed to sublime at -20 ºC for an extended period of time (ca. 24 hours). The AFP is incorporated into the crystal only at specific locations and orientations, and this information reveals the specific plane(s) to which the AFP is bound. My research at Queen's University (and here at AIST) has taken the ice-etching technique one step further by labelling AFPs with fluorescent tags (either green-fluorescent protein, or fluorescent dyes such as TRITC). This allows us to visualize AFPs on the surface of the crystal under UV light, making interpretation of the ice-crystal much simpler, and, through the use of differential labelling techniques, allowing for the possibility of growing hemispheres with more than one AFP in solution. We have successfully employed this technique to redefine the mechanism of action of type III AFP, a moderately active AFP found in several species of Arctic and Antarctic fish.

7. Research implementation and results under the program

Title of your research plan:

A macromolecular view of antifreeze protein:ice interactions

Description of the research activities:

I successfully implemented a system that allows the laboratory of Dr. Sakae Tsuda to grow single- ice-crystal hemispheres using fluorescently-tagged AFPs. Being able to perform these types of experiments involves several distinct steps. First, we showed that virtually all AFPs can be successfully labelled using a fluorescent compound specific for primary amines (TRITC or equivalent), so long as the site of modification was located away from the ice-binding surface of the protein. Second, we were able to grow single ice crystals using a temperature-controlled ethylene glycol bath. Third, we put together a system that allowed us to mount the single ice crystals on a temperature-controlled brass rod. This allowed us to control the growth of the crystals in the presence of the fluorescently-labeled AFPs, allowing for their incorporation into the ice crystal. Finally, we were able to visualize

the ice hemispheres using a UV light box located in a -1ºC room. With all this complete, we were able to survey several distinct types of AFPs to determine their specific ice-plane affinity. We showed that our technique produces the same result as the original 'ice-etching' technique by using fluorescently-tagged type I AFP. The fluorescent pattern produced by this protein is the same as was originally published by Knight *et. al* (1991). We demonstrated that Ca^{2+}-dependent type II AFP has affinity towards the secondary prism plane of ice. We demonstrated that type III AFP has affinity towards both the primary prism plane of ice and also a pyramidal plane of unspecified Miller indices. We also demonstrated through a series of site-specific mutations to a 'defective' isoform of type III AFP that it could be converted into its fully active counterpart. Finally, we were able to grow hemispheres in the presence of two AFPs labelled with different fluorescent compounds (see Figure 1). Doing so demonstrated that each protein binds to its own specific plane of ice and that the proteins do not spoil each others ice-binding site. The system set up in the lab of Dr. Tsuda can and will be employed in the future to determine the ice-plane specificity of all AFPs that he investigates.

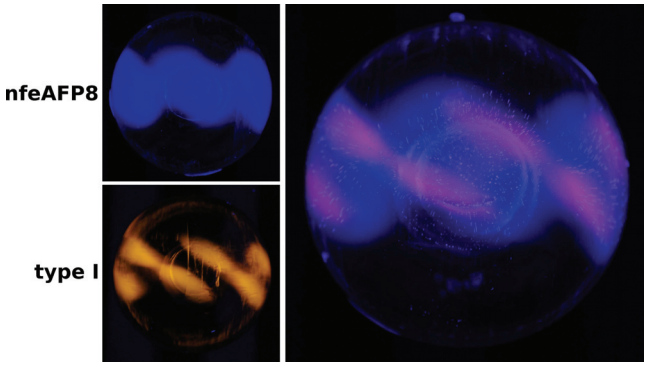


Figure 1: Combination hemisphere using pacific-blue labelled nfeAFP8 (a type III AFP isoform) and TRITC-labelled type I AFP. The single hemispheres are shown on the left, while the combination hemisphere is shown on the right.

8. Please add your comments (if any):

Excellent trip. I highly recommend the program to anyone considering applying.

RESEARCH REPORT

1. Name: William Gornall (ID No.: SP10405)

2. Current affiliation: University of Waterloo

3. Research fields and specialties:

Social Sciences

4. Host institution: Tokyo Metropolitan University

5. Host researcher: Professor Masaaki Kijima

6. Description of your current research

Before the recent financial crisis, over-the-counter derivative transactions were considered almost risk free. The possibility that large financial institutions would be unable to meet their obligations seemed remote enough to be assumed away. However, the spectacular collapses of AIG, Lehman, and Bear Sterns showed that it was far from prudent to consider these institutions infallible.

The risk of a major financial institution defaulting on its obligations paralyzed banks during the crisis – they were unwilling lend or to enter into contracts with other institutions because they were unsure of those institutions' credit exposure. Contagion, the possibility of a domino effect where one defaulting bank pushed others into insolvency, forced governments all over the world to nationalize, guarantee, and subsidize to prevent further financial damage.

My research hopes to provide a method to allow banks to more easily model the value of these credit exposures. I focus on extending trade level allocations of exposure – allowing a bank to apportion its credit risk on the transaction level. This is an understudied area and research should help financial institutions to better price over-the-counter derivative contracts and better manage their inherent risks.

7. Research implementation and results under the program

Title of your research plan:

A Structural Model of Trade Level Counterparty Risk

Description of the research activities:

Over the past two months I have worked to extend and modify the model Pykhtin and Rosen outline in their 2010 paper Pricing Counterparty Risk at the Trade Level and CVA Allocations. I changed their model in several ways, under guidance from Professor Masaaki Kijima.

Primarily, I moved it into a continuous time framework, while preserving the inherent normality assumptions. Such a structure could be used to quickly determine the present value of the credit risk associated with each trade within a portfolio. I also derived a wrong-way risk model base d on the Black and Cox default model. This model allows for wrong way risk to be estimated from market data on default probabilities and asset value correlations. As this model is compatible with a normality assumption, it can be used with Pykhtin and Rosen's results.

I was able to make significance progress on in my research during the summer, and I hope to continue working on this topic with a view to publication.

RESEARCH REPORT

1. Name: Julia Kam （ID No.: SP10406）

2. Current affiliation: Department of Psychology, University of British Columbia

3. Research fields and specialties:
Social Sciences (Psychology)

4. Host institution: Asia University

5. Host researcher: Fumihiko Itagaki

6. Description of your current research:

Our attention-to-task waxes and wanes over time. Sometimes, our attention is focused on the current task – "on task", while other times, we are not paying attention to our task-at-hand – "off task or mind wandering". Given the ubiquity and importance of these attentional cycles in everyday life, it is crucial to understand their neurocognitive underpinnings. Recent evidence suggests that sensory and cognitive responses in cortex are modulated by whether or not one is paying attention to the current task (Kam et al., 2011; Smallwood et al., 2008). However, it is unclear what aspects of cognition are impacted by fluctuations in task-related attention. My project at Asia University will contribute to this field of research by revealing how task-related attention influences a specific aspect of cognition – that is, working memory.

At the University of British Columbia, my area of research focuses on examining the influence of task-related attention (on task vs. off task) on processing of stimulus in the external environment. My masters work revealed that sensory gain control is engaged when our attention ebbs and flows over time (Kam et al., 2011). In addition, my other projects include understanding the manner in which the processing of errors and deviant stimulus are modulated by the transient fluctuations of our attention-to-task. I am also interested in understanding the individual differences in the patterns of task-related attention. In other words, what personality, demographic, or cultural factors may affect the frequency of mind wandering and how does that affect our performance in the current task? This area of resarch has important implications in our daily tasks like driving and in the educational context.

7. Research implementation and results under the program

Title of your research plan:

The influence of task-related attention on random number generation.

