RESEARCH REPORT

1. Name: Paul Agron (ID No.: SP04001)

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

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ■ **Engineering Sciences** ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: SONY CSL

5. Host researcher: Frank Nielson

6. Description of your current research

Our initial intent was to build on the results published by Kurt W. Fleischer and Alan Barr on cellular texture generation. However, while in contact for several months prior to the start of the summer program, Dr. Nielson and I decided that our interests coincide more closely in the area of graph drawing than they do in cellular textures.

The focus of our research this summer was finding ways to take advantage of graphics capabilities of today's computers to render combinatorial graphs. Traditionally the problem of graph drawing is approached from the standpoint of combinatorial and numerical optimization. Typically a number of aesthetic criteria are proposed and methods are given to optimize a drawing according to the criteria. In contrast, it was our intent to emphasize the human perception and the computer graphics aspects of graph drawing. We hope to show that readability of a graph can be improved through interactive browsing process and on-the-fly animation. Instead of attempting to display a large number of nodes and edges all at the same time our methods are designed for viewing parts of a graph at a time where a reasonable upper bound on the number of "features" can be presumed. For a focus+context effects our algorithm can be further extended with the level of detail (LOD) ideas.

To constrain the problem we chose to attack a specific class of graphs: the directed acyclic graphs (DAGs). Our method draws on the vast amount of material in the field of graph drawing such as: focus+context paradigm, semantic lenses, and the force directed methods. Our approach uses combinatorial methods in conjunction with numerical techniques. Specifically positions of the nodes are computed in 3D using a layering scheme. The nodes are treated as source of electric potential and the edges are treated as deformable wires which respond to the field generated by the nodes. This way we avoid edges running into nodes. In three dimensions we can avoid edge crossings as well by assigning potential to edges.

The layering scheme is based on a topological sorting of a digraph. Each node is assigned to a layer based on its shortest distance from the root (other clustering schemes are possible). Nodes within each layer are arranged in a circle with the radius proportional to node-size of the layer. Layers are then arranged coaxially on a line. The layering scheme provides a user with a global mental map of the whole graph, while a user is intended to browse the structure in parts.

To simulate the physics behind the edges we employ a mass-spring model. An edge is represented as a chain of linear segments with a given rest length. The segments are treated as linear springs and the joints are treated as mass particles. In addition we assign angular springs to the joints. This augmentation enables us to minimize total curvature of an edge. Within the duration of the fellowship we reviewed much literature and publications on graph drawing, specifically the force directed methods, and deformable models. In the future we hope address the labeling problem as well. At the present a node is depicted as a sphere (a dot). For a number of real-world depictions of graphs labels are essential. A selective labeling paradigm would fit well with our methods. We also hope to investigate the possibility of improving the readability of graphs by making use of the information about the projection.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Interactive graph drawing and the force directed methods

Description of the research activities:

I built an implementation that enabled us to experiment with our ideas. I educated myself with the state of the art, which enabled me to produce much within the short period of the fellowship. Specifically I familiarized myself with Cocoa API and the Objective-C programming languages. Issues related to realtime animation and concurrency had to be addressed as well. I evaluated a number of conference articles to support the research. At the conclusion of my term I presented the work to the fellow scientists and the lab administration.

RESEARCH REPORT

1. Name: Donde R Anderson (ID No.: SP04002)

2. Current affiliation: California Institute of Technology

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

X Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

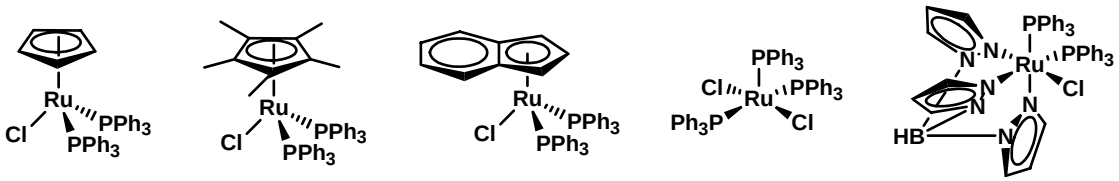
4. Host institution: Kyoto University, Graduate School of Engineering

5. Host researcher: Professor Mitsuo Sawamoto

6. Description of your current research

Radical polymerization is one of the leading industrial methods for polymer synthesis primarily because of its high tolerance of protic and polar compounds and its high reaction rate. In the 1990s, many researchers targeted the development of a new type of radical polymerization, living radical polymerization, in which polymer molecular weight can be controlled through initiator concentration and in which the distribution of molecular weights is narrow.

In 1995, Sawamoto and co-workers reported the first metal-catalyzed living radical polymerization of methyl methacrylate utilizing catalyst **4** (Figure 1). Over the last decade, they have demonstrated the use of several ruthenium-based catalysts for the living radical polymerization of monomers such as styrene and methyl acrylate. Control of polymer molecular weight and molecular weight distribution combined with the high functional group tolerance of radical polymerization has enabled the exploration of more complex types of polymer structures, including end-functionalized polymers, star polymers, and block copolymers.



1 **2** **3** **4** **5**

Figure 1. Ruthenium-based catalysts for living radical polymerization.

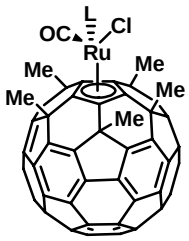
Although compounds **1**-**5** have been shown to successfully catalyze living radical polymerization, the activity of these catalysts remains low in comparison with other types of radical polymerization. Consequently, an important goal is the discovery of catalysts with higher polymerization activity. We aimed to achieve this goal by altering the catalyst ligand sphere.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

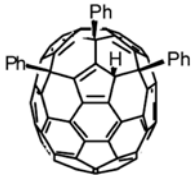
Title of your research plan: Synthesis of New Ruthenium-Based Catalysts for Living Radical Polymerization

Description of the research activities:

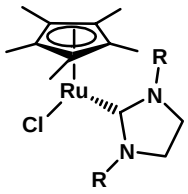
My research activities in the Sawamoto laboratory centered on learning more about living radical polymerization through organometallic and polymer synthesis. This summer, I evaluated the activity of catalysts **6a** and **6b** for the Kharasch addition reaction (analogous to the initiation step of living radical polymerization) and made progress toward the synthesis of catalysts **7a** and **7b**. Both families of catalysts were hypothesized to be more electron-rich than previously utilized catalysts and thus expected to exhibit higher activity. Unfortunately, catalysts **6a** and **6b** were found to be inactive for the Kharasch addition reaction between CCl_4 and methyl methacrylate, even in the presence of additives. These results may in part be due to the poor solubility of catalysts **6a** and **6b** in organic solvents, even at higher temperatures, and to the steric bulk of the five methyl groups near the ruthenium center. In the latter case, further work with indenyl-type ligand **7** may lead to a more open ligand sphere and enable more successful catalytic properties.



L = CO, **6a**
PEt_3, **6b**



7



R = , **8a**

, **8b**

Synthetic efforts were also made toward the synthesis of catalyst **8a** and **8b**. The N-heterocyclic carbene ligand on catalyst **8a** was not commercially available; my

attempts to synthesize this ligand were moderately successfully although purification was difficult due to the hydroscopic nature of its precursor. Both catalysts **8a** and **8b** are literature precedented, however, the techniques previously described required equipment not readily available. I attempted to synthesize **8a** and **8b** utilizing different synthetic strategies; although I acquired ^{1}H NMR evidence for both catalysts, purification was difficult and not achieved.

8. Please add your comments (if any):

I've had a fantastic experience in Japan from start to finish. Although I was apprehensive at first about not speaking any Japanese, my co-workers and I were able to communicate very well. They spoke great English and also taught me some useful Japanese phrases! I really enjoyed getting to know the students. They were very friendly and we often socialized outside of work; they treated me like a true member of the lab. Because of their friendliness, I have gained a sense of Japanese culture even though my stay has been short. Although there was not enough time to achieve the research results that I originally desired, I know that I have gained much more important experiences from day to day conversations with my labmates. I look forward to meeting them again in the future!

RESEARCH REPORT

1. Name:Christopher P. Arthur (ID No.: SP04003)

2. Current affiliation:

The University of Colorado at Boulder

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences

□ Chemistry Engineering Sciences X Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. Host institution:

Kyoto University

5. Host researcher:

Dr. Yoshinori Fujiyoshi

6. Description of your current research

I am currently studying the structure of the small synapses of the brain using a combination of electron tomography, electron crystallography, and x-ray crystallography. In particular I am interested in vessicle recycling and the proteins which facilitate this recycling.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Effects of electron dose on protein structure and 3-D single particle image reconstruction using electron microscopy.

Description of the research activities:

The field of electron crystallography is hampered in its abilities to achieve higher resolution three dimensional reconstructions by the problem of radiation damage caused by electron dosage in the microscope. A solution to this would seem to be simply to lower the number of electrons with which you acquire an image of your

sample. Lowering the number of electrons also lowers the image contrast which plays a vital role in 3-D image reconstruction. Another idea would be to spread out the number of electrons with which you acquire one image, over multiple images, then recombine all of the images into one image. This was the focus of my research in Japan. I used cryo-electron microscopy at liquid helium temperatures to see if it was possible to reduce radiation damage and thus increase the resolution of 3-D image reconstruction by taking multiple exposures of the same protein at much lower electron doses and recombining these images into one image for reconstruction image processing. I am currently processing the large amount of data which I was able to collect while in Japan.

8. Please add your comments (if any):

The EAPSI program was outstanding. My host researchers were very receptive to interaction and had a lot of input into my work while there. Everyone with whom I interacted was extremely nice and helpful. The JSPS did an outstanding job of organizing things for us. It was one of the best experiences I have ever had.

RESEARCH REPORT

1. Name: Matthew G. Averill (ID No.: SP04004)

2. Current affiliation: University of Texas at El Paso

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo Hongo Campus

5. Host researcher: Dr. Hiroshi Sato

6. Description of your current research

My current research involves three different aspects, one of which I have been working on while at the University of Tokyo. This research include studying the structure of the crust in the southern Rio Grande Rift of southern New Mexico and Far West Texas, working on computer codes for seismic tomography to model the velocity structure of the crust, and processing seismic data from the Tokai Region of Japan to determine the crustal structure related to subduction of the Philippine sea plate.

The first has consisted of setting up and implementing a large seismic experiment in Southern New Mexico and Far West Texas across the city of El Paso. This included surveying locations and organizing students for deployment of seismic instruments and helping set up explosive sources for the experiment. I have subsequently been processing this data using techniques to determine properties of the earth's crust in that field area.

The second aspect consists of working on the tomographic modeling technique for seismic refraction data. With the help of a computer science professor at the University of Texas at El Paso, I am trying to improve the code for modeling crustal seismic velocity structures determined from seismic experiments. We hope to be able to improve our ability to constrain information put into the program, increase the number of data that can be used in the program and better determine the resolution of the results for the modeling program.

The last aspect includes the work I have been doing in this program while in Japan. My advisor and the University of Texas at El Paso collaborated with Dr. Sato at the Earthquake Research Institute to perform and experiment in 2002. This experiment was designed to acquire seismic refraction data across the Tokai region of Japan as well as a small section of seismic reflection data along the profile. The entire profile has been studied and a paper discussing the results of modeling the velocity structure determined from the refraction data has already been published. However, the reflection seismic data has yet to be formally processed and discussed in its geologic context. Therefore, it was suggested by Dr. Sato that I work with this data set and produce a paper discussing the geologic interpretation of the seismic reflection data. Ultimately, we hope that these results will help us learn more about the crustal structure in active tectonic collision zones. I will be trying to make comparisons between these results and others obtained both in different areas of Japan and in different areas of the world.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Deep Crustal Structure Of The Tokai Region, Interpreted From Low-Fold, Near-Vertical Reflection Seismic Data.

Description of the research activities:

My research activities at the Earthquake Research Institute (ERI) at the University of Tokyo were pretty straightforward. I first acquired seismic data from a colleague in the institute. I used my computer to log into the computer system for the Institute in order to work with seismic data processing software, called PROMAX, designed by Landmark. The data required some reformatting and then I began applying some seismic data processing routines to enhance the data quality. Data processing generally involves substantial time to test different data parameters to see which work the best.

In addition to processing the data, I obtained travel-time data collected by picking times from arrivals of reflected/refracted energy in the seismic data. Using this data, I worked on setting up a tomographic modeling program that will help determine the velocity structure for the earth's crust along this profile. I will then use this velocity model to further process the reflection seismic data.

Additional research at this institute has involved obtaining geologic and geophysical references for this study area in Japan. ERI has an extensive library, which allows me to obtain papers discussing the tectonics and geology of Japan. I will take these with me to help produce a paper on the results of my research.

While this research requires more time then I had here to obtain full results I have set up the data to continue work when I return to my home university. I will continue to process the data and collaborate with Dr. Sato to develop a geologic interpretation for the results. It is our goal to produce a professional paper based on this research to submit by this coming December.

In addition to collaboration on this current research, I also had the opportunity to discuss my other research and possible future collaboration with Dr. Sato. My research here has hopefully opened avenues for additional collaboration between my department at UTEP and ERI.

8. Please add your comments (if any):

This was an amazing experience that I know will have long term effects on both my career and my life. It was interesting to see the different lifestyles and work habits between our cultures. Research in my department back home is very different from the research style here. It is a much more independent system here.

The amount of time allotted for this program is a bit awkward. In a two-month period we have enough time to many things and experience the culture, but not enough time to settle into it. Just when I got over the feeling that I was a visitor and got accustomed to working here, it is now time to leave. Although work habits are very different and I am not generally accustomed to living in a big city and working late hours, I think it would be nice to spend a more substantial amount of time here in order to become more settled in.

RESEARCH REPORT

1. Name: Christopher Bailey (ID No.: SP04005)

2. Current affiliation: University of Rochester

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry X Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Daigaku (University of Tokyo)

5. Host researcher:Dr. Masao Washizu

6. Description of your current research See attached.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:The investigation of inchworm motion at small volumes.

Description of the research activities:See attached.

8. Please add your comments (if any):None.

鷲津研究室報告会資料

Final Summer Report　(8/22/04)

The Investigation of Inchworm Motion at Small Dimensions

Bailey, Christopher G.

INTRODUCTION

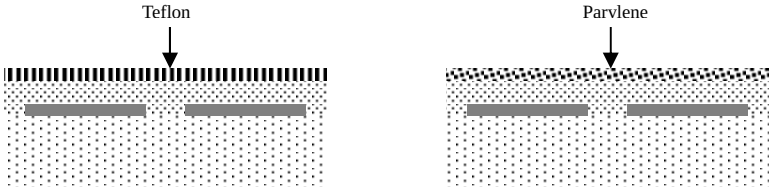
The lower limits of pipette dispensing volumes can be surpassed using what is called DEP, or Dielectrophoresis.　These devices can distribute droplets on the range of tens of pico-liters (Jones et. al.).

Masahide Gunji has developed an inchworm liquid actuation (not DEP) device for the manipulation of liquid which has yet to be tested in this range of droplet sizes.　It is of interest to find out the scalability range of this phenomenon.

An experiment is presented combining the small-volume capabilities of a liquid-DEP actuation device and the inchworm device.　This concept enables small-volume droplets (~1 nl) to be tested under the inchworm experimental conditions.

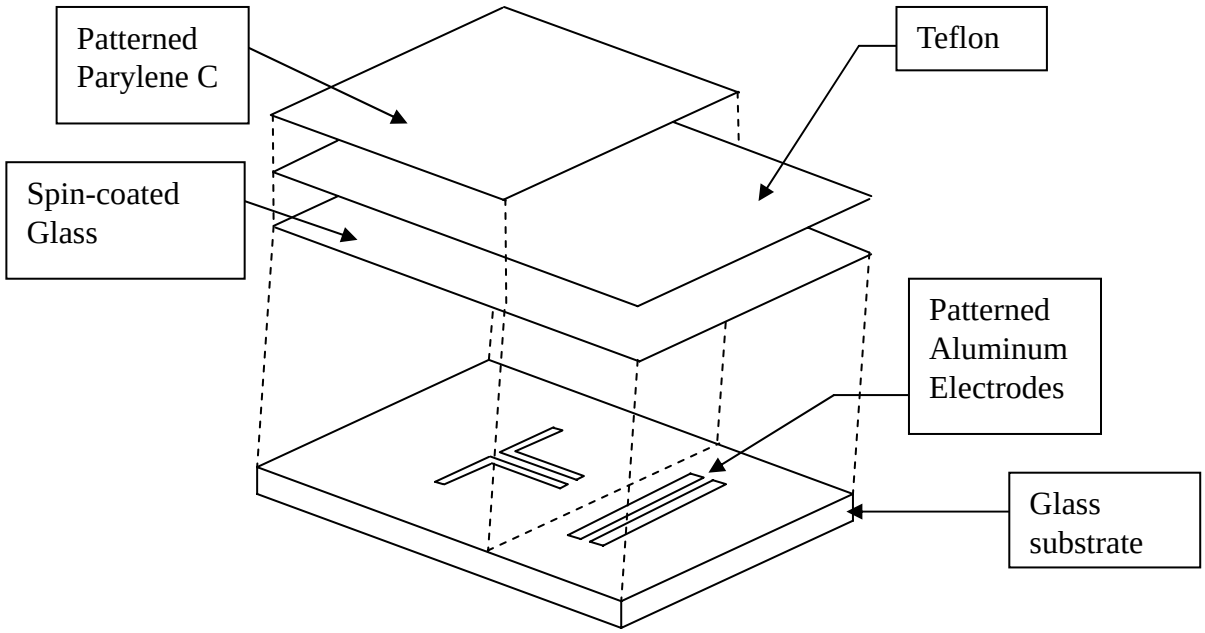
DEVICE DETAILS

In order to combine said experiments, the two devices must be fabricated on the same substrate. Samples were fabricated with both experiments' needs in mind. This is fairly simple since most of the fabrication steps are the same. However, the final fabrication step must be different due to actuation requirements with regard to hydrophobicity:



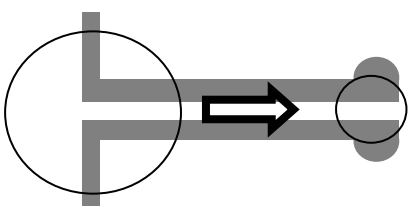
Inchworm DEP

An obvious solution to this dual-requirement is to pattern the final layer. Below is the layering schematic for device:



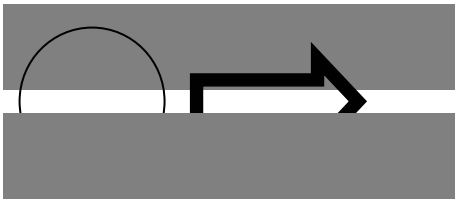
EXPERIMENTAL DETAILS & PROGRESS

DEP will be actuated first using ~300 VAC and 100kHz dispensing approximately 1 nl of liquid. On the left is a schematic of the device operation. On the right is a picture of this stage of the device.



Upon completion of the first stage of this two-stage experiment, the teflon-exposed side of the substrate was then utilized. The method of transport across the substrate to the inchworm device is air. It was observed, however, that upon crossing the interface of the two surfaces, the liquid became wetted. Teflon does not typically support aqueous wetting. This observation has led to the hypothesis that the patterning of the parylene had caused some surface damage to the exposed teflon. In order to continue pursuing our goal, the immediate solution was to fabricate teflon-only samples and attempt to create the smaller droplets unconventionally (either using air power or mechanical separation). This unconventional droplet formation was successful and temporarily served our needs.

Actuation of the inchworm device at these small volumes was observed. Based on theoretical frequency, the experiment was carried out under incorrect conditions. Tested was the range of 100 to 1000 Hz. The theoretical frequency is calculated to be 2 kHz based on device dimensions. Promising results were gathered at these incorrect frequencies. The droplet was observed to oscillate on the electrodes. Below is a schematic on the left, and a photo image on the right.



FUTURE

1. Pursuing the goal, we will soon use purely teflon-coated samples to test for the correct theoretical frequency of the inchworm device at these scales.
2. Also, the combination of the two structures is important if we are to obtain the capability of the automation and sequencing of these two devices.
3. The idea of a layer that can serve both devices' purposes is another important concept that deserves more research. There is the possiblity of mixing a substance with Teflon to lower its interfacial energy into a range suitable for both devices.

RESEARCH REPORT

1. Name: Jack Baker (ID No.: SP04006)

2. Current affiliation: Ph.D. student in Civil and Environmental Engineering, Stanford University

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry X **Engineering Sciences** ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Nagoya University

5. Host researcher: Yasuhiro Mori, Associate Professor, Department of Architecture

6. Description of your current research

Among the goals of Performance-Based Earthquake Engineering is estimation of the demand on a structure from a given earthquake. This is often done by calculating an "Intensity Measure" (IM) for a given earthquake ground motion, and then computing the probability that the earthquake will cause a given level of demand in the structure as a function of this IM. Traditional IMs (e.g., peak ground acceleration and spectral acceleration at the first-mode period of vibration) consist of a single parameter. In contrast, vector-valued IMs consist of two (or more) parameters. These vector-valued IMs have the potential to reduce the variability in structural response predictions, leading to more efficient estimation of demand (i.e., a reduction in the number of analyses needed).

My work consists of further development of this intensity measure framework, as well as identification of the best descriptors of earthquakes to use as intensity measures. My Japanese host uses a slightly different framework, although the two are similar enough that useful comparisons can be drawn between them.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Investigation of measures of earthquake intensity.

Description of the research activities:

I came to Japan to re-start a previous collaboration between my American advisor and my Japanese host. They had worked together a few years ago on a joint project, and had each followed up on separate parts of this research. We began the summer by holding a series of meetings where we presented our research to each other, and spend time discussing and asking questions. After a few weeks, my host noticed a problem that we had discovered in my previous research. I realized that a complication in current US evaluation procedures existed, and my Japanese host thought that perhaps his version of the procedure would correct the problem. We spent some time analyzing our previous data, and preliminary results show that his procedure solves an additional problem that he had not recognized. More work will be needed after I return home, but there is a possibility that we will be able to jointly publish this finding. The subtlety of the problem is such that we would not have recognized it using e-mail or other such communication. Only by spending time in person together were we able to see the connection between our two research fields, and solve a problem that we identified jointly.

8. Please add your comments (if any):

I had a wonderful experience in Japan, both professionally and personally. More importantly than the research I performed, I was able to meet a great number of Japanese professors and doctoral students, who I hope to stay in touch with for future collaborative work. I have two offers to return under JSPS postdoctoral appointments, and I think that I will consider these offers when I finish my Ph.D.

RESEARCH REPORT

1. Name: Rory Ball (ID No.: SP04007)

2. Current affiliation: University of Illinois at Urbana-Champaign

3. Research fields and specialties: Geotechnical Engineering

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry X Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo, Hongo Campus, Geotechnical Eng Lab

5. Host researcher: Professor Ikuo Towhata

6. Description of your current research:

My research project's objectives are to develop more reliable methods to determine the pullout capacity of tent anchor stakes and to evaluate variables that could affect the anchorage capacity of these stakes supporting the structure of large engineered tents. By conducting in situ tests on a variety of soils and making predictions with known methods, variables such as anchor diameter, embedment, inclination, load direction and fastening height can be assessed. My contribution to the project has been to develop a method to predict the anchorage capacity of a tent stake driven at a desired location with a minimal amount of soil information. To analyze the lateral capacity of a tent stake using numerical methods requires the soil type and soil strength information, but it would be unreasonable to assume the tent staking industry would run sieve analysis and undrained shear strength tests to determine these characteristics each time they wanted to pound stakes into the ground. The use of a dynamic cone penetrometer (DCP) to characterize the soil strength is one possible answer to quantify soil strength. The DCP method assesses soil strength by measuring the penetration resistance of the soil using a cone-tip that is advanced into the ground while a blow count per unit length is recorded. A greater penetration resistance corresponds to stronger soil. Correlations between strength and penetration resistance for the DCP test have been researched and used for years by engineers designing transportation facilities (roads) where rapid and accurate assessment of near-surface soil is important. In my research, I have created a relationship from results

from the DCP test to a predicted lateral capacity of a single tent stake. This was accomplished by first locating known correlations between DCP and undrained shear strength (fine-grained soils) or an internal angle of friction (coarse-grained soils) and then developing a relation between these soil strength properties and lateral capacity using the computer program LPILE. These predictions will be compared with full-scale, insitu tests and correction factors will be assigned if needed.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

"Response of Large Pile Group under Lateral Flow of Liquefied Sandy Soil Ground"

Description of the research activities:

The problem of soil-pile interaction was the subject of intensive investigations after the 1995 Kobe Earthquake, but still the mechanism of liquefaction induced soil lateral deformations acting on pile foundation is not clear. The present design codes lack information about pile group effects exposed on lateral spreading of liquefied soil. This topic was investigated in this study by a series of 1G shaking table tests. One of the main objectives was to investigate distribution and magnitude of lateral earth pressure among the piles. The basic model of the shaking table test consists of a gentle inclined soil model and a large group of piles. Two models of group piles were investigated: 6 x 6 and 11 x 11 pile models. Spacing between piles, soil density, and direction of shaking were main parameters which were varied during these experiments.

Results from the experiments show that piles were subjected to different lateral loading due to liquefaction induced horizontal displacements. Piles in the rows closer to upper slope received more lateral force than row of piles in the middle and down part. This finding suggests that liquefied soil flow between piles and spreading force passes the upper row of piles and acts on the subsequent rows. This shadowing effect was observed very clearly in the pile model with 5D pile spacing while in the 2.5D pile spacing model shadowing effect was not so apparent. The results of this investigation were compared with the present Highway Bridge Design Code-part 8 Verification of Seismic Performance of Foundations for Liquefaction-induced lateral spreading.

RESEARCH REPORT

1. Name: Brian Bircumshaw (ID No.: SP04008)

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Yamatake Corporation

5. Host researcher: Hirohiko Kazato

6. Description of your current research

At UC (University of California) Berkeley, my research is in high frequency MEMS (Microelectromechanical Systems) resonators. It is hoped that such resonators could be used to enable low-power wireless communications. The research involves designing, analyzing, fabricating, and testing these resonators. Currently, we are pursuing two designs that could be competitive with commercial devices if suitable fabrication processes are developed. Much of my research revolves around the design of these devices and how to analyze them properly.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Anisotropic Quartz Etching and General Recommendations for Project Improvement

Description of the research activities:

The first two weeks at Yamatake, I was briefed on the overall goals, timeline, and progress of the Ball Project. The Ball Project hopes to develop a cheap, reliable hydrogen gas sensor using a quartz sphere. SAWs (Surface Acoustic Waves) are created and allowed to propagate many times around the sphere. The delay time is then recorded. When hydrogen is introduced into the atmosphere, the delay time changes and an accurate measurement of the hydrogen content can be made.

I was asked by Yamatake to evaluate their project, overall, and advise them on any aspect that I felt could be improved. In this sense, I was treated as an outside consultant. To this end, in the first two weeks, I delved into every aspect of the project: design, theory, processing, and testing. I made multiple suggestions regarding various aspects of the project based on my research.

After the initial two weeks, however, I decided to study the anisotropic etching of quartz in more depth as I felt this could help the project considerably. The remainder of my time at Yamatake was spent developing procedures and best practices for the anisotropic etching of quartz. My results were somewhat successful. They were encouraging enough that research will continue into the anisotropic etching of quartz after I leave Yamatake.

I apologize for the vagueness of my answer. Based on the non-disclosure agreements I signed with Yamatake, I cannot go into details regarding my specific research and the results encountered. However, I can say that Yamatake allowed me considerable access to their facilities, and members of the Ball Project gave my ideas and concerns a great deal of attention. Although my time was short at Yamatake, I felt that it was productive and the results, overall, very satisfactory.

8. Please add your comments (if any):

I sincerely enjoyed my time at Yamatake. Working for a Japanese company was a rare and unique opportunity, and a very rewarding one. Mr. Hirohiko Kazato and Mr. Ken Fukiura made me feel welcome and useful. Being able to compare and contrast American and Japanese business practices will be of extraordinary value to me as I intend to work in both countries (across cultures, if possible). The opportunity to work with a company is not emphasized in the NSF and JSPS application processes. I realize that the scholarship aims to bring foreign researchers into contact with Japanese researchers. In this regard, universities are a wonderful location for award recipients. However, as more and more basic research is done by companies, and cross-collaboration between companies and universities becomes more critical, it is becoming increasingly important that students have relations with Japanese researchers in both the academic and industrial settings. As such, I would beseech NSF and JSPS to advertise the industrial opportunities more in coming years. My experience was rewarding and fruitful, and I think many others would enjoy such an opportunity if they were made more aware of it.

RESEARCH REPORT

1. Name: Shannon T. Bischoff (ID No.: SP04009)

2. Current affiliation: University of Arizona PhD Candidate

3. Research fields and specialties:

☐ Humanities X Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Akira Watanabe

6. Description of your current research

Theoretical Linguistics emphasizing theoretical syntax/abstract morpho-syntax. Linguistics is the scientific study of language. Linguists have been, and are, making observations about languages spoken throughout the world to theorize about *grammar*, the underlying linguistic system (within the brain) that allows speakers of every language to produce and comprehend an unlimited number of utterances or sentences. My research involves the analysis and theoretical modeling of linguistic structures (sentences) and the mechanism responsible for the production of such structures (sentences).

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Null Arguments in Japanese: A preliminary abstract morpho-syntactic analysis

Description of the research activities:

The research conducted observed the phenomenon of null (non-vocalized) subjects, objects and topics in the Japanese language. The objectives where: 1) to identify where such null forms are allowed in Japanese; 2) to compare the data with other languages that demonstrate similar phenomena; and 3) to determine what this can tell us about grammar and how the brain produces language.

Japanese, unlike English, allows the topic, the subject, or the object to go unvocalized in certain circumstances. Examples of topics, subjects, and objects in English follow:

A. Topic: As for ***John***, Taro hit him. [***John*** = topic]

B. Subject: As for John, ***Taro*** hit him. [***Taro*** = subject]

C. Object: As for John, Taro hit ***him***. [***him*** = object]

This study investigated the interpretability and grammatical structure of sentences in Japanese that do not have vocalized topics (henceforth zero-topics), vocalized subjects or objects (henceforth null arguments). The example below in Japanese corresponds to the English examples above, brackets '( )' indicated words that are not vocalized, not spoken.

D. Taro-ga nagutta (Japanese)

(zero-topic) Taro (null-object) hit

(As for John,) Taro hit (him).

The focus of the research was to determine where and when null arguments could appear in Japanese, and what factors license or allow them. Ultimately the goal of this research is to identify which parameters (innate faculties), allow or disallow null arguments in a given language.

To this end we interviewed some 30 native speakers of Japanese at the University of Tokyo to obtain interpretability judgments regarding 50 constructions (sentences) of various types. Some examples follow:

Null arguments in subject position ('___' indicates a null argument):

Taro ga tosuzen ___ kitano wo mita

Taro saw that ___ came.

Null arguments in object position:

Taro ga Hanako ga paati de ___ atta to itta

Taro said that ___ saw Hanako at the party.

Both positions:

Taro ga ___ ___ Hanako wo skida to kokuhaku saseta

Taro made ___ confess that ___ like Hanako.

Participants where asked if a sentence was understandable, and if so, what the null argument could refer to. That is, if the argument could refer to someone or something else in the sentence or perhaps if it could correspond to someone or something other not identified in the sentence directly. The following example illustrates.

Taro ga Hanako ga paati de ___ atta to itta

Taro said that ___ saw Hanako at the party.

In the above example we wanted to know if the '____' (null subject) could be interpreted as being: Taro or someone else. Students were asked to identify what the null argument could mean.

Taro ga Hanako ga paati de ___ atta to itta

Taro said that (Taro) saw Hanako at the party.

And/or

Taro said that (he/she/Bill/etc.) saw Hanako at the party.

The data was obtained with Naomi Ogasawara under the supervision of Dr. Akira Watanabe.

Once the data was collected through verbal elicitations, my colleague Naomi Ogasawara and I analyzed the data. We identified where, and under what circumstances, null arguments and zero-topics could occur. Once this was completed, the remainder of the research time was spent focusing on ways in which to account for the data theoretically. Dr. Watanabe's expertise in the field was quite helpful at this particular stage of the research.

8. Please add your comments (if any):

This experience was profitable in a number of ways. Regarding my research interests, it provided a unique opportunity to collect data that I would have otherwise not been able to obtain so quickly and easily. In regards to the collaborative aspects, Ms. Ogasawara and I will continue to work on this project, and others (at least one has come up as a direct result of this project. Furthermore, I will continue to work in consultation with Dr. Watanabe after I return to the US. This was an excellent experience both professionally and personally.

RESEARCH REPORT

1. Name: Carole J Burns （ID No.: SP04010 ）

2. Current affiliation: University of Utah

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐X Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Riken Center for Developmental Biology

5. Host researcher: Raj Ladher

6. Description of your current research (PhD research) During development, the growing embyro maintains a balance between differentiation and proliferation within stem cells and progenitor cells in order to produce the characteristic size, shape and complement of cell types typical of the mature organism. However, these cells do not exist in a static environment during development, instead the actions of multiple intrinsic and extrinsic factors continually act to shift this equilibrium toward a differentiated or undifferentiated state. This dissertation addresses these signals that propel a cell to adopt a differentiated state or promote its progression through the cell cycle, maintaining a population of undifferentiated precursors.Specifically, we investigated helix-loop-helix transcription factors during olfactory development in Xenopus. We show that basic HLH (bHLH) and repeat HLH (rHLH) transcription factors are sequentially expressed during olfactory placode development. Furthermore, we demonstrate that overexpression of the intrinsic bHLH transcription factor, Xath5, pushes precursors cells towards a differentiated state, increasing the number of mature olfactory receptor neurons. We next addressed how extrinsic signals might influence the state of a progenitor cell. We focused this question on the role of Wnt/Frizzled signaling during early eye and neuroendocrine development. Our work demonstrates that the Frizzled 5 receptor is expressed in the developing mouse retina and pituitary. We show that, in the retina and anterior hypothalamus, the loss of this gene affects proliferation and survival of neuronal progenitor cells. We also used a canonical Wnt/B-catenin mouse reporter line to demonstrate when canonical signaling is active during the development of these tissues and found that at early developmental stages, canonical signaling does not overlap with the regions that express Fz5.We crossed these two lines of mice and demonstrate that the loss of Frizzled 5 activity does not impact canonical Wnt/Frizzled signaling in the retina or neuroendocrine axis, suggesting that this receptor may act through one of the alternative Wnt pathways to exert its influence on retina and neuroendocrine development.Collectively, our results further our understanding of the impact that intrinsic and extrinsic signaling sources have on progenitor cell proliferation and differentiation.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Olfactory Placode Induction in Chick

Description of the research activities: This project was primarily focused on understanding the inductive interactions that underlie olfactory placode formation. This research utilized the chick model system and an in vitro culture assay. Briefly, presumptive olfactory placodes were explanted from HH stage 9, 12, or 15 chicken embryos. Stage 9 tissue was cultured intact, whereas stage 12 or 15 OP was cultured either intact or future olfactory ectoderm alone, for one week. In this way the abilty of the future olfactory ectoderm to generate olfactory tissue in either the presence or absence of potential inducing signals from intervening mesenchyme and/or endoderm could be determined by assaying these cultures for molecular markers (such as olfactory marker protein or LHRH antibody) of olfactory development. The second part of this project aimed to determine the competance of the cranial ectoderm from various regions to form olfactory placode by transplanting quail cranial ectoderm from various regions into the presumptive olfactory region of the chick. Although the time constraints of the program prevented all but cursory control surgeries toward this aim, the in vitro cultures appear promising. The cultures exhibit healthy growth as well as numerous processes suggesting that, in some instances neural development may have occurred. Furthermore, we attempted to test the usefulness of several molecular markers that have been suggested to denote olfactory development.

RESEARCH REPORT

1. Name: Michael Campos (ID No.: SP04011)

2. Current affiliation: Computation and Neural Systems; California Institute of Technology; Pasadena, CA 91125

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences X Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Advanced Telecommunications Research Institute International (ATR)

5. Host researcher: Kenji Doya & Kazuyuki Samejima

6. Description of your current research

I have participated in one major project during my graduate studies. The project is in the field of systems neuroscience, and describes the potential meaning of a consistent neural signal in a high-level cognitive area of cortex and its usefulness in learning. The following abstract is from the talk I gave at my host institution at the beginning of the summer program:

Title: The supplementary motor area encodes reward expectancy in eye movement tasks

Abstract: To elucidate the role of the dorsomedial frontal cortex (DMFC) in the control of saccades, we compared neural activity recorded from two awake behaving macaque monkeys during the performance of memory-guided and object-based saccade tasks. We found that neurons in the supplementary motor area (SMA) in the posterior extent of the DMFC were most active – and often bursting – in the post-saccadic interval. The neurons discharged a burst after a ~200 ms delay following the target acquiring saccade in the memory task, but often fired concurrently with the target acquiring saccade in the object task. Noting that this brain area is not directly related to the generation of the animal's instructed behavior (saccade), the hypothesis that this post-saccadic bursting activity reflects the expectation of a reward was tested with a series of manipulations to the memory-saccade task. It was found that, while the timing of the bursting activity corresponds to a visual feedback stimulus, the visual feedback is not required for the neurons to discharge a burst. Second, blocks of no-reward trials reveal an extinction of

the bursting activity as the monkeys come to understand that they would not be rewarded for properly generated saccades. Finally, the delivery of unexpected rewards confirmed that, in many of the neurons, the activity is not related to a motor plan to acquire the reward (e.g. licking). Reward expectancy is thus represented by the activity of SMA neurons. As in neural network models, the reward signal found in DMFC could be used to train other parts of cortex to perform visuospatial tasks. The reward expectancy signal in the DMFC may thus participate in the learning of goal-oriented behavior.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Comparison of two computational models of choice behavior in a free-choice stochastic reward task

Description of the research activities:

I worked with researchers at ATR to compare a model they have proposed to account for monkey choice behavior with a different model that was published recently by another group considering a similar task.

By applying Bayesian statistical methods to monkey neurophysiology, we can appreciate the neural signals that correlate with internal variables that are not otherwise decipherable. In this approach, behavior is assumed to be generated from internal variables, which are themselves influenced by external variables such as recent outcomes of behavior, but also idiosyncratic parameters such as previous knowledge, disposition and preference. After positing a model to predict choice behavior, Bayesian analysis can be used to calculate the likely parameter values that contributed to the observed behavior. By applying this method sequentially over the course of an experimental session, subjective states corresponding to hidden variables of the model can be tracked.

A potential pitfall of this approach is that the model used to infer internal parameters is not consistent with neural mechanisms used by the subject. Oftentimes, multiple models could be used to explain the same behavior, and each model could use its own set of parameters. By using the wrong model, one could infer an

internal variable that is not present in the primate brain. Neural recordings can hopefully discover the existence of neural correlates of hidden variables in the brain. Given the noise of neural data, however, it may not be possible to distinguish if the recorded neural signal is a parameter of one model versus another.

To fit the parameters of the models, based on the sequence of choice behavior and consideration of the previous reward incomes, we use of the sequential monte carlo (SMC) algorithm. SMC can discover the values of the hidden variables in each of these models that are most likely to lead to the actual choices of the monkey. Based on these results we can infer which aspects of the model increase the likelihood of prediction, and thus which are more likely to describe mechanisms used by the monkey. Furthermore, by fitting parameters to each monkey, insight can be gained into the task performance strategies employed by individual monkeys.

8. Please add your comments (if any):

I will be able to apply the techniques that I learned over the summer to my ongoing thesis work. In particular, I want to look at trial-by-trial fluctuations in the reward expectancy signal described in the abstract I included above. The technique I worked with this summer has equipped me to take this next step in my thesis research.

9. (If any) Advisor's remarks:

He worked very hard and discovered new findings with monkey behavioral analysis and computational modeling. In spike of communication difficulty, he has learned many things and proposed new ideas for analyzing and understanding the behaviors through daily discussions. I was often surprised with his creativity. I hope that what he learned in the summer course through our methodology and data is helpful in his original work. -KS

RESEARCH REPORT

1. Name: Steven C Chan (ID No.:SP0412)

2. Current affiliation: University of Maryland, College Park, Maryland, United States

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

X Interdisciplinary and Frontier Sciences

4. Host institution: Japan Marine and Science Technology Center FRCGC, Yokohama

5. Host researcher: Dr. Toshio Yamagata

6. Description of your current research

My research in the University of Maryland involves understanding the dynamics of the North Atlantic Oscillation (NAO). The NAO is the leading climate variability mode in the extra-tropical Northern Hemisphere. It strongly influences the climate of Europe, North Africa, Arctic, and eastern parts of North America.

Recent research results indicate that the stratosphere plays an important role in the development and the decay of the NAO, but the cause of that is unclear. During NAO events, it is observed that wind anomalies from the stratosphere propagates down to the troposphere, and triggers the troposphere component of the NAO. How such propagation is an open science question, and it needs to be answered.

My research in the University of Maryland intends to answer this question. We are looking at the daily variability of the NAO climate patterns to develop a comprehensive history of stratosphere-troposphere interactions during NAO events. By knowing the history of such interaction, it may be possible to understand the underlying geophysical fluid dynamics that are triggering NAO events.

At the current stage of our project, we are focused at one specific strong NAO event (96-97). Our final goal is to expand that to multiple NAO events. It will be interesting to see how different NAO events differ with each other.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

The Connection between the Indian Ocean Dipole and the climate of the La Plata River Basin in South America

Description of the research activities:

I am involved in a project that tries to understand the connection between the Indian Ocean and South American climate. Past research has indicated that South American climate is influenced by a phenomenon that is called the Indian Ocean Dipole (IOD). There is a statistical significant correlation between the rainfalls over certain parts of South America with the Indian Ocean Dipole. The anomalies seem to be especially strong in the La Plata Basin and the southern parts of the Amazon Basin. Planetary waves (fluid waves that owes in origin from the rotation and the shape of the Earth) also seem to propagate out from the Indian Ocean and move toward South America to influence the climate in South America.