Description of the research activities:

At Asia University, my host supervisor and I examined whether task-related attention influences working memory, as assessed by the random number generation (RNG) task. We had participants perform the RNG task in three blocks and report their attention levels upon completing each block. The RNG task requires participant to generate numbers as randomly as possible via key presses on a number pad. Data analysis involved examining the patterns of the RNG task performance as a function of whether participants were categorized in the on-task or off-task group.

Preliminary data analysis suggests that the pattern of random number generation differs between the on-task group and the off-task group. Not only do they tend to repeatedly press different sets of numbers, the two groups also tend to differ in the frequency of key presses of certain numbers.

My involvement in this project included drafting the research question, designing the task paradigm, and finalizing the protocol. As well, I collected data for this project by running participants in this experiment. Lastly, I was involved in analyzing the data, and will continue to work on this project to prepare this for publication.

8. Please add your comments (if any):

The 2010 JSPS Summer Program has provided foreign graduate students with a unique opportunity to collaborate with Japanese researchers. It is a wonderful avenue for eliciting cross-nation collaboration both during the program and thereafter. As a participant in this program, I have had an educational and fulfilling experience in the past ten weeks both professionally and personally.

RESEARCH REPORT

1. Name: Jianwei Mu （ID No.: SP10407）

2. Current affiliation: McMaster University, Hamilton, Ontario

3. Research fields and specialties:

Engineering Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Yoshiaki Nakano

6. Description of your current research

Driven by the demand of high speed network and exponential grown bandwidth hungry applications, photonic integrated circuit (PIC), among the most advanced technologies decreasing the cost while simultaneously improving the system performance, has attracted much attention recently. PIC exceeds discrete optical discrete components not only in the reduction of power consumption and size, but the improved reliability. High-index contrast materials such as silicon and silicon nitride are favored in photonic integration as they enable dense integration, tight bends, etc. On the other hand, the availability of low-cost high-purity wafers, the mature silicon processing technology and the compatibility with standard CMOS processes open up the possibilities of dense photonic integrated functional devices. Especially, waveguide structure based on silicon nitride has many advantages such as a wide spectral transparency window, highly controllable thickness and small interface roughness etc.

Though there is a considerable potential for developing photonic integrated circuit using high index contrast materials, there are noticeable drawbacks. One the major challenges with high index contrast waveguides is the coupling between the standard single mode fiber and the small dimension waveguide core. The conventional approach is butt-coupling in which the waveguide end-face has to be cleaved or polished. In photonic integrated circuit, vertical coupling is more favored since the device cleave is avoided which makes on wafer testing possible. Moreover, the vertical grating coupler is usually compact and has the advantage of easy alignment.

Generally, the coupling efficiency of the vertical coupling determined by three factors: diffraction loss towards the substrate; mode mismatching of the radiation fields with the fiber mode; and the second order Bragg reflection. Also, the high-index contrast waveguide also means the coupler is polarization dependent and most of the designs are based on TE polarization.

My research in University of Tokyo focused on the investigation and fabrication of high coupling efficiency vertical grating coupler based on Silicon Nitride slot waveguide grating structure. Our design is expected to have improved polarization dependence without the loss of coupling efficiency. We have fabricated two types of vertical grating coupers based on Silicon nitride materials and the measurement is in process.

7. Research implementation and results under the program

Title of your research plan:

Silicon nitride waveguide grating coupler for normal fiber incidence

Description of the research activities:

Two different grating couplers for normal fiber incidence based on silicon nitride waveguide structure have been theoretically investigated and fabricated.

1) Bottom layer stack

A bottom reflector consists of two pairs of Si/SiO2 mirror has been sputtered on the Si substrate. The main purpose of the bottom reflector is to reduce the leakage loss to the substrate thus enhances the coupling efficiency. It should be noted that the amorphous Si is generated during the sputtering process, however, since the wave is expected to be reflected back and does not propagate in the amorphous silicon region, the scattering and absorption loss is neglected.

2) Slot waveguide grating coupler

Above the bottom layer stack, a 1.5 micron silicon oxide buffer layer is sputtered; later a 200 nanometer silicon nitride film is grown on the buffer. A 100-nanometer silicon oxide layer is put onto the nitride film, covered with another 200 nanometer thick silicon nitride. The grating is formed by etching the silicon nitride waveguide structure. Finally a silicon oxide overlay is applied to decrease the reflection of the fiber mode.

As the thin silicon oxide film (100 nm) is sandwiched by high index silicon nitride, the slot mode is formed due to the discontinuity of the electrical field. The slot mode is inherently TM polarized and is sensitive to the cladding variations. On the other hand, the quasi-TE mode is formed between the air and the silicon oxide buffer, the simulation shows that by optimization, the polarization dependency could be reduced.

3) Silicon nitride waveguide grating

For comparison purpose, a 400 nanometer thick silicon nitride is put onto the silicon oxide buffer layer and the grating is formed by etching the waveguide core. A 200 nanometer silicon oxide overlay is employed to reduce the surface reflection. This grating is a typical in/out grating coupler with high polarization dependency, thus could be a good reference for slot waveguide grating coupler.

The devices were fabricated on a 4 inches silicon wafer. The mask is made by E-beam lithography system CBL-9000. Limited by the report, the detailed fabrication process and the related SEM pictures will not be shown in the report. The measurement is in process, and we are preparing a detailed technical report and followed by optimized design and fabrication.

RESEARCH REPORT

1. Name: Kyle Nishiyama （ID No.: SP10408）

2. Current affiliation: University of Calgary

3. Research fields and specialties:

Engineering Sciences, Medical, Dental and Pharmaceutical Sciences

4. Host institution: Nagasaki University Hospital

5. Host researcher: Dr. Masako Ito

6. Description of your current research

Osteoporosis is a serious disease characterized by decreased bone quality leading to an increased risk of fracture. In our aging population, it is estimated that over 200 million people suffer from the disease and this represents a significant burden on our health care system. This research explores the use of a recently developed medical imaging technology (high resolution peripheral quantitative computed tomography; HR-pQCT) that provides high resolution images of bone micro-architecture in patients. This tool is a significant improvement over the current clinical use of dual x-ray absorptiometry (DXA) because it not only measures bone density, but also its three-dimensional structure. Using this technology and computer models, we can analyze the characteristics of a patient's bones and provide patient specific estimates bone strength, which is a key component in determining the risk of fracture. By applying this work to representative populations, (Canadian Multicentre Osteoporosis Study; CaMos) we can determine the normal variation in bone quality across age and sex, as well as the changes caused by disease. We can then use computer models (finite element analysis) to obtain patient specific estimates of bone strength and fracture risk. This research will provide important new insight into bone quality and establish a new clinical imaging tool for the assessment of fracture risk and treatments for patients with osteoporosis and other bone-related diseases.

7. Research implementation and results under the program

Title of your research plan:

Improved estimates of bone strength using finite element analysis and clinical computed tomography scans.

Description of the research activities:

My work in Japan has combined the technical expertise from the University of Calgary and the clinical expertise from Nagasaki University to develop a software tool to create finite element models based on clinical computed tomography (CT) images of the hip. These models are able to provide patient-specific estimates of bone strength and may provide a better basis for the assessment of fracture risk. During my time in Japan this software program was written taking into account clinical advice from Dr. Ito and other colleagues at Nagasaki University Hospital. Clinical CT images can be read by the program and converted to finite element models. Loading conditions that simulate walking or falling can be applied to the model to obtain estimates of the bone strength and the risk of fracture. Using various datasets collected in Japan, bone strength was estimated for normal populations, subjects with and without fractures, as well as subjects participating in clinical trials for various osteoporosis treatments.