Making a link between the IOD and the South American climate is not an easy task. First, IOD is not the only factor that influences the La Plata Basin climate. El Nino-Southern Oscillation (ENSO) also plays an important role of the climate there. IOD itself has some spatial and temporal correlation with ENSO; separating the signal between the two is challenging. We try to separate ENSO and IOD influence to South American climate by only choosing years that there are only IOD events but no ENSO events.

A second difficulty is the lack of IOD event sample size. There are only 6 to 7 unique IOD events during the last 50 years, where meteorological data are “well” collected globally. The Southern Hemisphere is generally poorly observed, and the “observed” ocean and atmosphere data are heavily based on computer simulations. In order to overcome that difficulty, we have used data that are generated by coupled general circulation model (CGCM). The CGCM attempts to reproduce the physical processes of the Earth in a computer. The specific CGCM that we used is from one of the world most powerful supercomputers – The Earth Simulator. The CGCM is very powerful in expanding the amount of IOD events if we assume the CGCM has good skill in reproducing realistic IOD events. The specific CGCM that is used are shown to perform well in both simulating IOD and ENSO events.

We take the IOD events out from the CGCM data, and make composites of these computer simulated IOD events. We are most interested in precipitation, wind vectors, geopotential height, stream function, velocity potential, and Rossby wave generation. Precipitation is the bottom-line for meteorology – is it dry or wet? The CGCM realistic reproduces the observed precipitation anomalies that are observed in the observations. This lends creditability to the model's ability to simulate realistic IOD events.

For wind vectors, geopotential height, stream function, and velocity potential, we have compared the CGCM with the observations in both lower (850-hPa level) and upper troposphere (200-hPa level). The CGCM seems to be able to simulate the Rossby wave train that is moving out from Africa and the Indian Ocean. We also calculated the Rossby wave source in both the CGCM and observations. It is clear from both CGCM and observations that anomalous convection in Africa and Indian Ocean is a Rossby Wave source.

A possible further in-depth investigation is to perform idealized fluid dynamics experiments with the use of computers. Further discussions about that would be held after my return to the United States.

8. Please add your comments (if any):

This is a lifetime experience. Living in a foreign country is a big learning experience. The research experience is only a medium of communication. To understand both Japanese science culture and popular culture, you need to be in Japan itself. My stay in Japan is like my legs have gotten a huge boost that enables me to jump out from a deep well.

I highly encourage this program to continue. Economically and politically, the world is becoming a melting pot. And, science knowledge knows no border. This program helps to break down the cultural and political border that is drawn between scientists from different nations.

RESEARCH REPORT

1. Name: Keith Choe （ID No.: SP04013）

2. Current affiliation: Department of Zoology, University of Florida, PO BOX 118525, Gainesville, FL 32611

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences **X Biological Sciences**

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Professor Shigehisa Hirose

6. Description of your current research

The overall goal of my dissertation is to identify mechanisms of acid-base and salt regulation in elasmobranchs. To regulate their internal pH, most fishes use their gills to secrete acid directly into the water that surrounds them. Interestingly, previous studies have demonstrated that acid (H^+ and/or NH_4^+) secreted from gills is exchanged for Na^+. Appropriately, this transport system has been hypothesized to allow freshwater fishes to absorb Na^+ in addition to regulate internal pH. Little is known about these mechanisms in elasmobranchs (an ancestral group of vertebrates that includes sharks, skates, and stingrays), because freshwater species are relatively few and many are large and difficult to study (e.g., bullsharks). I chose to study the Atlantic stingray (*Dasyatis sabina*), a small elasmobranch that lives in Florida, USA. Importantly, these stingrays are completely euryhaline providing me the ability to compare transport mechanisms between seawater and fresh water acclimated individuals of the same genetic stock. My current project is to identify and characterize ion transport proteins that allow stingray gills to secrete acid into, and absorb salt from, environmental water.

In addition to increasing our understanding of physiological strategies in an understudied group of fishes, this project will help determine how acid and salt transport proteins evolved in the vertebrate lineage. Comparing the structures and functions of homologous transport proteins from evolutionarily distantly related animals (e.g., stingrays and humans) can determine how different portions of transport proteins effects overall activity and function. My hope is that this can contribute to a better fundamental understanding of transport proteins that are involved in pathologies such as diabetes and hypertension.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Localization of Na^+/H^+ exchanger, isoform 3, in the gills of a euryhaline elasmobranch

Description of the research activities:

Previously, I determined the DNA sequence of Na^+/H^+ exchanger, isoform 3 (NHE3) from the gills of the Atlantic stingray. In mammals, NHE3 is an ion transporter that helps regulate blood pressure, pH, and Na^+ concentration. In stingrays, I showed that levels of NHE3 mRNA are high in the gills of stingrays and were markedly increased when stingrays were transferred from seawater to freshwater. As a result of the elevated expression in low salinities, I hypothesize that NHE3 in the gills is needed for Na^+ absorption in FW stingrays. However, for my hypothesis to be supported, it will be critical to determine what gill cells contain NHE3, and where in the cells the NHE3 protein is located. As an EAPSI fellow in Professor Hirose's laboratory I have initiated studies to localize NHE3 in stingrays. This has involved producing circular, recombinant DNA fragments (plasmids) that contain DNA sequences that match the NHE3 I identified from stingray gills. These plasmids are now being used to produce the following diagnostic tools for NHE3 localization in fixed gills from stingrays: 1) antibodies that will be used to label NHE3 protein, and 2) RNA probes that will be used to label NHE3 mRNA. Over the next few months, efforts will be coordinated between members of Professor Hirose's lab and myself to complete this localization project.

8. Please add your comments (if any):

My experience in Professor Hirose's lab has been extremely positive for many reasons. Firstly, I cannot overstate how generous Professor Hirose has been with his time and funding. Without me asking, he offered to let me use his facilities and funding so that I could work solely on projects to strengthen my dissertation. One of his assistant professors, Akira Kato, assisted me daily, and will continue to work on my project after I have returned to the U.S. Secondly, Professor Hirose and his graduate students are highly knowledgeable in molecular and cellular biology, and I have learned many techniques that will be vital to my future research plans. Lastly, I now have many new friends and collaborators in a lab that is leading in my field of research, and I am already thinking of ways to return and continue our collaborations. I have little doubt that one day I will look back at this summer's experience as a pivotal point in my career. Thank you for this incredible opportunity!

RESEARCH REPORT

1. Name: Esther Chon (ID No.: SP04014)

2. Current affiliation: University of Tokyo, Laboratory of Veterinary Ethology

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences x Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of California Davis, School of Veterinary Medicine

5. Host researcher: Yukari Takeuchi, DVM, PhD

6. Description of your current research

Studies have shown that kittens raised alone are not reared with an instilled wariness of their environment but are conjectured to be more bold, less fearful, and perhaps more likely to display aggression. My current research, therefore, looks at differences in aggressive or fearful behavior between queen-weaned versus orphaned and subsequently hand-reared kittens, towards both human beings and con-specifics.

Kittens and foster owners were recruited through the UC Davis School of Veterinary Medicine, Orphaned Kitten Project, which randomly allocates one or more kittens to veterinary student foster owners, who may or may not have a healthy adult cat(s) in the household. These foster owners raise the kitten(s) under a standard protocol to assure good welfare. At the weight of one kilogram, the kittens are neutered and available for adoption. When they are about six months old, their new permanent owners are called for a telephone interview. This interview is scripted and asks about any behavioral problems, particularly aggression and fear, the cats have toward both human beings and other felines.

Control kittens are provided by Sacramento County Animal Care and Regulation. Selected kittens are weaned by their queen before adoption and subsequently not hand-reared, and match the age of the orphan kittens. The adopters are called when the kitten is approximately six months old and are given the same scripted telephone interview as the treatment group. The treatment and control group owners are again called and interviewed when the kittens are approximately twelve months old.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Determining whether a correlation exists between specific mutations in genes coding for neurotransmitter receptors and certain behaviors in the canine.

Description of the research activities:

My research project contributes to a larger ongoing project, in which the correlation between genetic mutations and behavioral characteristics will be analyzed. This study utilizes 5 common canine breeds. The genotyping material is obtained from blood samples withdrawn for general canine health checks in numerous veterinary clinics in Japan. The genomic DNA is extracted, analyzed for specific mutations, amplified, sequenced, and analyzed by procedures developed specifically for each putatively mutated region of the target genes. The genotype and allele frequencies are determined for each evident mutated region, then they are correlated to certain behavioral traits obtained from the dogs' owners via survey questions. The results of each breed are then compared.

8. Please add your comments (if any):

This experience was excellent in enhancing my knowledge of science and research in veterinary medicine as well as teaching me about a culture so completely different from my own. Living in such a foreign environment for 2 months exposed me to all the different nuances of the Japanese way of life that can't be learned from a book. I highly recommend this experience for anyone who would like to be completely immersed in a different world, both scientifically and culturally.

I also highly recommend that students in the program live with a roommate. The fact that I had another American friend to come home to after a long, and sometimes frustrating, day at the lab, was comforting and consoling. I enjoyed my roommate's company so much that being cramped in a tiny "mansion" with her for these past two months was almost worth it. It is recommended that students get a rough idea of the dimensions of their rooms before selecting them.

RESEARCH REPORT

1. Name: Aaron Danner (ID No.: SP04015)

2. Current affiliation: University of Illinois, Urbana-Champaign, USA

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☒ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

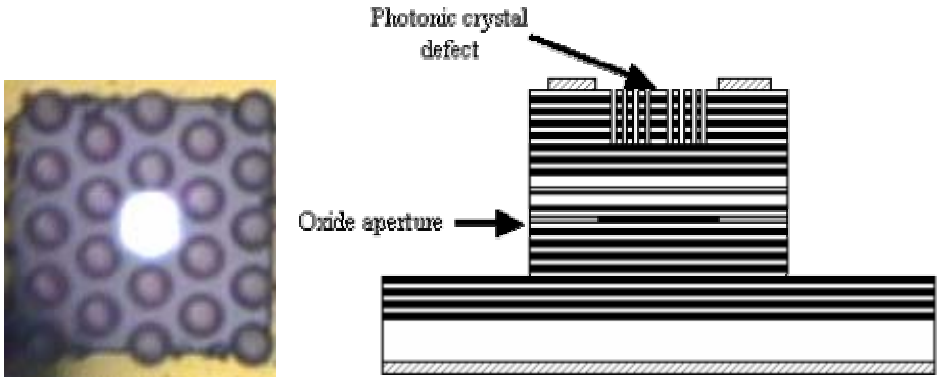
5. Host researcher: Fumio Koyama

6. Description of your current research

The vertical cavity surface-emitting laser (VCSEL) was invented in Kenichi Iga's group at Tokyo Institute of Technology in 1977 [1]. This type of laser is important in optical communications systems (such as sources for optical fibers used in telecommunications systems) as well as in sensing applications. In addition, operation in a fundamental lateral mode is usually preferred. This implies a sharp wavelength peak in the spectrum and a Gaussian-like beam profile. It is important for minimizing dispersion loss in propagation down an optical fiber, easy fiber coupling, and is necessary for many sensing applications since it can be focused to the smallest spot size possible.

Our research efforts at the University of Illinois, Urbana-Champaign were geared toward development of a single mode VCSEL that is also capable of achieving high output powers with a simplified fabrication process. Figure 1(a) illustrates a top view of a *photonic crystal* VCSEL [2] fabricated at the University of Illinois and Figure 1(b) illustrates a cross-sectional diagram of the structure. Normally, the small circular holes (the photonic crystal structure) surrounding the central lasing region are not present in an oxidized VCSEL, but we have studied this structure as a possible means of achieving single mode operation with high output power. This conversion of a multimode device to a single mode device through the addition of the etched holes is illustrated in the spectrum of a device, shown in Figure 2 both before (a) and after (b) the addition of the etched holes [3].

Devices were fabricated and brought to Tokyo Institute of Technology to carry out high speed modulation characterization. Since the devices show promising dc characteristics, it was thought that they may also possess good stability under modulation and retain their modal characteristics for high speed communications applications..



(a) (b)

Fig. 1(a) Near field image (top view) of central lasing region surrounded by etched holes, (b) Cross section diagram of a photonic crystal VCSEL showing distributed Bragg mirrors, metal contacts, active region and confinement features

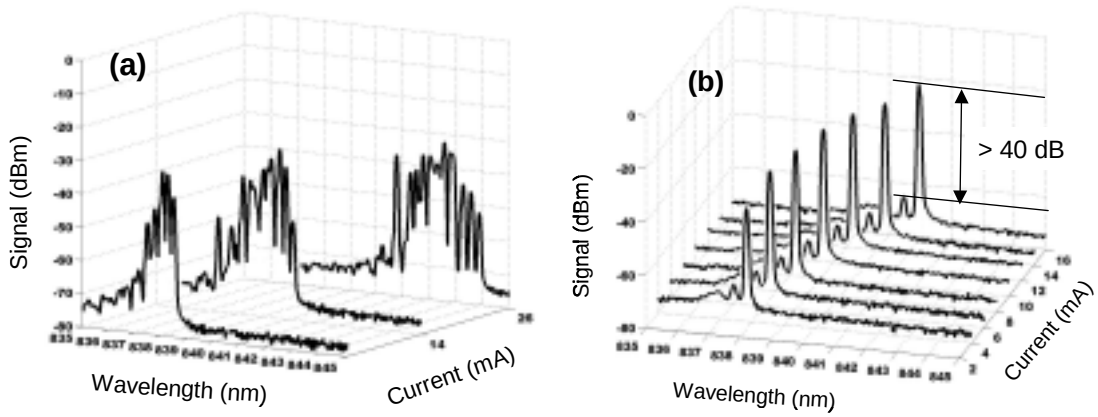


Fig. 2 Illustration of effect of etched holes, properly designed, on the spectrum of an oxide VCSEL. The spectrum of a laser is shown (a) without etched holes and (b) with etched holes present

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Modulation of photonic crystal vertical cavity lasers

Description of the research activities: The lasers brought to Tokyo Institute of Technology were previously designed to operate with a high single mode power output under dc characteristics [4]. We wished to evaluate the modulation speed of the devices for possible use as low cost single mode sources for communications purposes. The small signal characteristics of a promising device are shown in Figure 4. Typically, a device can operate at least as fast as the -3 dB cutoff of its modulation response with a small signal input. In this case, the largest –3 dB bandwidth achieved was 9 GHz. The device of Figure 4 is a single mode photonic crystal VCSEL that remains single mode under modulation with over a milliwatt of output power. The large signal modulation characteristics can be evaluated qualitatively through an eye diagram. Figure 5 shows eye diagrams at two modulation speeds, and indicate this particular device is suitable for operation at approximately 2.5 Gbps.. (In this case, no filters were used and improvement is possible.) The JSPS program

allowed the characterization of our photonic crystal VCSELs under high speed large signal modulation. In addition, new structures involving surface metal gratings were evaluated to possibly increase the single mode power available in photonic crystal or oxide VCSELs.

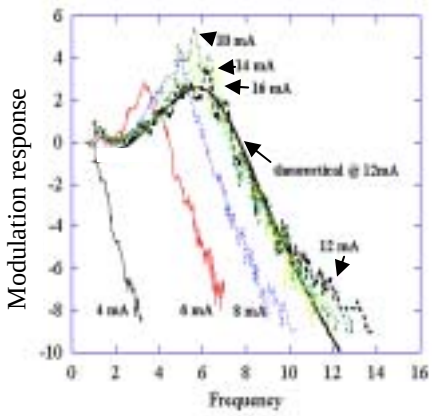
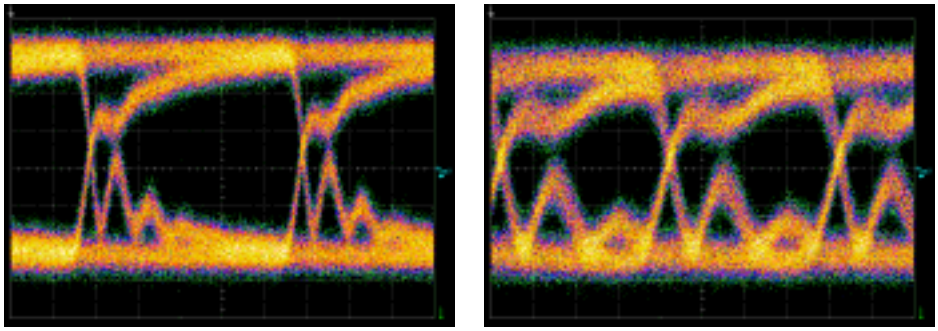


Fig. 4 Small signal modulation characteristics of photonic crystal VCSEL



(a) (b)

Fig 5 Large signal eye diagram (NRZ) for (a) 1 Gbps and (b) 2.5 Gbps operation

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[2] D. S. Song, S. H. Kim, H. G. Park, C. K. Kim, and Y.H. Lee, Appl. Phys. Lett., 80, 3901-3903 (2002).

[3] N. Yokouchi, A.J. Danner, and K.D. Choquette, J. of Sel. Topics in Quant. Elect., **9**, 1439 (2003).

[4] A.J. Danner, J.J. Raftery, Jr., and K.D. Choquette, CLEO 2004, Paper CTuP13, San Francisco, CA.

8. Please add your comments (if any): Visits to NTT Research Laboratory, Yokohama National University, and Furukawa Electric Company were also accomplished. Research results made possible by this JSPS program will be presented at the International Semiconductor Laser Conference, held in Sept. 2004, Matsue, Japan.

9. (If any) Advisor's remarks: In addition to advancing Aaron's PhD efforts, this intern experience also enabled him to learn about the research culture in Japan as evident from his visits to other institutions. Aaron devoted significant effort toward learning to speak and read Japanese, which was viewed very favorably by his hosts (comments that I received). I believe he admirably represented the University of Illinois during his visit..(*Kent Choquette, U. of Illinois*)

RESEARCH REPORT

1. Name: Ryan Derby-Talbot (ID No.: SP04016)

2. Current affiliation: The University of Texas at Austin

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Nara Women's University

5. Host researcher: Tsuyoshi Kobayashi

6. Description of your current research

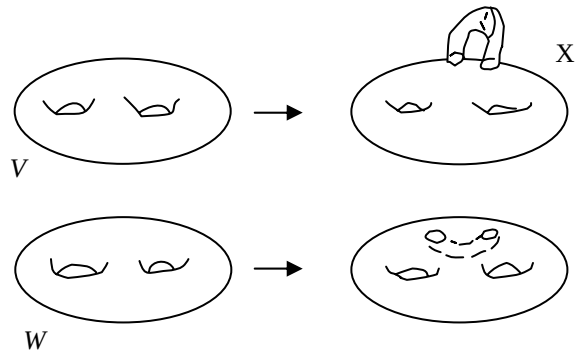
Low dimensional topology is an area of mathematics concerning the nature of objects called *manifolds*. In simple terms, an *n*-manifold is a space such that a small region around a point is deformable to a standard *n* dimensional disk. For example, the sphere is a 2-manifold: the region around any point on the sphere is deformable (can be "flattened") to a 2 dimensional disk. The torus, i.e. the surface of a donut, is another example of a 2-manifold. An interesting property of these objects is that while they are referred to as 2 dimensional objects (the 2 in 2-manifold), they globally embed in 3 dimensions.

Topology, unlike geometry, centers on understanding spaces up to *deformation*. In other words, the notions of length and angle are irrelevant in distinguishing between objects. Topologically speaking, a ping-pong ball and a beach ball are the same: we can imagine deforming the shape of one onto the other, for example by shrinking the beach ball. Also, a slightly deflated beach ball and the original beach ball are the same topologically, as again we may deform the shape of one onto the other. Given this understanding of the notion of sameness, therefore, a possible question that one might ask is whether we can list all possible 2-manifolds. In other words, can we classify 2-manifolds, or at least develop a sufficient understanding of their differences? The above examples of the sphere and torus appear to be distinct objects, but there is a possibility that one might deform in some complicated way onto the other, making them topologically the same. Using the mathematical tools of topology, which use techniques from algebra, in particular group theory, it can be proven that the sphere and the torus are in fact distinct. We can continue to build other 2-manifolds and show they are distinct from the previous ones. In the 1930's the list of all possible 2-manifolds was completed.

The next question one might ask is whether or not we can imagine doing the same for *n*-manifolds, where *n* is larger than 2. For *n* larger than 3, it is in fact proven that it is impossible to classify *n*-manifolds. For $n = 3$, however, the question remains open. In other words, it is not known whether or not it is possible to construct a list of 3-manifolds where each 3-manifold appears exactly once. Hence we will focus our attention on 3-manifolds. Note that the observation above about dimension applies here as well – while we refer to 3-manifolds as 3 dimensional, they embed into 4, 5 and 6 dimensional space. In other words, there is no way to visualize these shapes like we can visualize the sphere and torus.