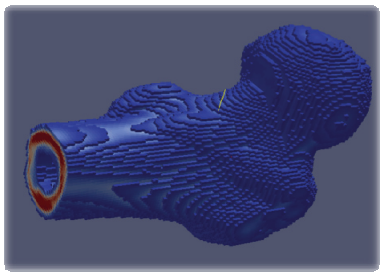


Figure 1: Sample finite element model generated from computed tomography image.

8. Please add your comments (if any):

I would like to thank JSPS and Dr. Ito for this opportunity to be able to work with one of the top researchers in my field, and at the same time, experience Japanese culture. This program has initiated a great relationship between the University of Calgary and Nagasaki University and the groundwork for future collaborations.

9. Advisor's remarks (if any):

Thanks to the JSPS summer program for the opportunity to start collaboration between the University of Calgary and Nagasaki University. Mr. Kyle Nishiyama is an enthusiastic student, and has done good work.

RESEARCH REPORT

1. Name: Madeline Rosamond (ID No.: SP10410)

2. Current affiliation: University of Waterloo

3. Research fields and specialties:

Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Dr. Naohiro Yoshida

6. Description of your current research

Agricultural runoff and wastewater effluent contribute large quantities of nitrogen (N) to water bodies of heavily populated catchments. Nitrate (NO_3^-) and ammonium (NH_4^+) are toxic to humans and wildlife at high concentration and degrade freshwater habitat by eutrophication. The microbial processes of nitrification (NH_4^+ oxidation) and denitrification (NO_3^- reduction) produce nitrous oxide (N_2O), a potent greenhouse gas that aids the destruction of stratospheric ozone[1]. The extent of diel N_2O cycling in streams and rivers across trophic gradients and the controls and limitations on N_2O concentration is currently unknown. Similarly, the dynamics of N cycling are not well understood in eutrophic water bodies with varying redox conditions and multiple microbial N transformation pathways. Natural abundance stable isotope analysis of inorganic N species ($\delta^{15}N$, $\delta^{18}O$) is a promising new tool for understanding complex N sources and processes, but research in aquatic environments is lacking.

We have quantified N_2O concentration across trophic gradients by sampling 24 streams and rivers across Southern Ontario, Canada. Streams were sampled twice per sampling date to capture changes in diel variation during the growing season. N_2O was correlated to a variety of potential abiotic and biotic controlling factors (e.g. temperature, DO, substrate concentration). Stable isotopic analysis of NH_4^+, NO_3^- and N_2O was carried out to help determine the processes responsible for N_2O production and to quantify of net isotope effects (ε) associated with N_2O production in streams. Laboratory incubations of stream sediment were conducted to determine the ^{15}N and ^{18}O isotope effects of N_2O produced by nitrification and denitrification in riverine sediment. The objective of this experiment was to quantify the effect of N_2O production rate on ε and determine if ε changes seasonally and/or spatially in the river. This information, combined with NO_3^- and NH_4^+ concentration and isotopic data collected in the field, will provide a better understanding of dynamic N cycling and N_2O production in aquatic systems. This will enable more effective management of heavily-impacted catchments and provide insight into the role of rivers in the global N cycle.

7. Research implementation and results under the program

Title of your research plan:

Diel N_2O Isotopomers in the Grand River, Ontario, Canada

Description of the research activities:

The isotope effect (ε) of N_2O production by nitrification has been shown to be distinct from that of N_2O production by denitrification in laboratory[3] and natural soils[4]. Quantification of ε requires isotopic characterization of N substrates (NH_4^+ or NO_3^-). This is difficult in running waters, where the isotopic composition of the dissolved substrate in the water column may differ from those found in the sediment. This may occur if (a) the substrate flux to sediment is diffusion-limited; (b) the isotopic composition of the substrate changes spatially or temporal scale (e.g. by addition of STP effluent, agricultural runoff); or (c) the residence times of N_2O and the substrate in the river are different.

N_2O is an asymmetric molecule with two ^{15}N isotopomers (^{15}N-^{14}N-^{16}O and ^{14}N-^{15}N-^{16}O). Toyoda *et al.*[5] showed that N_2O produced in the Tama River, Japan and N_2O produced in STPs had distinct isotopomeric signatures, which were independent of the isotope ratio of the substrate. As the former was thought to be produced by denitrification and the latter nitrification, N_2O isotopomers are a potentially valuable tool to determine pathways of N_2O production.

However, the study could not determine ε of N_2O because substrates (NH_4^+ and NO_3^-) were not isotopically characterized. N_2O emissions to the atmosphere were also not measured.

Our previous work has shown that the concentration and stable isotope ratios of dissolved N_2O can exhibit significant diel variation in rivers, despite high levels of DO. It is still unclear, however, if diel variation of $\delta^{15}N$-N_2O and $\delta^{18}O$-N_2O is a result of varying rates of N_2O production by a single microbial process (nitrification *or* denitrification), or a result of N_2O production by multiple pathways (nitrification *and* denitrification). Thus, I propose to work with Dr. Naohiro Yoshida and examine the concentration and stable isotopes of DO, NH_4^+, NO_3^- and N_2O and N_2O isotopomers on a diel scale in the Grand River, Ontario above and below a large STP outfall.

The Environmental Geochemistry Lab at University of Waterloo collected river water samples for DO, DOC, NH_4^+, NO_3^- , and N_2O concentration, stable isotopic concentration of DO, NH_4^+, NO_3^- and N_2O, and stable isotopomeric composition of N_2O at two sites on the Grand River, upstream and downstream of two large STPs, every 2 hours over 28 hours. Samples for N_2O isotopomeric analysis were shipped to the Naohiro Yoshida lab and analysed for N_2O isotopomers. All other analysis is to be conducted at the University of Waterloo. Unfortunately, a problem with the machine for preparing N_2O samples for isotopomeric analysis at U. Waterloo broke, and only the downstream site samples were processed correctly.

Quantifying the stable isotopic composition of NH_4^+, NO_3^- and N_2O will allow us to calculate N_2O isotope effects and isotopomeric values, giving us two indicators of N_2O production pathway. The gas exchange coefficient (k) will be predicted for each site using a non-steady state model[6] that correlates environmental variables with DO concentration and $\delta^{18}O$-O_2. N_2O concentration and k will be used to quantify N_2O emissions to the atmosphere.

At the time of writing, the analysis of N_2O isotopomers was not yet completed, but preliminary data seems to indicate that STP samples are isotopomerically distinct from river samples. N_2O isotopomers in river samples seem to show a small amount of diel variation, such that the fraction of N_2O produced by NO2- reduction increases at night. This suggests that NO2- reduction increases in periods of low DO because anoxic habitat for NO2- reducers in sediment is increased.

8. Please add your comments (if any):

I am very happy with the JSPS program. It was very well organized, the research was exciting and interesting, and the other JSPS fellows I met, as well as the students in my host laboratory were great. Two suggestions: to include some Japanese culture in the language classes, i.e, some of the more important social faux pas. Everyone here is very forgiving of my bad etiquette but too polite to correct me! Also, if it's possible to let the Canadians know about their acceptance earlier, it would be easier for us to schedule Japanese lessons back home, etc. I loved this program and am sad to go home – will definitely recommend it to everyone I know!

9. Advisor's remarks (if any):

It was a pleasure of me to host Ms. Madeline Rosamond who is highly motivated PhD student. She prepared research plan well and started her research smoothly among our lab members with her outgoing and personality. Her presence although short definitely influenced our lab members especially Japanese PhD students in a positive way. She has not finished all what she prepared because of short time and heat wave but I am sure she will continue collaboration with us even after she returned. This summer exchange program seems a nice mechanism to stimulate young scientists and I would like to accept more young scientists from abroad and suggest some of our Japanese PhD students to apply for this. I would like to give my sincere gratitude to those who take care of this system at JSPS. Naohiro Yoshida, a host Prof. at Tokyo Tech.

RESEARCH REPORT

1. Name: Tynan Stevens （ID No.: SP10411）

2. Current affiliation: Dalhousie University, Halifax, Canada

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Kyushu University, Fukuoka, Japan

5. Host researcher: Dr. Shozo Tobimatsu

6. Description of your current research

My current research centers around non-invasive technologies used for the detection and localization of brain function. I work primarily with functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG), developing methods for applying these technologies to diagnostic roles. The diagnosis and analysis of brain function is becoming increasingly prevalent and important in areas such as brain trauma, cancer, epilepsy, dementia, and comatose state.

My current stream of research is using MEG and fMRI to investigate the organization of brain function in individual patients prior to neurosurgical procedures. These two technologies use different physical/physiological mechanisms to measure neuronal activity, and therefore cannot be expected to convey identical information about the organization of the brain. In particular, I aim to demonstrate that there are global, regional, and functionally related differences in the reliability and accuracy of these two technologies. MEG is generally considered more sensitive to superficial activity sources, while fMRI is prone to signal loss near air-tissue boundaries. It is therefore expected that there will be brain locations for which MEG excels and areas for which fMRI is more well suited. This information may help guide the choice of technology on a case-by-case basis, or suggest adoption of a multimodal approach.

7. Research implementation and results under the program

Title of your research plan: Simultaneous Versus Independent Steady State Stimulation of the Left and Right Visual Fields.

Description of the research activities:

Background

The goal of this work was to use magnetoencephalography (MEG) to detect the brain's response to focal stimuli presented in various parts of the visual field. This work would serve as a pilot study towards developing a comprehensive automated visual field test to parallel the current clinical methods.

MEG measures brain function through the magnetic fields produced neural activity. The visual cortex of the brain contains a map of the visual field, such that stimuli which appear in at a specific location in the visual field excite a specific patch of cortex. To obtain a clear response from the cortex, many responses to the stimuli must be averaged, because of the low signal to noise inherent in the MEG method. Assessing many locations in the visual field thus takes a prohibitive amount of time.

One possible acceleration method is to use steady-state responses, where a rapid train of stimuli are presented, driving an oscillatory response at the stimulus frequency. The detection of the steady state response is faster than transient responses, because the *a priori* knowledge of the stimulus frequency allows Fourier detection. However, the required time is still too long for testing more than a few visual field locations.

This process cannot easily be accelerated by stimulating multiple locations simultaneously, because the magnetic fields summate, appearing as one large source. The proposed solution to this problem is to use unique stimulus frequencies for each location in the visual field. The response to each stimulus location can be separated by Fourier decomposition. This pilot study aimed to validate this method, by comparing the measured response spectra, and relative localization results when the left and right visual fields are stimulated by multiple frequencies simultaneously to when they are stimulated individually.

Methods

Seven volunteers were studied by MEG using both simultaneous and independent steady state stimulation of the left and right visual fields. The subjects were aged 26-43 years (mean 34), and were all right handed. Two females and five males were included in the study group. The MEG machine is an Elekta Neuromag 306 sensor (204 gradiometers and 102 magnetometers) device, used in the seated position. Visual stimuli were presented using a 100 Hz projector.

Monocular steady state stimulation was conducted using pattern reversal stimuli, at reversal rates of 14.3 Hz and 16.7 Hz. These frequencies were chosen for three reasons: to avoid alpha band contamination (8-12 Hz), to ensure that the shared harmonics were well outside the frequency range of interest (100 Hz), and because subjects did not detect a difference between these two frequencies. The pattern presented was a vertical sinusoidal grating, with a spatial frequency of 1 cpd, and an extent of 5 degrees both horizontally and vertically. The center of each stimulus was at 5 degrees eccentricity, in the parafoveal region.

To be able to distinguish biased sensitivity of the left and right visual field from biased sensitivity to one of the two stimulation frequencies, each frequency was presented both to the left and right visual field. There were therefore six conditions present (two for simultaneous stimulation, and four for independent). A static grating was presented to the non-stimulus side during the independent stimulation conditions to prevent sacades towards the alternating grating.

The stimuli were divided into three blocks, one containing both simultaneously presented stimuli pairs, one containing the 14.3 Hz left visual field and 16.7 Hz right field stimuli, and the third containing the 16.7 Hz left and 14.3 Hz right field stimuli. Each block consisted of 15 repetitions of the stimuli in that block. Each repetition lasted 9.24 seconds with approximately 1.5 seconds between repetitions, for a total block time of 5 minutes 30 seconds. Each block was repeated for the left and right eye separately. Block order and stimulus order within blocks were randomized. The sinusoidal grating was removed from the screen during the inter-stimulus interval.

To maintain subject fixation and attention, a simple fixation task was employed. A blue, red, or green fixation dot (size 1 degree) was presented at the center of the screen. Immediately following the stimulus, the dot would change color randomly. Thus two thirds of the time, on average, the new color would be different from the previous color, and the subject would respond via a button press.

The responses obtained were averaged into 1.68 second intervals. The time series data was then Fourier transformed, and the power spectra were compared to assess the linearity of the response summation between conditions. The time series data was then further averaged over 60 ms (for the 16.7 Hz stimuli) and 70 ms (for the 14.3 Hz stimuli) windows to isolate the individual frequency waveforms. The peak dipole fits (assessed by percent of the observed field explained by the single dipole) over the 60 or 70 ms signal window was extracted to analyze the localization results.

Results

The steady state response amplitude varied significantly from subject to subject. Within subjects, there was often an observed difference between the response amplitude from the left and right visual field, more so than from the two different frequencies. Responses were consistently present for 5 of 7 subjects. At the sensor level, stimulation of the left visual field caused a stronger response from the right hemisphere, and *vice versa*. This follows the known organization of the visual system, as the receptive nerve fibers from the left visual field project from the right retina to the right cortex. This pattern was observed for both the simultaneous and independent stimulation conditions. Investigation of the single dipole fits indicated that the origin of the signals from the simultaneous stimulation could be separated into left and right cortical sources. Preliminary comparisons with the dipole fits obtained from the independent and stimulation conditions indicate that the localization discrepancy is 1-2 mm for dipoles with a goodness of fit of 80 percent or more. For less good fits, dipole localization fails. A more thorough quantitative analysis will be performed.

8. Please add your comments (if any): Aspects of implementing this study presented major challenges. The stimulus programs had to be written from scratch, as presenting independent frequencies to the left and right field is a novel paradigm. After some preliminary experiments, and fine tuning of the stimulation parameters, this left little time for data collection and analysis. A sufficient amount of data was collected; however I was unable to complete my analysis, so this project will continue upon my return to Canada. I enjoyed my experience, I learned a lot, and I would consider the project a success.