One way of understanding 3-manifolds is to construct them from simpler pieces which we can more easily analyze. In 1898 a Danish mathematician named Poul Heegaard developed one such technique for building 3-manifolds. His technique was to construct 3-manifolds by taking two *handlebodies* and abstractly gluing them together along their boundaries. A handlebody can be thought of as a solid ball with a number of holes drilled straight through it. We regard the decomposition of a 3-manifold into two handlebodies (the reverse of the above construction) as a *Heegaard splitting*. Hence a Heegaard splitting is a construction of a 3-manifold, which we cannot visualize, by using pieces (handlebodies), which we can visualize. It is a classical theorem from the 1950's that any 3-manifold has a Heegaard splitting. Therefore, our attention turns toward understanding all the possible Heegaard splittings that a given 3-manifold contains. If M is a 3-manifold, what can we say about the Heegaard splittings of M and their relationship to the topological nature of M?

During the last 50 years, in particular the last 2 decades, many techniques have been developed to understand Heegaard splittings and their relationship to the 3-manifolds they form. The underlying question is: Can we completely describe all the possible Heegaard splittings for a given 3-manifold M? A classical theorem of Reidemeister and Singer from the 1930's states that given two Heegaard splittings for M, after a certain number of moves called *stabilizations*, the two splittings can be made equivalent – one can be deformed onto the other in M. To define a stabilization we require some notation. Let V and W be the handlebodies given by the Heegaard splitting, and let $V \cup W$ denote the Heegaard splitting. A stabilization of $V \cup W$ is obtained by attaching the ends of a solid tube, X, to V such that in W, the tube can be pushed to lie on the boundary. See the figure.



Hence the Reidemeister-Singer Theorem states that two Heegaard splittings of M will become the same after a certain number of tubes are added or drilled out of the handlebodies forming the Heegaard splittings. An interesting aspect of this theorem is the phrase "*a certain number* of stabilizations." How many stabilizations are necessary? This is the question of the Stabilization Problem for Heegaard Splittings:

Given two Heegaard splittings for M, how many stabilizations are needed to make the Heegaard splittings become the same?

Answering this question would shed a remarkable amount of light on the question of classifying all possible Heegaard splittings for a given 3-manifold.

So far, the evidence indicates it may be possible to prove that only *one* stabilization is necessary to make two Heegaard splittings (of the same genus – for the topologist who may be reading this) the same. In 1996 J. Schultens proved that for the class of 3-manifolds called Seifert fibered spaces, indeed, only one stabilization is required. In fact, every concrete example of two distinct Heegaard splittings of a 3-manifold examined to date has revealed that only one stabilization has been necessary. Making more general statements about the number of required stabilizations, however, has been difficult. For example, in the class of 3-manifolds called non-Haken 3-manifolds, in 1996 J. Rubinstein and M. Scharlemann showed that the number of required stabilizations is no larger than $12g - 9$, where g denotes the *genus*, or number of holes, in the handlebodies of the original Heegaard splittings. Recently, I have shown that for Heegaard splittings differing by a Dehn twist around a separating torus in the torus decomposition for M, the number of required stabilizations is bounded above by $4g - 4$.

According to these results, our investigation concerns the following:

1. Improving the bounds for the required number of stabilizations to make two Heegaard splittings the same.

2. Proving or disproving that one stabilization is all that is required to make two Heegaard splittings of the genus isotopic.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Stabilizations of Heegaard splittings of 3-manifolds

Description of the research activities:

Professor Kobayashi and I examined the Stabilization Problem for Heegaard Splittings (see the above description of research for definitions) in several examples of 3-manifolds, and in the general class of 3-manifolds called *graph manifolds*. Graph manifolds are manifolds which can be filled by circles – in particular they are formed by taking 3-manifolds called Seifert fibered spaces, which are well-understood, and attaching them together along their boundaries. Our hope was to show that Heegaard splittings of these manifolds require only one stabilization to become the same, or to find examples of Heegaard splittings requiring more than one stabilization.

Our attempts to understand Heegaard splittings of graph manifolds brought forth several ideas that I believe are key to analyzing this problem. In particular, we were able to show that with suitable hypotheses, one stabilization of a Heegaard splitting of a graph manifold allows us to deform the Heegaard splitting to a canonical form with respect to the Seifert fibered pieces of the 3-manifold. This could lead to a complete answer of the Stabilization Problem in the case of graph manifolds.

We further developed the ideas for graph manifolds to give candidate examples of Heegaard splittings of 3-manifolds that seem to require more than one stabilization to become the same. Determining whether the two Heegaard splittings obtained after a single stabilization are distinct, however, is a subtle and difficult question. We worked on this quite hard, and made (and continue to make) some progress on this issue. These examples seem to be distinct in a straightforward way. However, we found a technical point that prevents us from being able to conclude that our constructed Heegaard splittings are indeed distinct.

8. Please add your comments (if any):

It has been an incredibly valuable experience to work with Prof. Kobayashi. His work on this subject has contributed substantially to the development of the field, and has influenced much of my own work. Working with him brought forth new ideas from both of us, and has left me progressing in my research whereas before I felt stuck. In addition to working with Prof. Kobayashi, I presented my work to several other mathematicians who were able to share their feedback and discuss their own work. I was able to attend 3 conferences on topology during the summer, and had the opportunity there to speak with many mathematicians. I look forward to when I can meet with all of them again. I would especially like to thank the department of mathematics at Nara Women's University for providing me with the space and resources to conduct the research, and Professor Kobayashi for his time and energy.

9. (If any) Advisor's remarks:

I had a pleasant and productive time through the discussions with Mr. Derby-Talbot. The subject that we have worked on is the Stabilization Problem for Heegaard splittings, which is one of the most important problems in the field. As far as I know, I do not think even a candidate example has been known for the negative answer to this problem. We found several examples that seem to be very convincing for a negative answer. We have been trying to prove that these are actually examples of what we want, and the research is still going on (I wish I were able to continue the direct discussion a little bit more). Mr. Derby-Talbot studies very hard, and he communicated with many Japanese mathematicians during the program. I am sure that his contribution to Japanese mathematical society and to mathematics itself is very big.

RESEARCH REPORT

1. Name: Shannon DeVaney （ID No.: SP04017 ）

2. Current affiliation: University of Kansas, Department of Ecology & Evolutionary Biology and Natural History Museum & Biodiversity Research Center

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences X☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Ocean Research Institute, University of Tokyo

5. Host researcher: Professor Mutsumi Nishida

6. Description of your current research

My research focuses on the molecular systematics of the order Stomiiformes, a diverse group of deep open ocean fishes. Stomiiform fishes are ecologically important in the open ocean and are a good system for studying broad evolutionary questions. However, the interrelationships of the order are not well resolved, which prevents further research related to these fishes' evolution.

Stomiiformes comprises about 321 recognized species in four families: Gonostomatidae (bristlemouths), Sternoptychidae (marine hatchetfishes), Photichthyidae (lightfishes), and Stomiidae (barbeled dragonfishes, viperfishes, and loosejaws). Widely distributed in temperate and tropical oceans, stomiiforms are also highly abundant: *Cyclothone* (Gonostomatidae) and *Vinciguerria* (Photichthyidae) are probably the two most abundant vertebrate genera in the world.

Morphology has been used to study the relationships of stomiiform fishes, but morphological data has not yet provided a robust estimate of phylogeny. A molecular approach is advantageous because hundreds or thousands of characters are available in each gene, whereas the total number of characters in a morphological analysis is only in the tens or occasionally the hundreds. Phylogenetic accuracy is positively correlated with the number of characters used. Hypotheses of phylogenetic relationships are made on the basis of synapomorphies, or shared derived characters. That is, when the same evolutionary change is present in two or more species, the species that have the change may be related.

I am currently working to sequence portions of the nuclear gene RAG1 and am exploring the use of several more nuclear genes, including X-src, Tmo-4c4, and POM-C. Nuclear gene sequence data can be difficult to obtain, particularly if the tissue sample is of marginal quality, as is unfortunately often the case with stomiiforms. Therefore, I have only limited data so far from RAG1 (for only about 17 species), which leads to only mediocre results when the data are analyzed. I hope that increased taxon sampling and more genes in the analysis will lead to good results; however, sequencing nuclear genes in stomiiforms has so far proved very difficult. I came to Japan to learn the technique of sequencing the entire mitochondrial genome (whereas most of a cell's genetic material is contained in the nucleus, the mitochondria – organelles vital for cellular respiration – contain a circular genome about 17,000 base pairs long).

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Reconstructing evolutionary relationships of stomiiform fishes using whole mitochondrial genome sequences.

Description of the research activities:

For my doctoral dissertation research, I study the evolutionary relationships of fishes in the order Stomiiformes. At the University of Kansas in the United States, I determine DNA sequences for slowly-evolving protein-coding genes from the nuclear genome of these fishes. Because these nuclear genes change at a relatively slow rate, they are useful for studying deep divergences, i.e., those that happened far back in time. However, because I am interested in relationships at different levels (i.e., lower-level relationships such as those among closely related species as well as higher-level relationships such as those among families or between Stomiiformes and other orders), I need to incorporate other kinds of data in my research program. My goal for the summer program was to learn whole mitochondrial genome sequencing. Mitogenomic data is promising for studying phylogenetic relationships because the genome contains a large amount of data (about 17,000 nucleotide base pairs).

My host institute in Japan was the Ocean Research Institute (ORI) of the University of Tokyo. My host scientist, Professor Nishida, is one of the leaders of a large-scale effort to resolve the relationships of the teleost (ray-finned) fishes, a group composed of more than 27,000 known species – more than all other vertebrates combined. Not only was it an incredible opportunity to learn mitogenomic techniques from the real experts in the field, but I am also excited to be able to produce data that can be incorporated into their ambitious and important project.

When my research time in Japan began, I first spent several days with Dr. Miya, zoology curator at the Natural History Museum and Institute in Chiba, for an introduction to current mitogenomic techniques. Then I worked for the remaining time in the Nishida laboratory at ORI. I had brought extracted total genomic DNA samples from several stomiiform species with me from my home laboratory, so I was able to concentrate on amplifying and sequencing the mitochondrial genome.

The first, and most critical, step in whole mitochondrial genome sequencing is long PCR. Long PCR is a modified version of the standard polymerase chain reaction that is used to make many copies of a target DNA fragment. Whereas standard (or “short”) PCR is useful for amplifying fragments of several hundred base pairs, long PCR can be used to amplify fragments of several thousand base pairs, or about half of the mitochondrial genome. The long PCR product is then used as a high-quality template for short PCR, which is in turn the template for sequencing. One of the benefits of beginning with long PCR is that it amplifies only the mitochondrial genome, thereby eliminating pseudogenes in the nuclear genome that are similar to mitochondrial genes and can complicate data collection and analysis. My method for long PCR was to use four different primer combinations, amplifying the mitochondrial genome in four overlapping sections. Even when not every primer combination led to successful amplification, I was able to amplify all or most of the mitochondrial genome for most of the species for which I had good quality tissue. Long PCR success is heavily dependent upon tissue quality, which can be a problem in working with stomiiforms; many deep-sea fishes have tissue that is poor quality for molecular biology. Another problem is that many stomiiform species have gene order rearrangements in the mitochondrial genome. This can make it difficult to amplify the genome. However, stomiiforms are important for understanding the relationships of teleost fishes, so it is necessary to try to work around these difficulties. Fortunately, Dr. Miya in particular has experience with stomiiform fishes and was able to warn me of potential problems and advise me on suitable approaches.

Using long PCR product as a template, I then used short PCR to amplify smaller fragments of the genome (typically somewhere between 500 and 2000 base pairs) so that I could sequence them. For a first pass, I tried 17 primer combinations spanning the genome. My success rate in short PCR amplification was usually 50% to 75%. For regions of the genome that did not amplify successfully in the first pass, I tried other primer combinations. The primers I used were from a series of over 170 fish-versatile primers designed by Dr. Miya.

Short PCR products were purified in an enzymatic reaction to remove unincorporated primers and dNTPs (dinucleotide triphosphates, the building blocks of DNA). I then sequenced the fragments

using the same primers I used to create them, using the ABI Big Dye terminator cycle sequencing kit. Sequencing success rate was around 70%. Some sequences had a signal-to-noise ratio that was too small to be able to use the data. I aligned overlapping sequence fragments using the sequence editing software program Sequencher.

Using the methods outlined above, I obtained almost the whole mitochondrial genome sequence for *Echiostoma barbatum* (Stomiidae) and partial sequences for *Polymetme thaeocoryla* (Phosichthyidae) and *Photostomias guernei* (Stomiidae). I have not found any gene rearrangements in these species. The data I have collected so far are, of course, not sufficient to analyze stomiiform relationships, but I have learned enough this summer to be able to continue this work in the future.

I also performed long PCR for *Argyropelecus gigas* (Sternoptychidae), *Maurolicus weitzmani* (Sternoptychidae), *Bonapartia pedaliota* (Gonostomatidae), *Aristostomias tittmanni* (Stomiidae), and *Tactostoma macropus* (Stomiidae). Long PCR was unsuccessful for the sternoptychids, probably due to gene rearrangements; Dr. Miya has also had difficulty with long PCR for this family. The long PCR for *Bonapartia* was also mostly unsuccessful, but this is probably due to poor quality of that tissue sample. For the remaining species, two or three of the primer pairs I tried led to successful amplification, which indicates that sequencing the mitogenome for those species will be possible.

I intend to continue mitogenomic research when I return to my home laboratory at the University of Kansas, in addition to the nuclear gene sequencing program I have already been pursuing. What I have learned in Japan will enable me to have a stronger research program leading to my doctoral degree, and it will allow me to contribute to the important research project that my hosts are undertaking. I hope to continue to collaborate with members of my host laboratory, and I think that such collaborations can be mutually beneficial.

8. Please add your comments (if any):

I would like to sincerely thank Professor Nishida and Dr. Miya for allowing me to visit their labs and generously assisting me in my research and my stay in Japan. I would also like to thank all of the graduate students and postdoctoral fellows in the Nishida lab, who contributed greatly to the intellectual value of my visit and also made my time very enjoyable. I thank JSPS and NSF for this wonderful opportunity; it has surpassed all my expectations.

RESEARCH REPORT

1. Name: Esparza, Louis (ID No.: SP04018)

2. Current affiliation: Department of Sociology, Stony Brook University, NY, USA

3. Research fields and specialties:

☐ Humanities ☒ **Social sciences** ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Department of International Relations, Sophia University, Tokyo, JAPAN

5. Host researcher: Dr. Daishiro Nomiya

6. Description of your current research

The World Trade Organization (WTO) failed to come to a trade agreement at the Cancun Ministerial meetings, largely due to divisions between G4 and G22 countries on the issue of agricultural tariffs. Japan, like the other G4 nations, financially supports various areas of its agricultural production—the most outstanding case being their 500% tariff on imported foreign rice. The literature on this topic mainly explains this phenomenon through Japan's position in the international economic system. My research will attempt to explain Japan's stance in WTO negotiations as an internal matter only recently influenced from the outside. By collecting data on farm organizations, the rice industry, and collecting qualitative data from Japan Agricultural Cooperatives, I intend to establish that Japan's stance on agricultural policy in WTO negotiations has just as much to do with factors particular to Japan than with influences from without.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Japan at a Crossroads: Agricultural Change in an Era of Economic Globalization.

Description of the research activities:

I collected quantitative data compiled by the Ministry of Agriculture, Forestry, and Fishing (MAFF) on the trends related to the rice industry in Japan. I also conducted an extensive interview with a central person in the Japan Agricultural Cooperatives (JA) National office, the most powerful farm lobbying organization in the country. Visits to experts in international economic policy were undertaken for consultation purposes on this project as well.

8. Please add your comments (if any):

My experience working at Sophia University was very fulfilling. I have learned much not just about this area of research, but also about new ways of approaching problems and new ways of thinking that I have never been exposed to before.

RESEARCH REPORT

1. Name: Michael S. Evans （ID No.: SP04019）

2. Current Affiliation: University of California, San Diego

3. Research Fields and Specialties: Social Sciences, Sociology/Science Studies

4. Host Institution: University of Tokyo

5. Host Researcher: Professor Takehiko Hashimoto

6. Description of your current research:

My current research centers around the idea that values are communicated through objects, particularly designed technological objects produced as a result of scientific and technical research. In the science studies tradition, I participate in and observe science and technological development as it happens to understand fully how values are designed into objects. I am particularly interested in uncovering the hidden work of such infrastructural objects such as computer hardware, software, and organization and classification systems in the production and exchange of scientific knowledge. Examples of such infrastructural objects include high-performance computing hardware, bioinformatics database software, knowledge management systems, and advanced mathematical classification algorithms. Because these systems are used to "do science," often without being questioned as sources of epistemological variation, it is important to understand the hidden work that they accomplish, and how the human values communicated through these infrastructural objects affect the outcome of scientific research.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: **Knowledge Resolution in Scientific Infrastructure**

Description of the research activities:

Following Bowker and Star (1999), I maintain that infrastructure does hidden work. Simply put, humans create objects to perform actions. These objects perform actions in a particular way, often by intentional design. As objects become taken for granted as part of infrastructure, their particular way of doing work, the human values that drive them, and the amount of work that they do become routine. The standardization of objects as infrastructure hides the work that they do, allowing them to be seen as value-neutral "tools" or "instruments." This has important implications for many different fields, as humans often connect through infrastructures and objects. These connections ensure that objects are as much a part of social networks as people, and therefore that

assumptions built into objects ramify in significant ways throughout social networks. In scientific fields, this means that the human values built into infrastructural objects supporting scientific research may have an effect on the kind and type of science that can be done.

The primary goal of this research was to examine how ideas about knowledge, or knowledge models, affect the development of infrastructural objects that support scientific research. To achieve the primary research goal, I engaged in detailed interviews with people creating, developing, and using scientific infrastructure in order to explore how assumptions about knowledge underpin various infrastructural objects. Represented in the interview sample were several different types of scientific infrastructure, including specialized bioinformatics database software, knowledge management systems, geometrical algorithms, content delivery networks, and high-performance/dependable computing. Also represented were types of infrastructure not generally labeled as scientific but helpful as comparative cases, including personal information devices, product lifecycle modeling software, and collaborative learning software. I chose informants based on their ability to provide information about the objects, rather than on any quantitative sampling methodology. No standard questionnaire was employed, but two themes provided a common basis to most interviews. The first theme was the idea of knowledge modeling, or how knowledge is imagined as part of the object in question. The second theme was uncertainty, or how doubt is considered as part of the object. Using these themes, I constructed rough interview guides for each interview. These guides were for my use only and were not presented to the interviewee in advance. Other themes that emerged through interviews included the distinction between private and public knowledge, the role of collaboration, and the tension between control and openness.

It is difficult, and perhaps impossible, to encapsulate ideas about knowledge into a single measurement. Nonetheless, the most significant and explicit ideas about knowledge seemed to land along a continuum with vague but identifiable polar definitions, which I use as a starting point for establishing relationships with other dimensions. For analytical purposes, I will identify this continuum as *resolution*. Knowledge resolution, in this scheme, describes the extent to which knowledge is considered as a "thing." High resolution describes a concept of knowledge as something that can be stored and retrieved. Low resolution describes a concept of knowledge as something that is an outcome of interaction and relation, which cannot be stored and retrieved but must be produced.

The dimension of resolution helps organize the various examples of infrastructure into an interpretive framework. In the cases examined in this research, how people think about knowledge, and how they talk about knowledge, make a significant difference in two key areas of infrastructure formation and development: handling of uncertainty (predictability of outcome) and expected expertise of users (how much one already has to know about the output to use the information effectively). I found that these two areas are closely related to one another, but that both are most dependent on the level of resolution. Two specific cases help illuminate these relationships.

One illustrative case is a bioinformatics database developed with the idea that "biochemistry doesn't have universal laws, but we can replace them with empirical data." This information infrastructure provides search and retrieve functions for specific protein interactions, allowing a biochemist to enter a particular protein (or import microarray data) and extrapolate interaction relationships with other proteins, based on aggregated information extracted from scientific literature and updated by biochemists on the development team. Simply put, the bioinformatics database software treats interaction relationships as facts to be stored in a database and retrieved to support scientific decision-making. It is high resolution infrastructure. However, high

resolution infrastructure does not easily allow the expression of doubt or uncertainty. In the case of the bioinformatics database software, the degree of uncertainty (due to system errors, semantic ambiguity, or incorrect source data) is not handled by the system but is displayed to the user as a list of choices that they must make. In other words, high resolution infrastructure pushes the handling of doubt and uncertainty out of the infrastructure and onto the user. The consequence of this approach is that the users of the infrastructure must possess a high level of expertise to make the software relevant and useful. In the words of one informant, "good scientists can easily omit" the bad or unhelpful data.

Another illustrative case is a knowledge management system that is designed to take text input from the user, rearrange it according to different possible organizing schemes, and present it back to the user in a 2-dimensional visual map. Such a system is low resolution infrastructure, built with the idea that knowledge is the product of interaction and stimulation rather than a "thing" to be stored and retrieved. In this system, no relationship is privileged or considered more true than any other, allowing the system to stimulate the production of knowledge by presenting alternative possibilities rather than retrieving "facts" from a database. In direct opposition to the idea that the outcome of interaction with the system should be predictable, the creator of the software claims that "we don't mind different effects to different users." In this case of low resolution infrastructure, uncertainty is designed as part of the knowledge production process. The consequence of such handling of uncertainty is that the presentation of information does not require specialized expertise to confirm or refute its truth-status, opening the system to varying levels of expertise as well as varying perspectives.

Most cases examined in this study can be classified as either high resolution or low resolution infrastructure. In high resolution infrastructure, the consideration of knowledge as a "thing" that can be stored and retrieved drives a tension between truth-status and reliability of data. This tension, coupled with difficulty in expressing uncertainty, propels the need for higher levels of expertise on the part of users to determine what is useful and relevant. This in turn limits the scope of infrastructure and bounds its ability to support significantly new insights, though it may alleviate some of the more tedious work of doing science. In low resolution infrastructure, however, the consideration of knowledge as the outcome of interaction and stimulation allows a more general approach to problem-solving. Without the infrastructural challenge of determining truth-status of system output, the need for specialized user expertise is mitigated. At the same time, the possibilities for finding unique and creative solutions are increased. Thus infrastructural resolution has an important impact on what kind of science can be done. The cases examined in this project indicate that these infrastructural objects are not just mere tools, but important factors in the possible outcomes of scientific research.

Next steps for pursuing this research project are to examine similar processes of infrastructure development in the United States as comparison cases for the Japanese data. It is also important to pursue other possible factors in infrastructure development that are indicated in the Japanese cases, including financial situation and ideas about control, ownership, and openness. I also plan to spend time installing and using some of the software programs in the research data in order to get a participant or user viewpoint on how these systems can be applied and understood. I will continue research in Japan remotely through email interviews.

RESEARCH REPORT

1. Name: Katherine L. Fiori (ID No.: SP04020)

2. Current affiliation:

University of Michigan

3. Research fields and specialties:

☐ Humanities **X Social sciences** ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Hiroko Akiyama

6. Description of your current research

My research focuses on the study of social relationships among the elderly in a cross-cultural context; specifically, in Germany, Japan, and the US. I am interested in learning which constellations of social relations among older adults are most beneficial for physical and psychological health, and whether these constellations or clusters vary by culture.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Social Relations among Older Adults in Japan: A Cluster Analytic Approach

Description of the research activities:

In the past few decades, as the field of social relations in the elderly has expanded, it has become clear that different aspects of social relations (such as structural vs. functional; negative vs. positive) have different implications for physical and psychological health (e.g., Antonucci, 2001; Rook, 1984; Russell & Cutrona, 1991; Seeman, 1996). Although in general the literature shows that social support improves health and increases chances of living longer (e.g., Berkman & Syme, 1979; Sugisawa, Liang, & Liu, 1994), specific findings have often been inconsistent (Sugisawa et al., 1994). In the present study I proposed that it is specific *constellations* or *profiles* of all aspects of social relations (both structural and functional) that are truly predictive. By taking a pattern-centered rather than a variable-centered approach to the analyses, I hoped to address some of the inconsistencies and complexities in the literature on social relations in the elderly. If certain profiles do predict physical and/or psychological health, this information could be used to better understand how best to promote social networks with positive health implications. Furthermore, it is important and yet rare to examine such constellations of social relations in a cross-cultural context. My research in Japan is the second step in a series of analyses which will attempt to do just that with datasets from Germany, Japan, and the US.

Thus, in my attempt to replicate research on German elderly which I conducted earlier in the summer, I used cluster analysis as a statistical strategy to extract information about the existence of subgroups whose social relations profiles resemble each other more than they resemble other subgroups within a sample of Japanese elderly aged 70 and older (using the cross-national survey "Social Relations and Mental Health Over the Life Course", which has community-based representative samples from both the United States and Japan; Antonucci & Akiyama, 1993). A few researchers have already considered typologies of social networks in order to better understand the "combination and interaction of disparate network characteristics" (Litwin, 1995, p. 155). However, most of these researchers have only included structural (e.g., network size), rather than functional (e.g.,

emotional support) aspects of social relations. In my cluster analysis of Japanese elderly, I included both functional *and* structural variables: total network size, average network proximity, number of friends, number of family, average frequency of contact, proportion of network members considered very close, emotional closeness, emotional support, instrumental support, and negative relations.

A series of hierarchical and K-means cluster analyses revealed a four cluster solution: the "casual friends" cluster, consisting of individuals with large friend-based networks but infrequent contact and few close others; the "small but close" cluster, consisting of participants with a small network with few friends or family, but a high proportion of close others who provide a lot of support; the "family-focused" cluster, consisting of individuals with a family-based network in close proximity and frequent contact; and finally, the "restricted" cluster, consisting of individuals with few close others, very little emotional or instrumental support, and lots of negative relations.

As expected, there was some overlap with the clusters found in the German analyses., but also many differences. Unlike in the German analyses, I found very few demographic differences among the clusters, and contrary to my hypotheses, I also found no psychological or physical health differences by cluster (which I did find in the German dataset). This is likely due to the fact that I was able to include information about social *activities* in the German analyses which I was unable to include in the Japanese analyses because these data were not available. It may also be due to the likelihood of more dramatic gender differences in social relations among Japanese elderly as compared to German elderly. As suggested by my Japanese colleagues, in the next steps of my research I plan to run cluster analyses separately by gender, with the expectation that the clusters for Japanese men and women will differ. I will continue to examine different constellations of variables as well as conduct more direct comparative analyses with the Japanese, German, and US data.

RESEARCH REPORT

1. Name: Todd Gamblin (ID No.: SP04021)

2. Current affiliation: University of North Carolina at Chapel Hill

3. Research fields and specialties:

☐ Humanities ☐ Social sciences **X Mathematical and Physical Sciences**

☐ Chemistry **X Engineering Sciences** ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Takashi Nanya

6. Description of your current research

I am currently doing research in an emerging area of hardware design, called *asynchronous* or "clockless" computing. This area of research holds great promise for hardware systems in the near future. Today's microprocessors use a global clock, which imposes design challenges that make it difficult to attain these high-speed, power-efficient and modular designs. In a clocked system, on every clock tick, all components typically wait for the slowest one to finish, limiting the speed of the system's operation. In addition, it is a challenge to selectively shut down those parts of a clocked system that are not required for a particular computation, so typically much more power is consumed per clock cycle than is necessary.

Asynchronous chips can potentially run faster than clocked systems because they are not limited by the slowest part. Completion times of components can be data-dependent, and clocked systems must wait each cycle for the slowest component to finish, so they artificially assume the worst case. In an asynchronous system, there is no such delay, and average-case timing may be obtained for the whole system. Also, because components only perform computations when necessary, clockless chips can potentially consume far less power than synchronous chips. In effect, there is an automatic shutdown of inactive parts of a chip, at an arbitrarily fine level of granularity. Finally, components in an asynchronous chip communicate with a standard request/acknowledge interface. The common interface affords asynchronous designers the modularity that object-oriented programmers have enjoyed for a long time, in that chip parts can be pluggable, and chips need not be redesigned when integrated together.

My work centers on the synthesis of asynchronous circuits and systems at a high level. This is essentially the early stage of translation, where a hardware specification in a high-level language is converted into a collection of functional blocks, and controllers which sequence them. My current focus is on generating the controller specifications, which are then transformed at the low level into logic gates and silicon. During this control synthesis, several optimizations are applied to produce faster and more efficient implementations.

In particular, I am studying the optimization of control-data flow graphs (CDFG's) generated by high-level language compilers, for synthesis into asynchronous circuits. By investigating dependencies within the graphs, I hope to derive safe transformations to increase parallelism between what will later become asynchronous control circuits. I am also investigating the application of software compiler optimization techniques to clockless circuits. This new approach would treat control circuits like code, with particular attention paid to the relationship between loops and hardware pipelines. I plan to design a compilation tool to generate CDFG's from hardware description languages, and to apply many of these optimizations.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Design of a low-power register file for use in Globally Asynchronous, Locally Synchronous microprocessors.

Description of the research activities:

Professor Nanya's lab is currently designing a high-performance, low power, Globally Asynchronous, Locally Synchronous (GALS) microprocessor. GALS is a promising technology because it allows for the interconnection of existing synchronous chip components with asynchronous "glue logic". The asynchronous components act as interconnects and timing mediators between clocked components of the chip. I worked with Dr. Masaaki Kondo, a postdoctoral researcher in Professor Nanya's lab, to design a low-power register file for use in a GALS processor.

Modern processors use large, multi-ported register files to increase the number of values that can be active in a processor at any time, and to allow for more parallelism between instructions respectively. However, as register files grow in this way, they consume more power and their access time becomes slower. To solve these problems, Kondo has developed a register architecture that takes advantage of the fact that in modern applications, many data values are short numbers, and their binary representation contains mostly zeros. Many operations deal with only a small portion of the bits in the number, and it is wasteful to transfer and entire 64-bit number when only 16 bits would suffice.

Kondo's register file partitions the register file into separately accessible chunks, so that operations can specifically access different parts of the number. Chunks that consist entirely of zeros are not stored at all, and this information is condensed and stored as bookkeeping information. Each register is allocated as a record pointing to the chunks where its data is stored. Numbers are tested when they are stored so that the processor knows which chunks are entirely zero, and these chunks are represented with special values in the allocation record. This bookkeeping and comparing to zero comes at a price in power consumption. A partitioned register file consumes more power than a conventional register file of the same size, but the partitioned allocation scheme enables more information to be stored in the file and reduces contention on register values, so a smaller partitioned register file can function with identical performance but lower power than a conventional register.

My research combines Kondo's approach with another that I hope will reduce the bookkeeping overhead and allow for an even smaller register file. I studied an allocation approach developed by Gonzales *et al.* at University of Catalunya in Spain, which allows for registers to be allocated later in the pipeline. Kondo's scheme requires dynamic allocation because the size of a value is not known when space for it is allocated. However, if allocation is done later in the pipeline, then the register file can be simpler and bookkeeping can be eliminated. Rather than dynamically allocated chunks, I propose a file with registers of different sizes. For example, in a 64-bit machine, there would be a certain number of 64-bit registers, a certain number of 32-bit registers, and a certain number of 16-bit registers. This would be implemented as three banks of "chunks", one each for the low 16 bits, the next lowest 16 bits, and the high 32 bits. The number of chunks of a particular size would be chosen based on statistical profiles of target applications. The registers in this scheme are thus still partitioned into smaller words, as in Kondo's scheme, but the size of a value allocated to a register is implicit in its name rather than contained in an allocation record.

I have partially implemented a simulator for the new register file, and I plan to continue collaborating with Professor Nanya and finish it during the coming semester. I expect my work to provide the following benefits:

1. As with Kondo's design, my register file should use less power because it stores only significant bits from values, and not strings of zeros.
2. Power reduction benefits of partitioning (as in Kondo's design) should be maintained.
3. The new allocation strategy reserves registers for shorter amounts of time during execution, and should reduce the time a register spends allocated but unused, increasing processor throughput.

4. Less power spent on bookkeeping overhead for register allocation.

I plan to make the results of this research available in my final report for the NSF in December.

RESEARCH REPORT

1. Name: Jenny Gu (ID No.: SP04022)

2. Current affiliation: University of California, San Diego

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ■ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: RIKEN – Yokohama Institute

5. Host researcher: Dr. Kimura Shuhei and Dr. Mariko Hatakeyama

6. Description of your current research

The biological system is a network of various molecules necessary for function. Of these molecules, proteins are critical for many activities such as signal transduction, gene transcription, and enzymatic functions. Understanding the details of this reaction chain will help facilitate a better understanding of the steps that are executed by the cellular system to achieve the intended outcome. Knowledge of key turning points in the network will benefit drug design by providing target sites to be inhibited.

Due to the intricacies of the network and data intensive nature of gene expression data, algorithms that are highly specific and sensitive in detecting the causal relationships between proteins are needed. Various methodologies have been proposed, but there still remains room for improvement. To improve the detection quality, research efforts are being conducted to design a new tool that will extract and integrate the most beneficial contribution from existing algorithms to decipher the regulating network.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Improving Detection of Interacting Gene Pairs in a Regulatory Network.

Description of the research activities:

My research activity at RIKEN – Yokohama Institute involved programming an algorithm to detect pairwise correlation of gene expression data in C++. This algorithm, known as P-Q analysis, intends to detect gene pairs where one gene is regulated by the other, or both genes are co-regulated by a third gene. After coding the algorithm, the performance was tested on simulated gene expression datasets based on the S-system genetic network model. It is important to test the performance of an algorithm on simulated datasets where the infrastructure of the network is known before application to real biological datasets where the infrastructure requires clarification.

The results of the study revealed that P-Q analysis does not perform as well as we hoped when applied to the S-system genetic network model. Currently, we are investigating the source of the problem. One possibility is that the original application of the algorithm was applied on a dataset generated by Monte Carlo simulation where the model structure contained connection following the power-law. This raises the question of the algorithm performance dependency on the underlying infrastructure model that is assumed for gene regulatory networks. The impact that network topology may have on detection performance needs to be investigated.

The ultimate goal of the research focus is to design a new algorithm that will extract information from different methodologies to produce a consensus report that will be more accurate. When the performance of the P-Q analysis is improved for networks based on the assumptions of S-system models, it will be incorporated with the output of several other approaches in hopes of increasing the sensitivity and selectivity of detecting interacting pairs in gene regulatory networks.

8. Please add your comments (if any):

It has been a pleasure to work on this project for the short duration that I am here at RIKEN. I was able to get the satisfaction that comes with completing a program and running it on data to see how well it performs, even if more work is needed for improvement. Furthermore, I also had the opportunities to meet with researchers related to my field of work and discuss their research efforts. Overall, my experience working in Japan has been an extremely positive one and I look forward to future opportunities.

RESEARCH REPORT

1. Name: Jandy Hanna (ID No.: SP04023)

2. Current affiliation: Duke University, Dept. BAA

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences
□ Chemistry □ Engineering Sciences □ Biological Sciences
□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences
□ Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Dr. Eishi Hirasaki, under the supervision of Dr. Hiroo Kumakura
Laboratory of Biological Anthropology Department of Human Sciences
Osaka University hirasaki@hus.osaka-u.ac.jp, kumakura@hus.osaka-u.ac.jp

6. Description of your current research

. Primates are distinguished by several locomotor characteristics that most non-primate mammals do not exhibit. These locomotor characteristics were biomechanically examined and quantified by several Japanese researchers in the early 1960's. Based on their important work, subsequent studies suggest that these locomotor characteristics have been important throughout primate locomotor evolution, even in the origin of locomotor modes such as brachiation and striding bipedalism. My current research centers on primate locomotion, and my specific dissertation project examines the energetics of climbing, and the implications for primate locomotor evolution. As a primarily arboreal radiation, all primates regularly move on inclined and vertical supports in the forest canopy. Some primates appear to have morphological adaptations for climbing, while others are more generalized quadrupeds. It has been suggested that adaptations for climbing were critical in the evolution of more specialized behaviors including suspensory locomotion and bipedalism. Despite the importance of understanding these adaptations, little is known about primate climbing dynamics. One aspect of climbing dynamics is efficiency, or the ratio of mechanical work output to metabolic energy input. It is thought that efficiency is influenced by climbing style (kinematics), and that specialized climbers use more efficient kinematics. By understanding the kinematics and relative efficiency of specialized climbers compared to generalized quadrupeds, putative adaptations for climbing can be better understood.

While in Japan, I proposed to collect energetic data during climbing for several primate species.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Vertical climbing efficiency in primates: Implications for primate locomotor evolution

Description of the research activities: Due to the limited time we spent at our host institutions (6 weeks), it was not possible to collect energetic data on climbing. In addition, habituating live animals to experimental conditions requires much more time than this program allowed. My host researcher and I had already come to this conclusion before I arrived in Japan. Thus, we came up with two alternative projects that would be beneficial in providing me with a greater understanding of primate locomotion.

First, my host researcher and colleagues are working on several long term research projects which study the locomotion of bipedally trained macaques. These projects have examined the energetics of bipedally trained macaques, and the kinetics (force plate and pressure pad data) and kinematics (movement data) of bipedally trained macaques, and are important for understanding the emergence of bipedalism in primates. My host researcher and colleagues, along with me, collected data on the pressure pad kinetics of bipedally trained macaques in late July. I began analyzing these data in early August. We have not finished analyzing data for this portion of their project, as more data need to be collected.

Second, physical anthropologists seek to understand the evolution and radiation of primates, in particular humans. Perhaps the first of a suite of unique characteristics that appeared in the human lineage (such as a large brain and altricial infants) is bipedal locomotion. Therefore, in order to fully understand human evolution, the evolution of bipedal locomotion must be understood. This research topic has been widely examined and several hypotheses regarding the evolution of bipedalism have been proposed. The two most widely accepted hypotheses focus on knuckle walking and vertical climbing as the locomotor mode preceding bipedalism. However, regardless of which hypothesis is the most likely to have led to humans, most researchers agree that vertical climbing shares similar kinematic and kinetic traits with bipedalism and was an important locomotor mode of the hominid ancestor (Fleagle *et al.*, 1981; Richmond & Strait, 2002). Thus, the study of vertical climbing in primates is an integral component of understanding the evolution of bipedalism and ultimately humans. Therefore, we collected kinematic (movement) data during vertical climbing of bipedally trained macaques in late July. I have finished

analyzing these data. Once data are collected during vertical climbing of untrained macaques, we will begin a paper for publication comparing vertical climbing in macaques trained for bipedal locomotion to macaques without training. These data will be important in fully understanding the relationship between vertical climbing and bipedalism.

In addition to these research activities, my host researcher made appointments for us to visit 4 different biological anthropology laboratories in Japan. This was an extremely important opportunity for my professional development. Each of these laboratories uses different equipment, and I was allowed to observe how the equipment works and what types of research can be done with the equipment. Additionally, not only was I introduced to the premiere researchers of primate locomotion, I was also able to meet many well-known researchers of primate functional morphology. It is quite common for researchers who study primate locomotion to collaborate with primate functional morphologists. Thus, the laboratory visits we made were important, as well.

9. (If any) Advisor's remarks: Since fifty days are not enough to start a new experiment when working with live animals, Ms. Jandy Hanna and discussed other options. We decided that taking part in my experiments was beneficial to her. She has experience with kinesiological analyses of primate locomotion and did not need training to take part in the experiments. Thus, she and I collected of foot pressure distributions during bipedal locomotion of trained Japanese macaques and will compare these data with those for non-trained monkeys. Although this was not the experiment she wrote in her application, it is important for understanding the evolution of bipedalism. Thus it is an interesting and beneficial study relevant to her dissertation project. She was involved in all the experiments and worked very hard. Most of the analyses so far have been done by her.

In addition, we also did another experiment more closely related to her dissertation project. Most of the data have been analyzed.

We have enjoyed working with this student and were pleased to have her in our lab this summer. We had many stimulating discussions about our common research interests, as well as stimulating discussions with the laboratories that we visited. We would really like to continue our joint-work.

RESEARCH REPORT

1. Name: Ulysses S. Hargrove (ID No.: SP04024)

2. Current affiliation:

The University of Texas at Dallas, Richardson, TX, USA 75083

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences

☐ Chemistry Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Shimane University, Shimane-ken, Japan

5. Host researcher: Dr. Jun-Ichi Kimura

6. Description of your current research

Earth's surface is composed of two fundamentally different crusts, oceanic and continental, which are broken into a number of individual plates. Where plates separate along spreading ridges, the underlying mantle passively upwells to fill the void, partially melting in the process. The magmas produced by the melting rise into the crust, cool, and solidify to form new oceanic crust. Where plates converge along subduction zones, the subduction of oceanic plates into the mantle induces partial melting. Resultant magmas rise and cool, solidifying as new continental crust arranged in magmatic arcs. Surprisingly, we know more about the formation of oceanic crust than we do about the continents.

A pivotal controversy in understanding continental crust formation is the relative importance of juvenile (derived from melting of the mantle rather than of pre-existing crust) additions to the crust along magmatic arcs (e.g. Izu-Ogasawara-Mariana) compared to those associated with mantle plumes (e.g. Yellowstone hotspot), where anomalous (non-tectonic) upwelling of mantle (not associated with spreading) induces melting and unusually rapid and voluminous additions to the crust. Each of the above mechanisms of generating new crust imparts a [diagnostic] chemical fingerprint on the magmas, which can be used to identify the tectonic setting in which they formed.

The current doctoral research project is designed to test the hypothesis that a significant portion of juvenile continental lithosphere (crust + upper mantle) was generated in the Neoproterozoic Era (1000-544 million years ago) by the addition of mantle plume material, primarily by the accretion of oceanic plateaus or Large Igneous Provinces (LIPs) to form part of the Arabian-Nubian Shield (ANS). The ANS underlies most of NE Africa and Arabia and is among the largest known repositories of Neoproterozoic juvenile crust. It formed by processes indistinguishable from those of modern plate tectonics (above), as it is littered with ophiolites (remnants of oceanic crust emplaced onto continents) and is constructed of well-defined and geologically distinct crustal terranes separated by identifiable sutures (the scars of continental collision). The terranes comprise primarily volcanic and plutonic rocks that exhibit trace-element and isotopic geochemistries

characteristic of juvenile crust.