RESEARCH REPORT

1. Name: Ishari Waduwara (ID No.: SP10412)

2. Current affiliation: University of Waterloo, Canada.

3. Research fields and specialties:

Biological Sciences

4. Host institution: RIKEN, Yokohama

5. Host researcher: Prof. Hitoshi Sakakibara

6. Description of your current research

Methylation reactions are critical to the regulation of numerous biological processes including epigenetic control of gene expression. The donor of methyl groups for almost all cellular methylation reactions is *S*-adenosylmethionine (SAM) which is the precursor for three key biosynthetic pathways: those producing polyamines [PAs: Spermidine (Spd), Spermine (Spm) and Thermospermine (Tspm)], nicotianamine (NA, metal chelator) and ethylene (phytohormone). Methylthioadenosine (MTA) is a common byproduct of these three pathways; it is hydrolysed by methylthioadenosine nucleosidase (MTN) to methylthioribose (MTR) and adenine.

In Arabidopsis there are 2 isoforms of MTN: AtMTN1 and At MTN2. Both *mtn1-1* and *mtn2-1* T-DNA insertion single mutants along with several other *mtn* mutant alleles appear phenotypically normal [similar to wild–type (*Wt*)] while double mutants (*mtn1-1mtn2-1*) show pleiotropic effects (Bürstenbinder et al 2010). These effects include bushy shoot architecture, short internodes, altered vascular development, auxin transport defects and sterility. In comparison to the *Wt, mtn1-1mtn2-1* mutants have increased MTA accumulation in both leaves and flowers. I hypothesize that the accumulated MTA inhibits NA and PA synthesis, resulting in growth and developmental defects of these lines. Decreases in NA production and altered PA profiles in the double mutant support this hypothesis.

Interestingly, several morphological defects that I have noticed in the *mtn* mutants have also been reported for lines deficient in Tspm (*tkv and acl5-1*) including the presence of short internodes, altered vascular development, and decreased auxin transport. Moreover, the SAM decarboxylase 4-deficient mutant (*bud2*) is short, bushy and has vascular defects in common with the *mtn* double mutant. Thus one of my goals of the experiments conducted in Japan was to determine the link between these mutant phenotypes with polyamines, auxin, and cytokinin levels.

Further, I have found that exogenous spermidine provided for *mtn1-1mtn2-1,* within a very short window of time (between 0 and 14 days after germination) affects fertility 6-8 weeks later. Thus the second goal of my Japan experiments was to determine the existing transcriptional changes between *mtn1-1mtn2-1* and Wt seedlings and which of them are sensitive to spermidine treatment.

7. Research implementation and results under the program

Title of your research plan:

Investigating links between hormone and polyamine metabolism in the model plant Arabidopsis

Description of the research activities:

Plant growth

Arabidopsis thaliana (Col) WT, *MTN1-1(+/-) MTN2-1(-/-)*, seeds were placed on 1/2MS or 1/2MS media supplemented with 100μM spermidine. Seeds of *bud2* and *tkv* mutants were placed on 1/2MS. After incubating the plates with seeds for 2 days in the 4^{o}C, the seeds were germinated on continuous light at 22 ^{o}C for 14 days. A set of these seedlings were then transplanted to peat soil (KUREHA, Tokyo, Japan) for harvesting aerial organ tissues. Another set of seedlings were transplanted to hydroponic solution for harvesting root tissues. All the transplanted seedlings were grown under 16 h light/8 h dark conditions at 90–100 μ mol m $^{-2}$ s $^{-1}$of white light.

Microarray analysis

RNA was extracted from14-day-old WT and *mtn1-1mtn2-1* seedlings grown on 1/2MS and 1/2MS supplemented with 100uM Spermidine using a RNeasy Plant Mini Kit (Qiagen, USA). Each replicate contained 10 seedlings. Microarray analysis will be performed using a ATH1 GeneChip Arabidopsis Genome array (Affymetrix, Santa Clare, CA and USA) as detailed in Nakamichi *et al* 2009. .

Hormone analysis

Wt, *mtn1-1mtn2-1*, *tkv,* and *bud2* germinated on 1/2MS and Wt, *mtn1-1mtn2-1* germinated on 1/2 MS supplemented with Spermidine were used for this experiment Samples were collected from 6 types of tissues (1. juvenile rosette leaves, 2. stems, 3. roots, 4. unopened buds, 5. stage 14 flowers and 6. stage 17b siliques) 2- weeks after bolting. Hormone extraction, detection and analysis of these tissues will be conducted as described in Kojima *et al* 2009.

Polyamine analysis

Samples were collected from all the genotypes and conditions described above under hormone analysis but from three types of tissues: 1. juvenile rosette leaves, 2. unopened buds, and 3. stage 14 flowers. Polyamine measurements will be carries out as detailed in Kamada-Nobusada *et al* 2008.

Results

The samples will be processed in the upcoming weeks and the results will be available in September 2010.

8. Please add your comments (if any): Due to an unexpected discovery, where seeds from spermidine-treated *mtn1-1mtn2-1* plants became fertile without further application of exogenous spermidine, I had to reschedule one set of experiments. As a result I was unable to obtain hormone and polyamine analysis data within the duration of the JSPS-summer program. However I have collected samples already and the hormone and polyamine analysis will be continued at the RIKEN lab under the supervision of Prof. Hitoshi Sakakibara. For microarray analysis, I have prepared RNA samples and the RIKEN microarray facility will process my samples and the raw data will be analyzed in collaboration with RIKEN.

9. Advisor's remarks (if any): Ishari Waduwara has conducted her research project soundly. As she had mentioned, spermidine-treated *mtn* double mutant became fertile. When she found the problem, she promptly discussed with her boss in Canada, and rescheduled her experiments. Finally, she successfully obtained whole set of her samples for analyses. She is so friendly and communicated well with all staff members in my lab. This greatly stimulates our staff for internationalization and understanding other cultures. I really appreciate her stay in my lab this summer. We are happy to keep in touch with her for collaboration.

RESEARCH REPORT

1. Name: Adele Wang （ID No.: SP10413）

2. Current affiliation:

University of British Columbia- Child and Family Research Institute

3. Research fields and specialties:

Biological Sciences

4. Host institution: Osaka University- Immunology Frontier Research Centre

5. Host researcher: Dr. Shimon Sakaguchi

6. Description of your current research

Breast cancer is the most common cancer affecting Canadian women; one-third of all women initially diagnosed with early stage breast cancer develop recurrent or metastatic breast cancer. Much research is focused on defining ways to improve the immune response to tumour cells since selective immune cell-mediated killing of cancer cells has the potential to be a life-long cure. For example, one approach is to vaccinate patients with cells that are designed to boost immunity to tumour-specific proteins. The challenge in the development of such cell-based cancer therapies, however, is overcoming the natural mechanisms of "immune tolerance": since tumours are derived from healthy tissues, they are normally tolerated by our immune system. A major mechanism of immune tolerance is active suppression by T regulatory (Treg) cells, and it is well established that one way tumours evade the immune system is by promoting the development of Treg cells. The development of Treg cells is linked to that of pro-inflammatory T helper 17 (Th17) cells, but it is unclear whether Th17 cells are beneficial or detrimental in the context of cancer. My current research interest is to study how cell-based tumour vaccines impact the balance of Treg versus Th17 cells. Specifically, I have developed methods to generate human dendritic cells (DCs) that have been genetically modified to present a breast cancer specific protein to the immune system. I have found that Treg cells can block the ability of these genetically-modified DCs to stimulate immune responses, indicating that this cell-to-cell interaction may limit the effectiveness of cell-based vaccines *in vivo*. On the other hand, upon interaction with genetically modified DCs, Treg cells change their ability to produce cytokines, suggesting that cell-based vaccines may turn off the suppressive function of Tregs. In order to better understand the potential for cell-based vaccines to boost effective anti-tumour immune responses, it is critical to understand the mechanistic bases for these effects.

7. Research implementation and results under the program

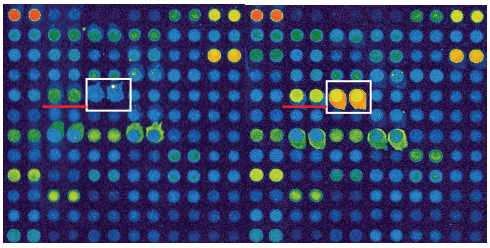
Title of your research plan:

Measuring immunological changes in vaccinated cancer patients using seromics

Description of the research activities:

Protein microarrays allow the determination of the presence and/ or the relative quantification of antibodies in biological samples such as plasma or serum. This technique is powerful in that thousands of human proteins representing many different cellular processes are deposited on a nitrocellulose-coated glass chip surface that can be used in a single assay to quantify specific recognition by antibodies in the sample. After reading arrays for intensity of antibody binding to each protein and following normalization and analyzes procedures, positive recognition of the proteins by the serum antibodies can be assessed. Therefore, analysis of series of cancer and normal sera using this method, referred as "seromics", can be used to track the antibody response of patients who are undergoing cancer immunotherapy in order to better understand the immunological response to the treatment.

A new project in Dr. Sakaguchi's lab is to investigate how patients respond to a particular cancer immunotherapy by examining antibodies from their sera using seromics. Cancer patients were vaccinated with a protein that is expressed in many tumours and in male germ cells, but is silent in other normal tissues. Sera from pre- and post-vaccination were collected and examined for the type of antibodies developed. Heat map colour scheme is used to quantify the amount of antibodies present in the sera where red means the highest level and blue is the minimum. Indeed sera of patients tested positive for the vaccine protein by producing the corresponding antibody after immunization **(Figure 1A)**.



Prestudy 12 weeks after immunization

Figure 1. A) Before vaccination, the patient had no antibody response towards the vaccinated protein (blue- white box). After immunization, the patient developed very high amount of antibody towards the vaccinated protein (orange- white box). **B)** Antibody towards another protein other than the one vaccinated was detected post-immunization (red line).

Interestingly, there were other antibodies that appeared to be specifically detected on the microarray in post-vaccine samples **(Figure 1B)**. This phenomenon could mean that antigen spreading has occurred; since the immune system has recognized the vaccine protein, the resultant antibody may indicate that an immune response has now contributed to the destruction of tumour cells. In that aspect, more tumour proteins will be exposed and the immune system can now make other antibodies to help with the tumour eradication. However, it is still unclear whether vaccine-related antigen spreading has really occurred or whether occurrence of new seroreactivity is just due to other natural concomitant induction of immune responses in the host, or even to non-specific cross reactivity of antibodies in the sera. Additional confirmation of specificity by ELISA and of antigen expression in the tumor by RT-PCR or immunohistochemistry is warranted. Correlation of the type of antigens identified in seromics with the clinical responses of patients to vaccination may eventually highlight proteins important for effective anti-tumor immune responses but also for overcoming immune tolerance.

The identification of other tumour proteins after vaccination could lead researchers to novel therapeutic targets. At the same time it is possible to use the reactivity to identified proteins to screen patients before vaccination and determine if a particular cancer immunotherapy will benefit them. Since we have pre- and post-vaccination sera from the patients, we can establish the profile of patients who are likely to respond to the cancer immunotherapy. Moreover, as mentioned above, the presence of Treg cells is a major barrier to successful immunotherapy. It would be interesting to examine the antibody profile of the patients who have undergone the administration of Treg depleting agent before the cancer immunotherapy and see if their immune response has been enhanced.

8. Please add your comments (if any):

Due to the confidential nature of this research and to the international distribution of this report in the JSPS booklet and on the JSPS website, I chose not to include details regarding the results from the experiments successfully conducted during my summer internship.

RESEARCH REPORT

1. Name: Gregory L. West （ID No.: SP10414 ）

2. Current affiliation: University of Toronto

3. Research fields and specialties:

Social Sciences, Biological Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Kazuhiko Yokosawa

6. Description of your current research

The following outlines my current research programs in progress:

1) Linking the perceptual prioritization of motivationally significant stimuli with motor action modulation. The notion of whether motivationally significant stimuli (e.g., a fearful face acting as a social signal of threat) are reflexively prioritized by the perceptual system has been a source of contention in the literature for some time. Using a novel psychophysical paradigm, my work has shown that the perceptual representation of a motivationally significant stimulus is actually accelerated in time relative to concurrent neutral stimuli directly competing for awareness. Further to this, my more recent work has demonstrated that this accelerated prioritization is driven by coarse low spatial frequency stimulus representations along the evolutionarily older magnocellular retinal pathway that is specialized for location and action. These data are the first to suggest a link between known perceptual biases for motivationally significant stimuli and action system modulation, a notion that has been suggested since the writings of Darwin yet has had little empirical support.

2) Behavioural evidence for the online control of saccadic eye movements. Saccadic eye movements have been thought to be ballistic in nature and mostly pre-programmed (i.e., no online corrections during the actual eye movement). Through using detailed measurement and analysis techniques initially developed in the limb movement literature, my work provides conclusive behavioural evidence that saccades do, in fact, receive online correction during the actual eye movement; significantly contributing to its target accuracy. This work extends behavioural evidence to some very recent findings identifying neural mechanisms responsible for this putative online feedback system. Using this developed technique, I have continued to explore the relationship between prioritized perceptual representations and the modulation of oculomotor action.

3) Identifying the effects of action video game playing on attentional deployment and motor action. Visuospatial experience obtained through action video game playing has previously been shown to modulate certain attentional processes, however, the time course of these events remain unclear. Using signal detection methods, my work has demonstrated that prolonged experience with action video game play modulates the earliest stage of attentional deployment; implying consequences associated with video game playing could exist at each subsequent stage of visual processing, possibly leading to changes in higher order cognitive processes. More recently, we have obtained data showing a direct link between action video game playing and oculomotor action; demonstrating that this experience greatly improves the system's ability to inhibit competing motor programs generated by distracting visual stimuli in favour of those contributing to the goal directed eye movement. As this lack of inhibition is strongly linked with cognitive decline associated with aging, this work presents possible avenues linking with applied rehabilitative and gerontological settings.

7. Research implementation and results under the program

Title of your research plan: Does emotion differentially affect magnocellular-action and parvocellular-spatial vision?

Description of the research activities: The human visual system is constantly bombarded with more information than it can possibly process at one time. Because of this, when multiple stimuli are concurrently displayed in the visual field they must compete for neural representation at the processing expense of their contemporaries. My previous work has demonstrated that social signals of environmental threat (e.g., a facial display of fear) "win" this competition for perceptual representation when directly competing against non-affective stimuli. In other words, the perception of a stimulus that has motivational significance to an organism is accelerated in time compared to contemporaneously displayed visual information. This raises the questions as to why, with the brain's limited neural resources, this prioritization of affective information occurs. One long existing proposal from evolutionary theory is that this process allows for the subsequent preparation and modulation of motor action. This coupled with our recent finding that affective information is initially prioritized along the magnocellular retinal pathway specialized for location and action has directed my current work to investigate a direct modulatory link between affective encoding and motor action.

If emotion is prioritized along the magnocellular pathway, it might have a differential effect on temporaland spatial measures of visual processing. We hypothesize that a magnocellular prioritization would result in a facilitation of the temporal resolution of the visual system. We tested this using a spatial and temporal discrimination task where participants will judge either aspatial or temporal gap, and report whether the gap is large/long or small/short (see Figure 1).