The objectives are to constrain the nature and timing of crustal growth in the ANS by studying the petrology, geochemistry, geochronology, and isotopic compositions of Neoproterozoic volcanic sequences and plutonic suites in order to test whether or not they represent, at least in part, accreted crust generated by a mantle plume or products of magmas that interacted with plume-derived lithosphere. To accomplish this, a large sample set collected from the ANS in western Saudi Arabia is being analyzed at the University of Texas at Dallas for major and trace-element geochemistry by inductively coupled plasma mass spectrometry (ICP-MS) and for Sr, Nd, and Pb isotopic compositions by thermal ionization mass spectrometry (TIMS). U-Pb isotopic ages of igneous zircons from the rocks are being determined using the sensitive high mass-resolution ion microprobe – reverse geometry (SHRIMP-RG) at Stanford University. Coupled with the studies of the physical characteristics and field relations of these samples, the information gathered from the geochemical, isotopic, and age analyses will shed important light on the timing and tectonic setting in which the magmas that formed these rocks were produced.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Detailed investigation of trace-element concentrations of whole-rock samples from the western Arabian Shield, Saudi Arabia by Inductively coupled plasma mass-spectrometry (ICP-MS)

Description of the research activities:

Research activities at Shimane involved sample digestion by alkali fusion and acid dissolution according to a method developed by J. Kimura and analysis for trace element concentration by ICP-MS. A total of ~90 samples were prepared and analyzed during the program at Shimane University.

During the sample digestion stage, 18 whole-rock powders and 1 rock standard (plus 1 procedural blank) were dissolved in a multi-acid ($HF + HClO_4$) solution in Pt crucibles on a hot plate, evaporated to dryness, and the residue fused in a muffle furnace with an alkali (Na_2CO_3) flux. Mixtures were left on a hot plate overnight to prevent condensation. On the following day, fusion mixtures were dissolved in a second multi-acid solution (HNO3 + HCl + HF), and the solutions transferred to polyethylene bottles and diluted with deionized H_2O.

Prior to analysis, 100 l aliquots of each sample solution were volumetrically transferred to polystyrene test tubes, to which was added a low (0.1 parts per million) concentration of internal standard (In) solution, and diluted with de-ionized H_2O to 10 ml. Samples were then analyzed on a PlasmaQuad3 ICP-MS. Analytical sessions typically spanned ~8 hours. Each analytical round consisted of 3 60-second scans of the procedural blank, 4 60-second scans of the sample solution, and 3 60-second scans of the sample + internal standard solution. A total of 28 elements were determined across the mass spectrum from 7 (Li) to 238 (U), including the rare earth

elements and high-field strength elements.

Each set of 18 samples took 2 days to prepare and 1 day to analyze. This required 30 days in the laboratory for the main sample suite and an additional 3 days for a replicate suite, for a total of 33 days.

The results of the analyses are still being interpreted. Provisional results will be presented in December 2004 at the annual convening of the American Geophysical Union (see reference below). Final results will form the basis for a manuscript to be submitted to a major peer-reviewed journal in the Spring 2004.

Hargrove, US, Stern, RJ, Kimura, J, and Johnson, P, in press, What is the Significance of Adakitic Granitoids and Zircon Inheritance in Juvenile Arc Rocks of the Neoproterozoic Makkah Batholith, Saudi Arabia? Eos (Transactions of the American Geophysical Union).

RESEARCH REPORT

1. Name: Kenneth Higa (ID No.: SP04025)

2. Current affiliation:

University of Illinois at Urbana-Champaign

Department of Chemical and Biomolecular Engineering

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Kyushu University

5. Host researcher: Professor Tetsuya Kusuda

6. Description of your current research

At the University of Illinois at Urbana-Champaign, I study the simulation of colloidal suspensions under the direction of Professor Jonathan Higdon. Our group has developed an algorithm that makes feasible the large-scale simulation of suspensions consisting of hard spheres subject to Brownian forces in a Newtonian fluid. I have extensively restructured the existing code and have introduced an object-oriented organizational scheme. Based on this reorganized code, I have produced parallel versions of our simulation for both shared-memory and distributed-memory supercomputers. In future work, we will introduce long-range interparticle forces and extend our algorithm to allow the simulation of processes such as gelation on reasonable laboratory time scales.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Investigation into an efficient domestic water use system for Xi'an city, China

Description of the research activities:

I assisted in an ongoing project whose goal is to propose an efficient water utilization system for China's Yellow River basin. I first used geographical image analysis software and satellite photographs from 1990 and 1997 to determine land usage in Xi'an city and its surroundings. I then used Chinese statistical yearbooks and existing data compiled by my host research group, in conjunction with geographic information systems software, to produce population and water usage maps of the same area. Finally, using the results of the two previous steps, I wrote a short proposal for a domestic water use system and calculated approximate sizes for various basins needed in wastewater treatment plants.

In addition, I assisted another research team in their study of the Kawasuna crab populations in the Kita river. I helped in taking samples from the Kita river in order to estimate population sizes and in extracting genetic material for DNA sequencing.

8. Please add your comments (if any):

The JSPS summer program has been a wonderful experience for me. I would like to pursue a career in environmental science, a career that I hope will involve and perhaps even encourage international cooperation. The JSPS summer program has given me an opportunity to interact with the scientific community outside of the United States and has offered me a glimpse into research field that attracts me, but which is different from my current work. In addition, this program was a tremendous opportunity for personal growth. Spending two months in Japan allowed me to see a world that on the surface seems so different from my own, but which is perhaps not so different after all. Adapting to everyday life with only barely functional spoken Japanese was a challenge, but a good one. And there were many other things that made this an experience full of unforgettable lessons. Finally, I would like to express my gratitude to my host research group for the kindness and generosity that they have shown me during my stay.

9. (If any) Advisor's remarks:

(From Mr. Osamu Higashi, my supervisor during my stay at Kyushu University).

I gave a research theme which title is "Research on urban area's efficient domestic water utilization in the Yellow River basin in association with urban expansion" for Mr. Higa. He was very interested in this theme, and investigated Chinese social and economical situation, and studied about water problems in the Yellow river basin very hard. He tried to read Chinese statistical year book to investigate the water use amount distribution in the yellow river basin, and discuss about the method of wastewater treatment system with other students. Then, he made a very good research report. He is very good student and I was very glad to work with him.

RESEARCH REPORT

1. Name: **Shaun C. Howard** (ID No.:SP04026)

2. Current affiliation: Department of Chemical and Materials Engineering
497 Rhodes Hall – ML 0012
University of Cincinnati
Cincinnati, OH 45221-0012
United States

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
X ☐ Chemistry Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: **Kyoto Institute of Technology**

5. Host researcher: **Hideto Matsuyama**

6. Description of your current research

My current research involves the study of mixed monolayers (Langmuir-Blodgett films) as a novel means for creating highly functionalized, ultrathin, membranes. I use organosilanes ($R\text{-}SiCl_3$) as a model system because they have been extensively studied, and because they are known to polymerize laterally when compressed in an Langmuir-Blodgett film.

My work has focused on the control of disperse-phase domains in mixed Langmuir-Blodgett monolayers of alkylsilanes and fluorosilanes. The latter forming the continuous phase and providing a Teflon-like structure that provides chemical resistance. Alkylsilanes of varying chain lengths are being examined for their effect on the size of dispersed-phase domains. L-B films are deposited on polished Si wafers or cleaved mica.

In addition to chain length, I also study the affect molar composition of the mixed monolayers, temperature, surface pressure, and outside forces such as electric fields. The primary method of characterization has been atomic force microscopy (AFM). Some time-of-flight SIMS (TOF-SIMS) was performed to verify chemical composition of the deposited monolayers.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Investigation of light-scattering technique for evaluation of monolayer phase transitions and study of hollow-fiber membrane production.

Description of the research activities:

In Prof. Matsuyama's lab I was able to learn about his surface light-scattering technique and discuss its operation with his students. While I did not bring materials to conduct an experiment using my own chemical system, I was able to determine that the technique would be extremely useful for monitoring the phase-change of Langmuir-Blodgett films.

I also learned about the fabrication and characterization of hollow-fiber membranes. I was able to work with Prof. Matsuyama's students to fabricate the fibers, and assist in a variety of characterization tests including tensile strength, permeation, and pore structure (the latter using SEM).

8. Please add your comments (if any):

Prof. Matsuyama was an excellent host. Both he and his students were very kind and generous with their time. I am very grateful for the opportunity to spend some time in his lab, and I hope that I have the chance to work with them again in the future.

9. (If any) Advisor's remarks:

Mr.Shaun Howard worked very hard in his short stay in my laboratory. He is so friendly that he freely spoke to my students. This always encouraged my students. He was interested in the light-scattering technique for monitoring the phase –change of Langmuir-Blodgett films. In spite of his short stay, the significant contribution to understanding the light scattering method has been done. I want to cooperate with him in near future.

RESEARCH REPORT

1. Name: Pamela Taylor Johnson (ID No.: SP04027)

2. Current affiliation: Tufts University

3. Research fields and specialties: Social Sciences (Cognitive Psychology)

4. Host Institution: Kyoto University

5. Host researcher: Kazuo Fujita

My research while doing work for my master's thesis at Tufts University is significantly different from that in which I have been involved at Kyoto University. Most of my research in the United States with Bob Cook focuses on the spatial and cognitive ability of pigeons. Specifically, my research touches upon pigeons' ability to recognize objects and expand that ability to pick particular objects out of an array of distractor objects. This sort of capacity is tested mainly through operant conditioning methods. The pigeon is placed in a black operant chamber with a touch screen on one side and a flat screen monitor pushed up to the touch screen. The pigeon is then shown a variety of different images and, depending on the test, has to respond accordingly to the correct stimulus. The pigeon is then rewarded for participation in the experiment. I have found my experience in previous laboratories to be extremely different from that which I experienced here in Japan.

The original project that I proposed for this research trip was unable to be conducted for a couple of reasons. The original experiment consisted of monkeys being in competition with one another and eventually deceiving the other monkey to obtain more food for themself. However, when something similar to this was done before my arrival, it was found that the monkeys tended to harm the deceiving monkey when they were placed back in the colony. Because of this, a new research plan was required that did not require the monkeys to be in competition with one another. After collaboration with a post-doc student and another graduate student in the lab, a project was finally decided upon. The project essentially tests the ability of monkeys to understand what a human will do in a given situation and react accordingly. In other words, try to see if a monkey can make inferences about a human's state of knowledge. This was to be implemented in the test phase by, during some trials, presenting the animals with an equal trainer. This trainer always shares the food equally. In the other half of the trials there is an "unequal" trainer. This trainer keeps most of the food and gives the monkey either a small portion of the food or the food that is preferred the least. Before I go into too much depth about the design of the study, let me explain that in order to test something like this, we must first make sure that the monkeys have strong food preferences one way or the other. Therefore, the first test that was conducted was to determine food preferences of 5 monkeys. The results from this test came back at chance levels, signifying that the animals had no strong preferences for the foods that we presented them with. Therefore, another test had to be conducted to determine food preference of the animals. This test

provided much more conclusive results. However, this is the point at which the research had to be terminated until two of the researchers return from a conference abroad (and unfortunately I will be back in America).

I also participated in another study involving Squirrel monkeys during my stay this summer. This was to examine the amount of "gaze alternation" that the monkeys participated with the experimenter when reaching for food. Three monkeys were used in this task. The monkeys were tested in a clear box with small openings on the right and left sides of the box that was facing the experimenter. Two small food cups were placed between the experimenter and the monkey and were in front of the left and right openings in the apparatus. A piece of food was placed in one of the cups and the monkey then had to point to which cup contained the food. There were 9 different conditions in the task, each to see if the monkey would react in a different way (i.e. reach toward one side more than the other, look at the experimenter's face more etc). The different conditions were: 1. experimenter looking at the cup with food 2. experimenter looking at the cup not containing the food, 3. experimenter looking at the ceiling, 4. experimenter participating in joint attention between the food and the monkey, 5. experimenter participating in joint attention between the unbaited cup and the monkey, 6. looking for 10 seconds at the ceiling and then 10 seconds at the monkey 7. looking for 10 seconds at the baited cup and then 10 seconds at the monkey, 8. looking for 10 seconds at the unbaited cup and then 10 seconds at the monkey and finally 9. only looking at the monkey. The data for this experiment are still being analyzed. It is expected that there will be the most gaze alternation during the trials with the experimenter sharing joint attention with the monkey and the baited cup.

My experience at Fujita's lab in Japan has been quite an excellent one. It has shown me an extremely different aspect of experimental psychology. The sort of methodology implemented in my home lab at Tufts University tends to be more computer-intensive and much less interactive with the subjects than what I experienced in the lab here in Japan. There are also a great many factors that must be accounted for when dealing with subjects as mentally complex as monkeys (and arguably close to humans) as opposed to those that are considered more "simple", like pigeons. I am extremely grateful that I have had this experience here in Japan. I am very thankful to my host researcher and JSPS for allowing me this wonderful opportunity.

RESEARCH REPORT

1. Name: Elaina Jorgensen (ID No.: SP04028)

2. Current affiliation: University of Washington

School of Aquatic and Fishery Sciences

Box 355020, Seattle, WA 98195-5020

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences x Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: National Science Museum, Tokyo

5. Host researcher: Dr. Tsunemi Kubodera

6. Description of your current research

The squid family Gonatidae is the most abundant and speciose of all the cephalopod families in the north Pacific. These squids are significant prey for marine mammals and seabirds as well as commercially important fish and are often taken as bycatch in commercial fishery ventures. However an accurate estimation of stock size of these squids remains unknown due to the difficulty collecting adult specimens, because they do not school and can easily avoid nets, and the inability to identify the paralarvae to species. Paralarvae have limited swimming ability so their distribution and abundance are considered accurate reflections of the distribution and abundance for the spawning adults of that species. Therefore paralarvae may be used to estimate spawning stock size for animals whose adult stages are difficult to collect, but this requires accurate identification of the paralarvae.

Paralarvae are relatively easy to collect and have been taken as bycatch in annual, ongoing ichthyoplankton surveys for the past 15 years by the National Oceanic and Atmospheric Administration (NOAA). The surveys have yielded over 5000 specimens of gonatid paralarvae, making this the largest, continuous dataset of gonatid paralarvae in existence.

The objectives of my research are to 1.) determine the taxonomic characters necessary to identify gonatid paralarvae to species; 2.) describe the distribution and abundance of gonatid paralarvae in the Gulf of Alaska; and 3.) estimate the location and timing of spawning events of individual gonatid species in the study area.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Taxonomy, distribution, and abundance of paralarvae of the family Gonatidae (Cephalopoda) in the Gulf of Alaska

Description of the research activities:

While working with Dr. Kubodera at the National Science Museum, Tokyo I was able to examine and illustrate specimens from the collections of cephalopods at the museum. From the catalogued specimens as well as my own, I was able to determine the taxonomic characters necessary to identify the paralarvae of the five species of gonatid squids in the Gulf of Alaska. I was able to have discussions with Dr. Kubodera about gonatid squids as well as other cephalopods, cephalopod ecology, and cephalopod sampling that allowed me to make great strides in compiling my thesis work.

I took the opportunity to present my preliminary results to the community of Japanese squid researchers during an annual squid research meeting in Niigata. From this meeting I was able to get feedback on my own research as well as hear what other research and techniques were being applied in my field. During this meeting I arranged to visit with squid researchers at Hokkaido Fisheries University, Hakodate. In Hakodate I worked with collections of gonatid paralarvae and had discussions with Dr. John Bower about current Gonatidae research and opportunities for future research cruises. I accompanied Dr. Yasunori Sakurai to two live tanks used to keep adult *Todarodes pacificus* for research and visited a larval rearing facility.

I assisted Dr. Kubodera with the English version of his cephalopod beak identification website as well as papers on cephalopod taxonomy and cephalopods in stomachs of apex predators. Finally, I attended a symposium on bio-data logging at the Polar Research Institute in Tokyo.

8. Please add your comments (if any): Dr. Kubodera is an expert in the field of cephalopod taxonomy and systematics as well as a kind, gracious, patient individual; it is because of all of these qualities that I can say that my experience this summer has been invaluable. This was a rare opportunity for me to work with another cephalopod researcher and the ability for me to ask questions and have spontaneous discussions about cephalopods has opened my mind to new ideas about my current research and built a foundation upon which to base future research. I would have never been able to make the connections with Dr. Kubodera or the other researchers I have met this summer without being here to interact with them. This has truly been a monumental experience.

9. (If any) Advisor's remarks: It was very helpful to have Elaina assist in translating our Japanese Beak Homepage into English and correct English in my scientific papers. She has concentrated on studying the gonatid paralarvae in our museum and drawn many systematic sketches. We have discussed the systematics of paralarvae in the north. Pacific and agreed on future cooperative research in this field. Besides concentrating on her work at the museum she has enjoyed several sights in Japan, including Kyoto, Hakodate, Hakone, Niigata, and Kamakura. I believe she has come to understand many aspects of Japanese history and culture.

RESEARCH REPORT

1. Name: Damien T. Kawakami (ID No.: SP04029)

2. Current affiliation: University of Minnesota, Saint Anthony Falls Laboratory

3. Research fields and specialties: fluid mechanics, cavitation

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University, Tsujimoto Laboratory

5. Host researcher: Professor Yoshinobu Tsujimoto

6. Description of your current research

The intent of the research done during the EAPSI research program was to investigate shape effects on the cavitation behavior of hydrofoils. Numerous investigators have studied cavitation behavior on hydrofoils of different design. Special attention has been given to the transitional and partial cavitating regions, since these regions are associated with large pressure fluctuations on the foil and in the surrounding flow. The flow in this region is very complex and not well understood. While many researches have studied this region, few have investigated the effects of foil shape on cavitation behavior. The Saint Anthony Falls lab has performed numerical simulations which suggest shape has a very large effect on cavitation behavior. The purpose of this research is to explore these findings experimentally.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Effect of hydrofoil shape on cavitation behavior

Description of the research activities:

- Investigated cavitation behavior for 7 different hydrofoil
- Took numerous high speed videos (2250 frames per second)
- Recorded pressure fluctuations upstream of the cavitating foil
- Measured cavity length and height

RESEARCH REPORT

1. Name: Resa Kelly (ID No.: SP04030)

2. Current affiliation: University of Northern Colorado

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

X Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Hiroshima University

5. Host researcher: Dr. Yoshida

6. Description of your current research

Many studies have explored how to improve students' understanding of chemistry at the submicroscopic level of the molecular, atomic and kinetic, the macroscopic level of the tangible, edible, visible, and the representational level of symbols, equations, and stoichiometry described by Johnstone (1993). Students do not seem to master chemistry to the same extent at all three levels. Articles presented by Nurrenbern and Pickering (1987), Sawrey (1990), and Nakhleh (1993) have shown that college students test better on algorithmic problems than on atomic level problems. In an attempt to improve the learning of molecular structures and dynamics, animations of submicrochemistry and macrochemistry processes have been developed to supplement instruction. Studies by Ardac and Akaygun (2004), Sanger, Phelps, and Fienhold (2000), Wu, Krajcik, and Soloway (2001), Burke, Greenbowe and Windschitl (1998), Sanger and Greenbowe (1997), and Williamson and Abraham (1995) have suggested that students who receive instruction including computer animations or visualizations of chemical processes at the molecular level are better able to answer conceptual questions about particulate phenomena.

In a pilot study I conducted in Spring, 2004, US high school students were shown two animations of salt dissolution after they watched a demonstration of the same event. Many students incorporated some features of the animations in their explanations yet

still gave answers that displayed some misconceptions. Since the animations had no narration or text to explain the process, students were left to infer what the animations were trying to communicate. In many lessons students are left to make inferences. According to Chi (2000), an inference is an identified piece of knowledge generated in an explanation that states something beyond what the instruction stated explicitly. For example, students are often presented with the instructor's explanations or lectures and they might read a textbook and examine the still-life pictures to try to make sense of chemistry concepts. Regardless of the instruction, students who draw new meaning from lessons and incorporate it into their explanations are making inferences (Chi, 2000). These findings have motivated further research into learning how expert and novice students respond in their explanations and drawings of demonstrations after they view supplementary information via an animation. In particular, how do Japanese students with very developed chemistry backgrounds change their explanations after they view supplementary information via two animations on salt dissolution and how do their explanations and drawings differ from US students? More specific questions are:

1. When presented with a demonstration of salt dissolution, how do Japanese chemistry students' explanations and drawings of the demonstration change upon viewing two animations?
2. What features from the animation do students incorporate into their explanations and drawings?
3. How do the explanations and drawings produced by Japanese students differ from those produced by American students?

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

A Study of Japanese College Students' Learning from Molecular Animations of Salt Dissolution

Description of the research activities:

The methods for gathering information for this qualitative study were direct observation of the students as they participated and analysis of worksheets that students filled out as they viewed the demonstration and animations. In addition, a questionnaire was attached to the students' worksheets to probe the students for more information about their experience.

Participants: The Japanese students who participated in the study consisted of two groups of varying experience. One group was made up of eleven master degree level graduate students who intend to teach chemistry in their future careers and the second group consisted of sixteen undergraduates enrolled in their third year of study.