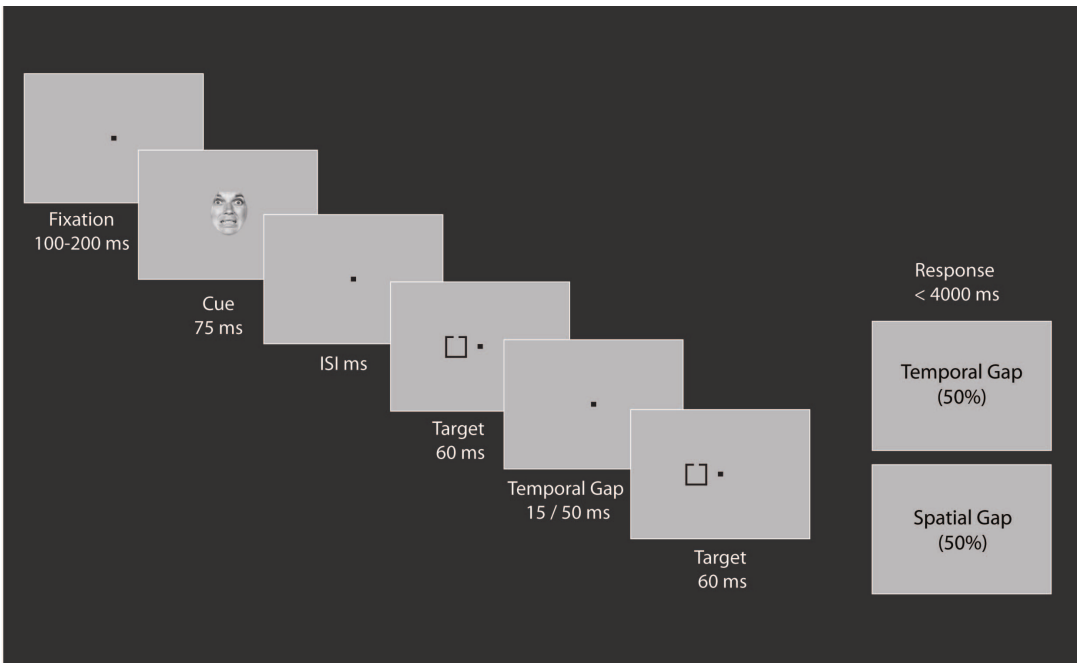


Figure 1. Participants were passively exposed to either an emotional or neutral face. A square with a large or small spatial gap was presented twice, separated by either a long or small temporal gap; thus creating a temporal and spatial component to the task. On half the trials participants reported whether the spatial gap was large/small, and on the other half they reported whether the temporal gap was short/long.

Our initial results suggest that emotion in fact had no differential effect on parvocellular and magnocellular processes. This is surprising given previous empirical evidence for emotion's privileged prioritization along magnocellular inputs (e.g., West, Anderson, Bedwell, & Pratt, 2010; *Psychological Science*). We at the University of Tokyo have therefore designed two follow up experiments to be conducted at the University of Toronto in the fall. The first will repeat our initial design with a longer exposure of the emotional stimulus as it was very brief in our initial design and may not have been salient enough to affect the subsequent task. The second experiment will include a step-function that will adjust task difficulty (i.e., the size of the spatial gap, and the size of the temporal gap) in response to online participant performance to keep performance constant 70%. This will allow for a more sensitive measure of the effect of emotion on task performance as ceiling and floor effects would be controlled for. Cross cultural comparisons will also be made between Japanese and Canadian participants while controlling for age and years of received education.

8. Please add your comments (if any):

I would like to thank all of the members of the High-Level Vision Lab at the University of Tokyo for their many helpful insights and warm hospitality. I would like to especially thank Yokosawa-sensei for his patience and great insights into our collaboration together. It is my hope that more collaborations will result from my time here at Todai.

RESEARCH REPORT

1. Name: Dong Yang (ID No.: SP10416)

2. Current affiliation: McMaster University, Canada

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Osaka University

5. Host researcher: Dr. Masayuki Matsumoto

6. Description of your current research

All-optical signal regenerators, as a critical component in the fiber-optic communication system, have been extensively studied. It has been demonstrated that the all-optical amplitude limiter utilizing the saturation of four-wave mixing (FWM) in a highly nonlinear fiber can effectively suppress the amplitude fluctuation without losing the phase information, and therefore the nonlinear phase noise originating from the amplitude noise can be reduced. The effectiveness of optical amplitude limiter has been demonstrated for phase-shift keying (PSK) based systems. But, in many applications, the signals with amplitude modulation and phase modulation are multiplexed simultaneously. Therefore, it is necessary to study the effectiveness of optical amplitude limiter for the amplitude/phase-modulation multiplexed signals. In current research, we are experimentally investigating its effectiveness for time-division multiplexed on-off keying (OOK) and differential phase shift keying (DPSK) signals. First, the transfer function of the limiter is obtained. Second, the system scheme for DPSK signal only with limiter, transmission link and densely dispersion-managed fiber (DDMF) is studied. Finally, the system scheme for the multiplexed OOK and DPSK with limiter is investigated.

7. Research implementation and results under the program

Title of your research plan:

Investigation of the effectiveness of the all-optical limiter for multiplexed OOK and DPSK signals.

Description of the research activities:

1. Test the limiter and obtain its transfer function.

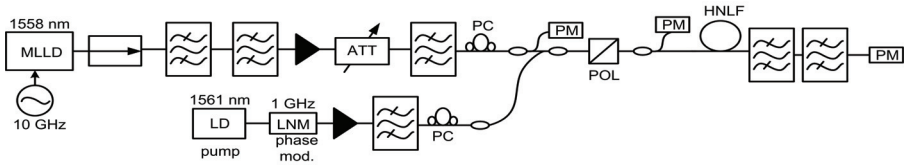


Fig. 1 Experimental setup for the FWM-based amplitude limiter.

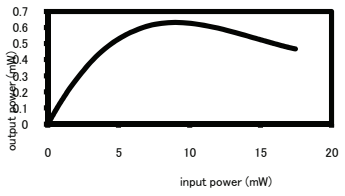


Fig. 2 Power transfer function of limiter.

Signal pulses with duration 1.5 ps are generated by a mode-locked laser diode (MLLD). The spectrum of the signal is narrowed by two detuned cascaded bandpass filters, and the resulting pulse width is around 6.7 ps. The pump laser operates at 1561 nm, and the power is set to 35 mW. In Fig. 2, it is shown that when the input power reaches 8mW, the limiter outputs the saturation power, about 0.63 mW.

2. Experiment of DPSK with all-optical amplitude limiter. The single-mode fiber (SMF) and dispersion compensating fiber (DCF), and DDMF are inserted before and after the limiter.

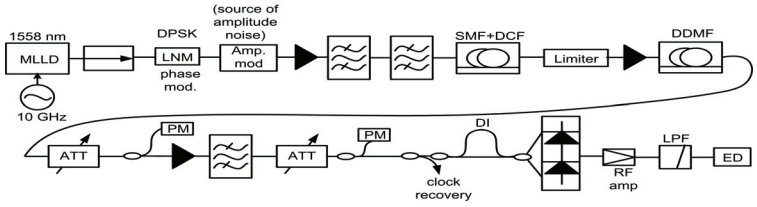


Fig. 3 Experimental setup for DPSK with limiter and transmission links.

In Fig. 3, the SMF and DDMF are of the length of 50 km and 40 km, respectively. DDMF is used to increase the self-phase modulation (SPM) leading to significant nonlinear phase noise. We have found that when the limiter is inserted after the transmission link (SMF+DCF), the bit error rate (BER) can be greatly decreased.

3. Experiment of multiplexed OOK and DPSK with all-optical amplitude limiter

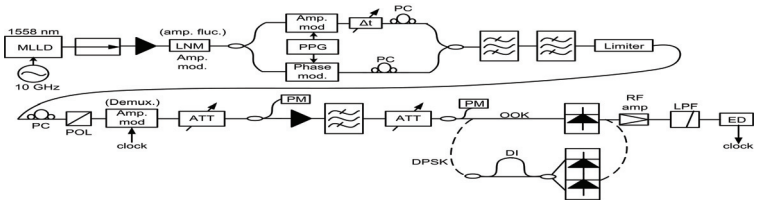
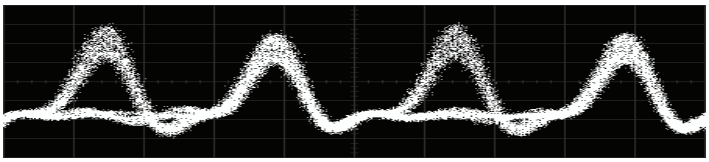


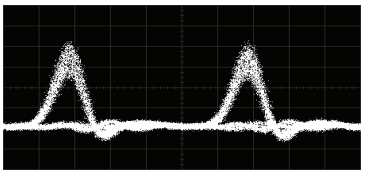
Fig. 4 Experimental setup for multiplexed OOK and DPSK with limiter.

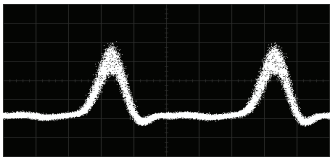
In Fig. 4, the first amplitude modulator before the multiplexer is used to intentionally fluctuate the amplitude of optical pulses. The second amplitude modulator before receiver is used to de-multiplex the multiplexed OOK and DPSK signals by tuning the phase shifter.

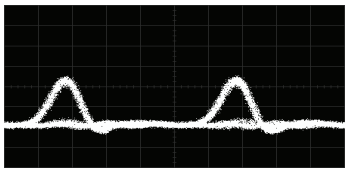
Input optical eye patterns (OOK+ DPSK)

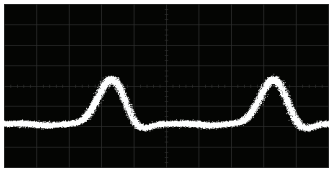


The following output optical eye patterns, observed after the de-multiplexer, demonstrate the amplitude noise reduction when the amplitude limiter is inserted. Left/Right-hand side (OOK/DPSK): with limiter pump off (top), and with limiter pump on (bottom). The horizontal axis indicates the varying of time, at the scale of 20 ps/div.









4. Summary

We have shown that the amplitude limiter can effectively suppress the nonlinear phase noise by reducing the amplitude fluctuation for DPSK signal. The reduction of amplitude noise using the optical amplitude limiter for time-division multiplexed OOK and DPSK signals has also been observed in optical eye patterns.

8. Please add your comments (if any): Very enjoy the research experience with my host research and his students. Sincerely thank all of you for everything. Hope to see you again.

9. Advisor's remarks (if any): Dong devoted himself to the experiment. We will continue the study and will publish the results as conference and journal papers.

RESEARCH REPORT

1. Name: Denise Brooks （ID No.: SP10417）

2. Current affiliation: University of British Columbia, Vancouver, Canada

3. Research fields and specialties:

Biological Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Lian

6. Description of your current research

My research has focused on connecting the functions of microbial communities to their functions in the environment adding to a considerable research effort that has been directed toward characterizing the distribution and function of microbial populations in soil. Given that soil microbes are responsible for 80 to 90% of the reactions that drive soil processes, are tightly coupled with plant physiology and productivity, and are sensitive and not highly resilient to disturbance, an understanding of the factors that structure microbial communities is essential in order to predict the effects that changes in land use or induced by climate change may have on future land productivity. For example, in temperate forests, trees form symbiotic associations with fungi on their roots; the majority being an ectomycorrhizal alliance. Ectomycorrhizal fungi secrete phosphatase enzymes which mobilize phosphorus from soil organic matter to their host. Soil bacteria also contribute to phosphorus mobilization through phosphatase release. I used molecular methods and enzyme assays, and developed new techniques to characterize the bacterial and ectomycorrhizal fungal contributions to phosphatase activities in soils of Douglas Fir (*Pseudotsuga menziesii*) forests regenerating after stand-replacing wildfire or from clearcut logging followed by broadcast burning.

7. Research implementation and results under the program

Title of your research plan:

Molecular analysis of bacterial isolates associated with the roots of Togasawara (*Pseudotsuga japonica*) and co-occurring tree species colonized by ectomycorrhizal fungi

Description of the research activities:

Togasawara (*Pseudotsuga japonica* aka Japanese Douglas-fir) is facing a high risk of extinction in the wild. Because ectomycorrhizal fungi (ECM) are critical to the success of *Pseudotsuga*, there has been an ongoing effort to characterize the bacterial communities associated with these fungi. Recent work has shown that the ECM communities of *P. japonica* are similar to those of coexisting conifers but clearly different from coexisting broadleaf trees, indicating some ecological and evolutional effects in structuring ECM fungal communities. By identifying the bacterial communities associated with *P. japonica* and comparing these communities to those of North American Pseudotsuga species, it may be possible to quantify the effects of ecological factors compared to evolutional or biogeographical factors in structuring the microbial communities that influence tree survival

Seedlings were collected from a natural stand of *Pseudotsuga Japonica* located in Nara prefecture, Japan. Fifty seedlings were harvested for analysis of bacteria associated with ectomycorrhizal root tips. Naturally regenerating seedlings of four tree genera were collected: 12 *Abies*, 14 *Pseudotsuga*, 12 *Quercus*, and 12 *Tsuga*. Bacteria were isolated from cleaned ectomycorrhizal root tips and identified by rDNA sequencing following a modification of the method developed by Tanaka and Nara (2009). The method developed by Tanaka and Nara selected for free-living rhizobium, a functionally important group of bacteria, using a series of molecular methods. In this study, I tested the effectiveness of selecting bacterial colonies based on their morphology to select for rhizobium bacteria.

Most of the bacteria cultured from the cleaned mycorrhizal root tips had colony morphologies very similar to the expected morphology of rhizobium, but preliminary genetic analysis of these colonies indicated that at least 95% were *Burkholderia* rather than rhizobium. Mycorrhizal root tips of *Pseudotsuga* and *Abies* seedlings harboured the most bacteria, while root tips of *Quercus* and*Tsuga* harboured significantly fewer. No difference was found in the relative abundance of *Burkholderia* among the four seedling genera. However, further work is needed to sequence additional genes in order to evaluate more fine-scale structuring of the *Burkholderia* population. While bacterial isolation can be labour-intensive, this technique can provide essential information regarding the distribution and potential functions of specific bacteria in the environment that is essential for ecologically meaningful conclusions to be drawn from data generated by high throughput sequencing methods.

8. Please add your comments (if any):

I am immensely grateful for the professional and unfailingly kind support of Dr. Nara and Dr. Tanaka. This project would have been impossible without their hard work and guidance. I am also deeply indebted to Dr. Lian for sponsoring me and to everyone in the research groups of Dr. Lian and Dr. Nara who have been so incredibly patient in answering all my questions. Everyone has gone to amazing lengths to help me with everything I've needed during my stay in Japan. Even though I know that I have troubled everyone, I have felt very welcome. I hope that we will continue to collaborate and that I will have the opportunity to lend my support to everyone here in the future.