Procedures: The students were presented with a test tube and they were asked to fill it with water. They were also given a small piece of black paper with a small spoonful of salt. Initially, students were asked to draw the salt and water as they saw it (macroscopically) and they were asked to draw the salt and water from the perspective of an atom (submicroscopically). That is, the students were asked to draw what the salt and water would look like if they were the size of an atom. The students were instructed to add the salt to the water and to record their observations from the two perspectives (macroscopic and submicroscopic) during the mixing of the salt and water, and after the salt dissolved. Next, the students were shown one of two animations of the submicroscopic process of sodium chloride dissolution with water. After viewing the

animation three to five times, the students were given the opportunity to rewrite their previous explanations on a new worksheet; however, if the students felt their initial explanations were acceptable as written they did not need to make changes. This process was repeated after students were shown the second animation. Finally, students were asked for their opinions and questions to complete the data collection process.

Results

As initially encountered with American students, the animations seemed to influence Japanese students' understanding in two main areas that I have labeled structure and function. In terms of structure Japanese students seem to behave more like experts in that they have a good understanding of the structure of water and solid sodium chloride prior to viewing the animations. In fact, nearly all of the students initially represented water with the space-filled, bent structure form while only two students represented water molecules merely as individual circles. In the case of salt there was a variety of representations with some more accurate than others. The most common way to represent salt (fifteen of twenty-one students represented salt in this manner) was as a two dimensional structure consisting of alternating circles of sodium and chloride. Seven students drew sodium chloride as a ball and stick structure.

After viewing the animations, nearly half of the students changed their description of salt to demonstrate the vibrational movement of the sodium chloride ions in the lattice. In addition, six students who previously drew a two dimensional structure of salt altered their explanation to represent salt three dimensionally, and three students who previously drew salt as a ball and stick structure corrected their explanation by removing the lines that served as bonds and redrew the ions to be closer together.

The other area affected by animations is how the process of dissolving occurs or what I

have labeled “function”. Japanese college students seem to struggle with how water forms spheres of hydration around the salt ions, which is a common area of confusion for American students too. Only eight students drew spheres of hydration around the salt ions, while fourteen students drew a randomly dispersed mixture of water molecules and ions. Interestingly, after viewing one animation, nineteen students incorporated improvements such as improved drawings of hydration spheres into their explanations of the dissolving process. The second animation did not inspire more significant improvements in the students' explanations, possibly because the first animation was sufficient.

While conducting this study, I became aware of some cultural differences between Japanese students and American students. It was quite obvious that the Japanese students were better prepared to discuss the submicroscopic level of matter than American students were. In fact, this was readily apparent in the Japanese students' drawings of water molecules and the solid structure of salt which appeared to reflect traditional textbook drawings. An additional contrast to American students was that Japanese students appeared to be more reserved with sharing their emerging models of new concepts. Some students were visibly concerned with what the person sitting next to them was drawing even though they were told many times over that this was not for a grade. In general, Japanese students seem to take their participation very seriously.

Due to the limited time available, a more complete analysis of the worksheets will have to be conducted later. Nevertheless, it appears that the two main areas where the animations influenced students' explanations of salt dissolution were in terms of the static structure of the salt cube and the function of how the dissolving process occurs. Most students' explanations improved to perfect or near perfect quality, which may be

due to the fact that the students already possessed an adequate understanding of dissolving and the animation served to clarify some misconceptions or possibly helped students to recall concepts that they did not initially remember.

References: Available upon request.

8. Please add your comments (if any):

The language barrier posed some problems for this study. The chemistry professor of the class translated all instructions to the students, and in turn translated students' comments or questions for me. The student explanations in the worksheets also had to be translated and their exact meaning may have been lost in the translation. However, the student drawings can be studied and compared without translation to drawings of students in other countries. This study was the first cross-cultural test of the use of student drawings as visual representations of mental models, which may provide a powerful tool for other cross-cultural studies.

RESEARCH REPORT

1. Name: Bijan Khazai (ID No.: SP04031)

2. Current affiliation:

University of California at Berkeley, Civil and Environmental Engineering

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Center for Disaster Reduction Systems, Kyoto University

5. Host researcher: Professor Haruo Hayashi

6. Description of your current research

Every large-scale disaster that leaves many people homeless triggers renewed and often intense debates about what approaches are appropriate to rebuild not only houses so that they are 'safe' or 'earthquake-resistant', but also households so that livelihoods are rehabilitated. Intermediate shelter and reconstruction programs absorb large amounts of international aid, yet we know very little about these programs' long-term results. I am currently working on studying a suite of post-earthquake reconstruction programs in developing countries and re-visiting these cities long after the reconstruction period has ceased. By using a comparative “case-study” approach, I would like to analyze the lessons learned from past reconstruction activities to address the question: “What makes a successful reconstruction and recovery program in a large-scale disaster in the developing world”.

My current research was initiated by a reconnaissance trip to Bam, Iran and the earthquake-stricken area, carried out from May 8-30, 2004, where I focused on understanding societal impacts five months after the Bam event, early recovery activities, longer-term recovery planning, and public policy aspects of earthquake loss-reduction in Iran. As part of this, fact-finding meetings were conducted with many organizations, including the International Institute of Earthquake Engineering and Seismology, which hosted the EERI team; UN-affiliated organizations; national-level entities concerned with

loss reduction and disaster response and recovery; international non-governmental organizations (NGOs); local NGOs in Bam, city and provincial government officials and agencies; and health care and mental health professionals.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Approaches and Challenges in the State of Post-disaster Reconstruction and Recovery Practice in the Developing World

Description of the research activities:

The Bam earthquake raises many questions that should be addressed in future social science and policy research. I used the bulk of my time here to study the literature of Disaster Sociology and Disaster Response and Reconstruction especially as applied to the developing world. I also used my time to formulating and addressing several key research questions I would like to pursue as a Post-doc. These include: (1) Studies to analyze factors associated with mortality and morbidity in the Bam event and to assess the post-earthquake search and rescue process. (2) Better understanding longer-term impacts upon the surviving population, including psychosocial impacts, and to track the social and economic recovery process for households and businesses. (3) Documenting decision-making, policy development, and policy implementation affecting the reconstruction of Bam and surrounding villages.

8. Please add your comments (if any): Ideally I would have like to have my time spent here learning about the Center for Disaster Reduction Systems programs and activities. This is what initially got me very interested in this program and the reason that I applied to the program. The time that I was in Japan, corresponded with travel time for my advisor. Due to his travel schedule and other engagements, unfortunately we only had a chance to meet for a short time. Once I made peace with the fact that this is the way it's going to be, I was able to be very productive working on research I had started early this summer. On my last day at DRS, I gave a seminar presentation of my research findings this summer. Given my circumstances and an accident I had which put me in a cast for a month, I think I made the best of my time here. My advice to any one applying to this program is to communicate

thoroughly with their research advisors and be clear about expectations on both sides before coming to a particular host research institute. In many circumstances that I observed, I noticed that those people who had the most success in collaborative work with their host research institutes had established ties with those institutes and a history of collaboration going back to their own advisors. Realistically, two months is not a long enough time to forge any new ties and collaborations, unless both parties have the energy and willingness to do so.

RESEARCH REPORT

1. Name: E. Toby Kiers **(ID No.: SP0** 4032)

2. Current affiliation:

University of California, Davis Department of Agronomy & Range Science Davis, CA 95616 USA

3. Research fields and specialties:

Evolutionary Ecology – Symbioses - Evolution and Stability of Cooperation

4. Host institution:

Graduate School of Human and Environmental Studies – Kyoto University, Yoshida-Nihonmatsu-cho,

5. Host researcher:

Professor Makoto Kato

6. Description of your current research

My dissertation research is focused on the evolution of cooperation in the legume-rhizobia symbiosis. In this mutualism, carbohydrates are provided by the host legume to the rhizobial symbiont in exchange for nitrogen (N_2) supplied to the legume. Although reciprocally beneficial, the stability of this cooperative relationship poses a dilemma to evolutionary theory. Either partner (through exploitation and cheating) could gain additional resources and destabilize the mutualistic balance, yet the symbiosis has persisted for millions of years. What then prevents cheating and eventual destabilization? One idea is that cooperation between species can be enforced if individuals are able to actively reward cooperation or punish less cooperative behavior. Research from my dissertation work suggests that factors, such as dominance by the host over the symbiont, can be important in stabilizing cooperation. This idea has been termed ‘sanctions’. The sanctions hypothesis proposes a direct link between the reproductive success of the symbiont and their cooperative ability. Yet the significance, in both frequency and intensity, of host sanctions as a cooperative stabilizing force remains unknown. Host sanctions or other indirect methods of resource control may be central in favoring cooperation in a diversity of mutualistic symbiosis. Controlling the reproductive fate of a symbiont can impose a strong selective pressure for cooperation but direct tests of the sanctions hypothesis are often difficult to perform. Ultimately, the aim of my research is to evaluate if host sanctions, as a selection pressure, are central to cooperative stability in other mutualistic symbioses.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Factors leading to evolutionary stability of obligate pollination mutualisms may be similar to those stabilizing the legume-rhizobia mutualism. In these systems, pollination of flowers is dependent on a host-specific pollinator. The pollinator deliberately collects pollen for deposition on stigmas. After pollination, the pollinator oviposits eggs into the flower and these larvae consume a portion of the seed crop. The relationship is defined by a biological trade; in exchange for pollination, the tree forfeits some viable seeds to the growing larvae of the pollinator. It has been suggested that exploitation by the pollinator could be limited by host-mediated selective punishment. The Kato Lab has recently discovered an obligate pollination mutualism between trees in the *Euporbiaceae* family and a moth genus, *Epicephala*. The general pattern is as follows: The flowers of these trees are highly specialized. Female moths use their proboscises to collect pollen from male flowers and deliberately deposit the pollen on the stigma and lay an egg. The eggs are laid in different places on the flower depending on the tree and moth species. In some species, egg laying damages the ovary, calyx or style. In others, there is no damage at all. In a few species there is multiple oviposition. 1-3 larvae (usually only 1) consumes either a fraction or all the seeds of an entire fruit, depending on the species. Species will vary in details of pollination such as location of oviposition, egg load per flower, number of larvae per fruit and degree of seed damage. Such diversity provides an excellent model system to study questions of asymmetrical host control because degree of cooperation (cost of supporting a symbiont) will vary among species. Hosts may differ in the strength of their symbiont regulation. This is shaped by symbiont selection pressures such as degree of seed consumption and oviposition damage. High egg and larval mortality is thought to be the major process to regulate (protect) seed set. At this point it is not clear if this larval mortality, which essentially mediates the reproductive output of the symbiont is host induced (consistent with our sanctions hypothesis) or an artifact of the pollinator lineage. Currently the Kato Lab is attempting to answer these important questions. While in Japan, I accompanied the Kato lab in studying populations of *Glochidion* on Tomoga-shima island, Amami island, Okinawa and Kume-jima island. The field work consisted of counting the number of flowers on marked branches and collecting fruits and flowers for analysis of changes in average flower egg loads across time. By monitoring the number of eggs laid per flower in random samples throughout the season, they are able to determine whether plants selectively abort flowers with heavier egg loads. Further, it is important to determine whether there is temporal variation in moth infestation among and within years and whether or not this is correlated with flower and fruit production. Additionally, on Tomoga-shima, floral essences were collected from sample trees in morning and evening. Previously collected data show that floral compounds differ before and after a pollination event. Such changes are significant because they could indicate a degree of host mediated control. Hosts may emit different floral compounds after pollination to limit further moth infestation and possibility even attract parasitoids of the pollinating moths. Attracting parasitoids would be a mechanism to limit seed exploitation

of pollinator larvae and keep moth populations low. Larval mortality due to parasitoids is as high as 58% in moths infected with braconoid wasps. Further field data and bioassays are needed to confirm or reject this hypothesis. Night field work on Tomoga-shima was also successful. We were able to observe the pollination and egg oviposition of the moth on the *Glochidion* flowers. As of now, only three other scientists have observed the elusive night pollinating moth to document the oviposition of eggs into the flower. Photo of the oviposition event is below:

Phylogenic analysis has revealed a high degree of specificity in moth pollinators. Interestingly, a related genus *Flueggea* is not pollinated by moths. Rather these species are pollinated by ants but the fruits are parasitized by host-specific moths in the same genus as the pollinating moths. These species may be basal to actively pollinating moths. The larvae of these moths consumed nearly all seeds within the developing fruit. The most interesting variation is in the patterns of seed destruction. In some species the larvae eat all of the seeds in a single fruit but leave other fruit on the tree untouched. In others, the larvae eat only a portion of the seeds but infest more fruits. These seed destruction patterns are key to understanding the stability of cooperation in obligate pollination systems because they delineate the cost of maintaining a symbiont population. Variation analysis of cost: benefit ratios have been undertaken in other obligate pollination systems (yucca-yucca moth; fig-fig-wasp). Ideally, similar data from this system can be generated. Specifically a) % of seeds that each larvae consume b) % of fruits with no viable larvae (larval mortality) c) % of fruits infested (variation in time and within/between populations) d) egg: flower ratios. With these data, we hope to outline major similarities and differences in the selection pressures that stabilize cooperation in obligate pollination systems.

9. (If any) Advisor's remarks:

I hope that she will pursue her research on the mechanism in which cooperative mutualism is sustained, especially in Glochidion-Epicephalla pollination mutualism. She was amazingly competent in theoretical and field works, and considerate in friendship with all members of my laboratory.

Makoto Kato

RESEARCH REPORT

1. Name: Katie Kindt （ID No.: SP04033 ）

2. Current affiliation: University of California- San Diego in the laboratory of Dr. William Schafer

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences X Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Nagoya University

5. Host researcher: Dr. Ikue Mori

6. Description of your current research

With 302 neurons of known connectivity, the nematode *Caenorhabditis elegans* provides a good system in which to study the molecular genetics of defined behaviors. One well characterized behavior in *C. elegans* is gentle touch avoidance, the movement away from a direct mechanical stimulus or non-localized tap to a culture plate. Genetic and cell-specific laser ablation studies have identified five touch receptor neurons and an interconnected network of four pairs of interneurons, which make up the touch circuit. In behavioral assays, the *C. elegans* touch circuit has been shown to undergo habituation, a simple form of non-associative learning and memory. Habituation is defined as a diminished response to a given stimulus after repeated stimulations. Studying habituation is useful because of its simplicity and because it represents a ubiquitous form of learning.

The goal of my current research is to utilize behavioral assays and new and established *in vivo* imaging to investigate the basis of neural plasticity at the cellular and molecular level. Where and how plasticity or changes that occur during learning and memory storage remains a fundamental question in neuroscience. *C. elegans* is an amenable organism for such a question since it can be dissected at many levels such as initial sensory response, synaptic strength of the sensory cell and response and integration of downstream interneurons. Tools such as cell specific laser ablations, cell specific rescue constructs, and *in vivo* imaging techniques are useful to address these questions. In addition to testing wildtype animals I can compare these results to mutants implicated in learning and memory. These experiments will more clearly define where in the circuit plasticity occurs during learning and is likely to provide insight to parallel processes in other systems.

These experiments will help address key unanswered questions regarding the molecular mechanisms of neural plasticity in *C. elegans*, and are likely to provide insight

into parallel processes in vertebrates. In addition, understanding the mechanisms behind this plasticity is important and relevant for changes that occur in drug addiction and withdrawl.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Dissecting the integration of simple learning in *C. elegans*

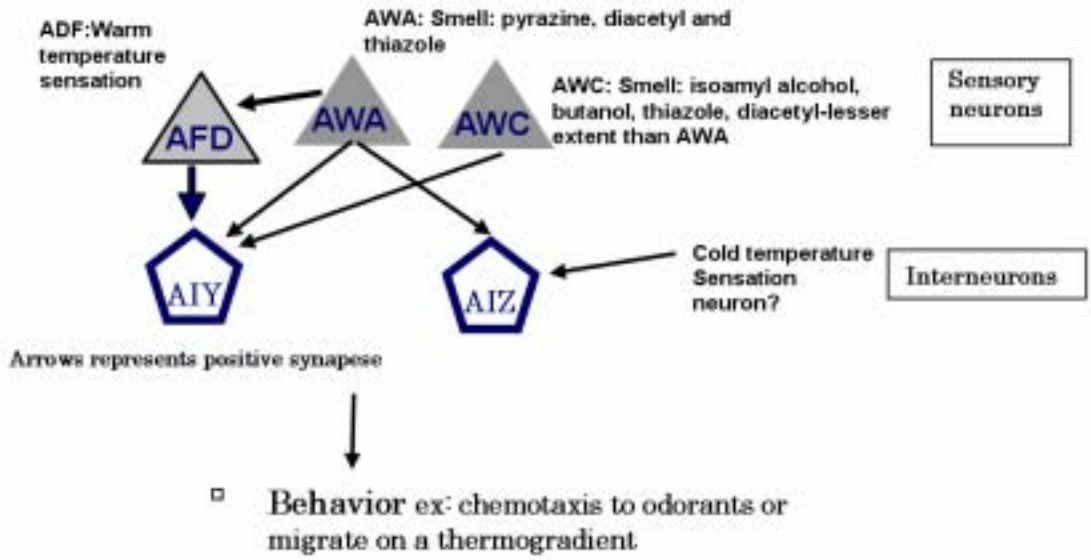
Description of the research activities:
When I say simple learning, maybe that is not he best word. Even in *C. elegans*, a small nematode with 302 neurons with known synaptic connections, a sequenced genome and an abundance of characterized mutants, understanding how this organism behaves and “learns” is no easy task. The Mori lab studies thermotaxis behavior in *C. elegans*; here worms will migrate to a specific temperature based on the temperature they were feed and cultivated at. Worms grown with food at a certain temperature “remember” this temperature and will migrate isothermally on a radial gradient at this temperature. In contrast, if worms are grown without food at a certain temperature, they will avoid this temperature.

In *C. elegans* there are 12 pairs of sensory neurons in the head, called the amphid neurons with specific sensory functions, such as osmotic avoidance, thermotaxis, smell, taste and pheromone sensation. While each sensory neuron has a distinct function, downstream there are sets of overlapping interneurons that are required to integrate multiple sensory cues to tell the animal how to behave. For example the AWA and AWC sensory neurons are required to smell attractive volatile odorants, while the AFD sensory neurons are required to sense up steps in temperature. Both sets of sensory neurons require similar downstream interneurons to complete their respective task or behavior: chemotaxis to odorants in the case of AWA and AWC, and thermotaxis for AFD.

I was interested in addressing how much overlap exists in these two sensory systems during learning and memory. Does learning or changes that lead to plasticity to one sensory input (odorant), alter the other sensory system (thermosensation)? It has been shown previously that prolonged exposure to odorants leads to adaptation, or a decrease in attraction to that odorant. It is still uncertain where changes occur in the odorant sensory circuit that lead to this phenomenon. For some odorants it has been suggested that adaptation occurs in the sensory neuron via odorant receptor downregulation, but still the mechanism remains relatively unknown. Where changes occur during learning and memory remain fundamental questions in neuroscience regardless of the system. Analysis of *C. elegans* relatively simple behavior and corresponding nervous system to address these questions.

In my experiments, I adapted worms to odorants diacetyl or thiazole (sensed by AWA and AWC) and tested their ability to thermotax. Through these assays I saw that worms moved to a temperature colder than their temperature of cultivation, very clearly and completely. This result was very interesting; it suggests that changes that occur during odorant adaptation have an affect on naïve thermosensation. How this could be occurring now poses an interesting question. It is uncertain whether the animals are learning to avoid the temperature they were cultivated and received odorant or whether there are changes within the circuitry that lead the worm drive the worm to cooler temperatures. In *C. elegans* there are many characterized mutants that would be useful to test possible mechanisms for this phenomenon. Continuing this project may provide interesting information on how

sensory systems integrate information during learning and memory



8. Please add your comments (if any):

I think that was a really great opportunity. The experiments that I did in Dr. Mori's lab are highly specialized and may have been very difficult to perform on my own in my lab in the U.S. I hope that I can find time to continue to work on this project or return after my PhD to complete them.

RESEARCH REPORT

1. Name: Laurel M. Knapp (ID No.:SP04034)

2. Current affiliation:

DePaul University, Chicago, IL

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐X Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: National Research Institute of Fisheries Engineering (Ibaraki, Japan)

5. Host researcher: Tomonari Akamatsu

6. Description of your current research

Much of my previous research interests and experiences have been in marine and aquatic biology. Recently I have become fascinated with the world of underwater sound. Many believe the underwater world to be silent place, however, marine and aquatic animals use sound to navigate, communicate, hunt and breed. Recently, an emphasis has been placed on the importance of understanding the effects on anthropogenic noise on these organisms. However, at this time few studies have examined this relationship. My thesis examines the relationship between anthropogenic noise and stress hormones (specifically cortisol), as well as the relationship between noise and behavior in two species of freshwater fishes that are expected to vary in their response to noise exposure.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Auditory Response in Goldfish (*Carassius auratus*)

Description of the research activities:

See attached

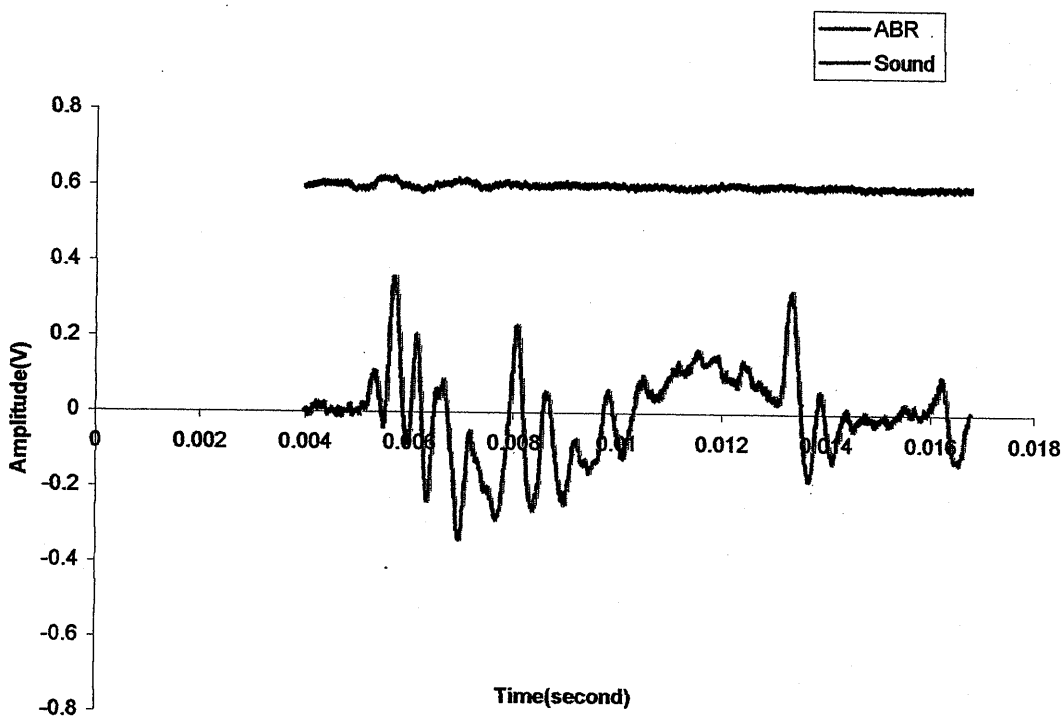
Auditory Response in Goldfish (*Carassius auratus*)
(Research Description)
Laurel Knapp

The auditory brain stem response, or auditory evoked response, is a relatively new method of measuring brain waves in response to sound. Brain waves are detected by an electrode placed near the brain surface, and are recorded on an oscilloscope. The auditory brain stem response (ABR) protocol has recently been adapted for use in fishes. Many researchers in the area of bioacoustics have since used this protocol.

The primary intent of my study in Japan was to be trained in the ABR protocol so that I may broaden my knowledge of the field of bioacoustics as well as be more marketable in this particular research area. Dr. Tomonari Akamatsu of the National Research Institute of Fisheries Engineering (Ibaraki, Japan) offered to train me in the use of ABR on fishes.

After my initial training, I was able to conduct an experiment involving goldfish, a species categorized as "hearing specialist" due to heightened auditory sensitivity (this means they can hear over a broad frequency range and have low auditory thresholds). One fish was placed in a tank in a soundproof chamber. Because the skull bone of the goldfish is relatively thin, it is possible to measure brain waves non-invasively by simply placing the electrode on top of the head (along the midline of the mesencephalon). A speaker, suspended above the water, played tone bursts produced by a personal computer using specialized sound software. Additionally, a hydrophone, an underwater sound recording device, was placed in the tank to record the sounds produced. Sound was recorded on oscilloscope, along with brain wave activity.

The type of sound stimuli utilized were tone bursts with a frequency of 1 kHz with a sound pressure level of 30 dB. The number of cycles or periods varied between 5 and 40 and opposing and unopposing polarities were also tested. The following graph is an auditory evoked response recorded in this experiment. The x-axis represents time, with the ABR appearing about 10msec after the sound is produced. The y-axis represents amplitude. The "sound" recording has been moved to the top of the graph for clarity: it should lie along the zero amplitude line on the center of the graph.



I consider my time in Japan well spent, as I was able to accomplish my goal of being ABR-trained as well as perform my own experiment with this new protocol.

RESEARCH REPORT

1. Name: Kenneth Kuhn (ID No.: SP04035)

2. Current affiliation:

Institute of Transportation Studies, 109 McLaughlin, UC Berkeley, Berkeley CA 94704

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution:
Kyoto University
5. Host researcher:
Professor Kiyoshi Kobayashi

6. Description of your current research

Asset management systems help public works agencies decide when and how to maintain and rehabilitate infrastructure facilities in a cost effective manner. Many sources of error, some difficult to quantify, can limit the ability of asset management systems to accurately predict how built systems will deteriorate. I study the application of newly developed robust optimization techniques to deal with epistemic uncertainty. Efficient solution algorithms need to be developed to solve the robust counterpart of the asset management problem. Case studies need to be performed to evaluate the usefulness of the proposed approach in reducing maintenance and rehabilitation (M&R) expenditures.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

The Temporal Distribution of Cost in Discounted Cost Minimizing Asset Management Policies

Description of the research activities:

I investigated how the use of a discount rate affects the distribution of costs over time in asset management systems. Professor Kobayashi guided my work and gave me a wealth of reading material to go over. We wrote a paper that Professor Kobayashi is presenting at a conference and that we hope to publish.

RESEARCH REPORT

1. Name: Jackson Lee (ID No.: SP04037)

2. Current affiliation:

University of Colorado, aerospace engineering

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

X Chemistry ☐ Engineering Sciences X Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

X Interdisciplinary and Frontier Sciences

4. Host institution:

Environmentally degradable polymer research group

Institute for Biological Resources and Functions

National Institute of Advanced Industrial Science and Technology, Tsukuba-shi

5. Host researcher:

Dr Yutaka Tokiwa

6. Description of your current research

My research centers around the application of environmental biotechnology to manned spaceflight advanced life support applications.

Advanced life support (ALS) focuses on devising more reliable or efficient recycling systems for long duration spaceflight for microgravity or a planetary stay. A highly interdisciplinary field, my interest lies in combining space research with current terrestrial research in environmental engineering for the use of bacteria to degrade environmental pollutants (bioremediation) or the production of useful synthetic compounds (biosynthesis) such as single cell protein or bioplastics, or basic microbiology research (microgravity response).

In an enclosed habitat, resource cycles seen on earth (water, carbon, nitrogen) will need to be duplicated to make launch weights feasible. Carbon cycling involves using plants to fix carbon dioxide exhaled by astronauts. The plants are then harvested and consumed by the astronauts, completing the cycle. However, a large fraction of cultivated plants are not eaten by astronauts. This "waste biomass" can constitute a vital source of raw material for several applications. My Masters' thesis research revolves around using this material plus light to produce hydrogen using a novel strain of purple non-sulfur bacteria isolated from freshwater. Additionally, this material can be a useful feedstock for other

processes, such as raw material for biodegradable plastics production.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Enzymatic degradation of DL-PHB by several different enzymes

Description of the research activities:

Biologically produced plastics (polymers) have a significant advantage in that they can be produced and degraded naturally, lessening our waste disposal and resource problems respectively both on earth and in space.

The same bacteria that are used to produce hydrogen have also been noted to produce natural polymers called poly hydroxyalkanoates (PHAs). These polymers can greatly lessen the strain on waste biomass recycling systems by providing a source of raw bioplastic materials as well as a degradation pathway for used plastics inside enclosed habitats.

Commercial biodegradable polymers are already available and gross production increases every year. Now, the search continues for other potentially useful polymers with novel or superior properties. DL-PHB (poly(DL-3 -hydroxybutyrate)), one particular PHA polymer was examined for enzymatic degradation.

DL-PHB is not commercially sold, so the polymer had to be synthesized by organic synthesis and measured for polymer length by gel permeation chromatography (GPC). Difficulty in obtaining high molecular weight polymers was observed. Oligomer of MW 1600 were produced and used in the degradation experiment instead.

After synthesis, the polymer was extracted into chloroform, dried, resuspended in chloroform and used to coat 1 cm^2 paper samples. Also used to make coated paper samples were several commercially available polymers and co-polymers (D-PHB, PHB/PHV 6.66%, PHB/PHV 8% (Biopol), PHB/PHV 10%, PHB/PHV 19.1%). The paper samples were immersed in a media of octyl-glucopyranoside, phosphate buffer, and enzyme. Lipase A and B were used as well as Protease A, B, C, D, and E. Also, lipase C, an enzyme isolated by this lab from bacteria was used. The bath was held at 37 or 50 C for 14 hours. Media was removed from each run and measured on a total organic carbon analyzer and compared with control values. Values greater than control values were an indication of degradability.

It has been previously shown that D-PHB are biodegradable by PHB-depolymerases. There is work also that mentions lipases do not degrade PHB.

Table 1 lists the complete degradation results for this experiment.

Generally speaking, lipase C had very high activity on all polymers, particularly at higher temperature. Lipase B were able to degrade DL-PHB at 50 C, but not at 37 C. Protease A was able to degrade all polymers 50 C but not at 37 C. Protease B-E had some activity or indeterminate activity, and biodegradation was decreased by high temperature. This experiment was a good test method developed in this lab.

My duties in the lab included aiding in the purification and distillation of polymer reactants, synthesis of polymers, polymer extraction, and purification, coated paper creation, GPC operation, running experiment trials, preparing and running samples, etc.

8. Please add your comments (if any):

As with most experiments, it took three times as long to prepare for the experiment as to actually run the experiment.

I've had much fun in Japan in the meantime, and hope to come back again.

The program duration is much too short. Even with university scheduling conflicts to consider, a longer summer program would be much more fruitful for research.

Table 1 Biodegradation of various PHB types

	Lipase A	Lipase B	Lipase C	Protease A	Protease B	Protease C	Protease D	Protease E
37 C								
DL-PHB MW 1600	-	?	+	-	?	+	+	+
D-PHB	-	-	+	-	?	+	+	+
PHB/PHV 6.66%	+	?	+	-	?	+	?	+
PHB/PHV 8.00%	+	?	+	-	?	+	?	?
PHB/PHV 10%	-	?	+	+	+	+	?	?
PHB/PHV 19.1%	-	+	+	-	?	?	-	-
50 C								
DL-PHB MW 1600	+	+	+	+	+	-	?	-
D-PHB	?	+	+	+	-	-	?	-
PHB/PHV 6.66%	-	+	+	+	-	?	?	-
PHB/PHV 8.00%	-	+	+	+	-	?	?	-
PHB/PHV 10%	-	+	+	+	+	?	+	?
PHB/PHV 19.1%	-	+	+	+	?	?	?	-

key: - negative, + postive, ? Indeterminate

RESEARCH REPORT

1. Name: Lynn Lee （ID No.: SP04038 ）

2. Current affiliation: Department of Chemistry, University of California, Berkeley

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences

X Chemistry □ Engineering Sciences □ Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. Host institution: Department of Polymer Chemistry, Kyoto University

5. Host researcher: Prof. Shinzaburo Ito

6. Description of your current research

Utilization of near-field scanning optical microscopy and various spectroscopic techniques to analyze organic thin films and biological materials on a high resolution, nanometer scale.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: C60-PPV Layer-by-Layer Ultrathin Films

Description of the research activities: There are strong interests in organic materials used in alternative energy applications due to the possibility of creating flexible, inexpensive systems. It has been shown that in a composite of electron-donating material and electron-accepting material, a photoinduced electron transfer reaction can occur at the donor-acceptor interface and a photovoltaic response can be generated. Attempts to improve device performance include blending the donor and acceptor materials together to form a single, microphase separated layer, which results in significant increase of the donor/acceptor interfacial area. Here, we have studied the photophysical characteristics of spin-cast thin films and layer-by-layer ultrathin films of C60-PPV (poly(phenylene vinylene)), where C60 is the electron accepting material and PPV is the electron donating conjugated polymer system. We utilized scanning near-field optical microscopy (SNOM) to an! alyze the degree of optical homogeneity of the film on a nanometric scale. Spin-cast thin films were casted from either dichlorobenzene or toluene. Films casted from dichlorobenzene showed efficient quenching of PPV emission and optical homogeneity in the films, both before and after annealing. PPV is more soluble in dichlorobenzene, and it was expected that good blending of the PPV and C60 would cause efficient quenching of

PPV fluorescence. For toluene, we also observed efficient quenching of PPv fluorescence. This homogeneity was surprising, as it was expected that more aggregation and inhomogeneity would be observed due to both materials' lower solubility in toluene. We also fabricated ultrathin films of C60-PPV via layer-by-layer electrostatic deposition method. Aqueous solutions of C60-PDDA bilayers (4) and PVV-PAA bilayers (4) were deposited onto quartz substrates. PDDA and PAA are counterions for C60 and PVV, respectively. Films of approximately 40 n! m thick were produced. We analyzed the films after annealing for 11 hours at 220 degrees Celsius in vacuum. Films containing only the PPV-PAA bilayers exhibited strong emission spectra at 512 and 540 nm (Fig. 1). Films containing the C60-PDDA/PPV-PAA bilayers showed a decrease in emission by an order of magnitude. From previous studies, this emission decrease by a factor of 10 indicates that a distinct interface between the bilayer structures of C60 and PPV is maintained, i.e. intercalation of C60 and PPV has not occurred.

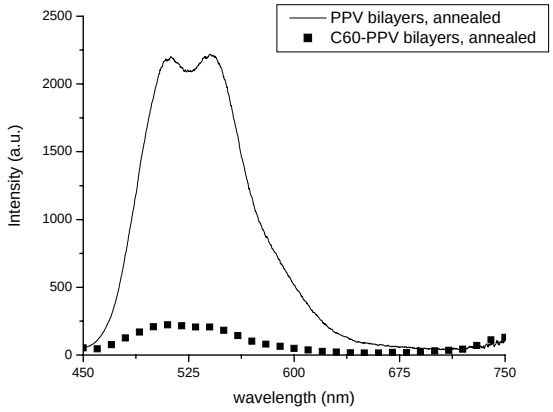


Figure 1: Fluorescence spectra of PPV-PAA bilayers (solid) and C-60/PPV bilayers (dotted) SNOM data showed that a high degree of homogeneity exist in annealed PVV-PAA bilayer films; films with C60-PDDA/PVV-PAA bilayers showed greater inhomogeneity in the films, where there are distinct bright and dark domains in the SNOM images. This is direct evidence of efficient PPV emission quenching by C60 in these ultrathin films. These preliminary results show that ultrathin films fabricated by layer-by-layer deposition have great potential in increasing the interface of the electron donor and acceptor materials and, as a result, in improving performance in organic-based devices.

8. Please add your comments (if any): I immensely enjoyed this opportunity to interact closely with Japanese scientists. International experience is increasingly important for young scientists, and this opportunity is a great introduction to working in a different culture and to communicating with different people, both inside and outside the laboratory.

RESEARCH REPORT

1. Name: Timothy J. Lee (ID No.: SP04039)

2. Current affiliation:

University of Wisconsin-Madison

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

X Chemistry X Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Yamaguchi University

5. Host researcher: Prof. Suzuko Yamazaki

6. Description of your current research

I principally do research in the applications of photocatalysis for environmental technology and engineering. Photocatalysis is the use of a semiconductor, activated by light, to catalyze oxidation/reduction reactions. Environmental applications include: 1. self-cleaning and disinfecting surfaces, 2. the treatment of wastewater and drinking water and 3. the treatment of contaminated air. My research primarily involves the treatment of drinking water.

By using TiO2 as the photocatalyst, we can use ultraviolet light to treat water. Photocatalysis has been demonstrated to be effective for disinfection of pathogens, destruction of harmful organic compounds, and removal of undesirable metals. My past research as well as my research here in Japan has primarily involved the removal of metals. In the past I have worked on the removal of arsenic, while here in Japan I have studied the removal of copper.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Removal of Copper (II) from Aqueous Solution Using TiO_2 Photocatalysis

Description of the research activities: We conducted a series of tests of the photoplating capability of the TiO_2 for the removal of copper (II). When light of the appropriate wavelengths (ultraviolet) are absorbed by TiO_2, it becomes a strong catalyst for oxidation/reduction reactions. For the removal of Cu (II) we are interested in reduction to Cu (0) metal. When copper is reduced, it coats the catalyst surface (photoplating) and is removed from water.

The experiments were performed in water, using a medium-pressure mercury lamp that emits ultraviolet radiation. The TiO_2 was initially created as a fine suspension (sol) created using sol-gel chemistry. The sol was then coated onto the surface of glass rings and heated to 500 ^{0}C to sinter the TiO_2. Several experiments were conducted with different amounts TiO_2 and different sintering conditions, as well as a mixture of TiO_2 and SiO_2, believed to improve catalyst performance.

The rings were each placed into a copper-bearing solution and illuminated with the lamp. The solution consisted of 500 mL of water, taken to approximately pH 3.6 with nitric acid, 25 mg of copper (II), and an electron donor (sodium formate). The solution was purged with nitrogen to remove as much dissolved oxygen as possible. This purge was performed for one hour prior to each experiment and was continued during the length of the experiment. Samples were taken from the reaction solution periodically during each six hour experiment, and the resulting concentration was measured with either inductively-coupled plasma optical emissions spectroscopy or atomic absorption spectroscopy. When the experiment was complete, the ring was removed and examined afterward. The rings were then placed into a concentrated nitric acid solution that re-dissolved the photoplated copper, and the copper concentration of this solution was then measured to confirm the amount on the surface.

The results demonstrated that thickness and sintering conditions did play an important role in the photoplating of copper, though the role of SiO_2 was unclear based on these experiments. The best results were observed for thicker coats of TiO_2, though one sample with a thick coat of mixed TiO_2-SiO_2 catalyst also showed excellent results.

9. (If any) Advisor's remarks:

Mr. Lee worked very hard and obtained data on the preparation of sol, making films of photocatalysts by dip-coating and removal of copper from water by photoplating on the films. He showed that the coating with the mixed TiO_2-SiO_2 sol worked efficiently for the removal of copper. Since specific surface areas of the photocatalysts increase by mixing the SiO_2, we will continue this research to clarify the effect of SiO_2 on the photoplating.

He collaborated very well with the students in my research group. They have learned a lot from working with him. I appreciate his efforts for the collaboration with us.

RESEARCH REPORT

1. Name: Matthew J. Major (ID No.: SP04040)

2. Current affiliation: Graduate student and research assistant of the Human Dynamics and Controls Laboratory of the University of Illinois at Urbana-Chamapaign

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry X Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Bionic Design Laboratory of Kyushu University at Fukuoka, Japan

5. Host researcher: Dr. Teruo Murakami and Dr. Nobuo Sakai

6. Description of your current research

My current research is a biomechanical study of aggressive in-line skating. Aggressive in-line skating is a sport that emphasizes balance. A popular activity is grinding, where the skater jumps onto a grind rail - which may be a specially designed structure at a skate park, or a common handrail on a staircase. In grinding, skaters jump up and accurately place their skates on the rail, smoothly decelerate, and balance upon the rail while sliding. In-line skaters have developed a heuristic approach to training. Inherent to their training are exercises that emphasize the development of muscle control during eccentric muscle contractions to smoothly decelerate the body. For example, before performing a grind, the skater will repeatedly jump upon an object and "stall" - that is, jump, place skates on the rail, decelerate, and hold that position. Our main focus is in the prevention of complete loss of balance, falls, and injury in the event of impact with the ground. We are collecting data on limb motion and forces developed during deceleration activities, such as grinding and stalling. By performing controlled jumping and balancing experiments, this project allows us to gain insight into how these individuals are able to use eccentric contraction to assist with maintaining balance and, perhaps, minimizing impact force and energy. A steel grind rail has been fabricated, which is constructed to behave like a simply-supported beam (i.e., sustain no moments at the supporting ends). Load cells at each end of the rail record applied vertical reaction forces. These signals are collected by the Vicon workstation. A Full-body marker set allows us to compute the center of gravity of the entire body and joint angles. Using inverse dynamics, we can compute the joint torques in the

lower extremities during grinds and stalls. Additionally, we are able to collect electromyographic (EMG) activity of the lower extremity musculature in order to identify which muscles or muscle groups are active during particular phases of each activity.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Upper Extremity Motion Capture:
Punching Form Utilizing Various Shoulder Joint Range of Motion

Description of the research activities:

The shoulder joint provides the largest range of motion (ROM) of all human physiological joints, uniquely utilizing three degrees of freedom. An exercise that takes advantage of this expansive ROM is punching, an activity present in various types of contact sports and martial arts. The objective of this study was to observe and analyze several punching motions which utilize the shoulder joint in varying ways. Three different forms of punching are chosen from three respective sports: Boxing, Shotokan Karate, and Choy Lay Fut Kung Fu. A standard Boxing jab begins with the shoulder flexed, elbow flexed, and hand pronated, executed by flexing the shoulder, extending the elbow, while sustaining hand pronation. A standard Karate forward punch begins with the shoulder extended, elbow flexed, and hand supinated, executed by flexing the shoulder, extending the elbow and pronating the hand. A standard Kung Fu uppercut begins with the shoulder extended, elbow flexed, and hand supinated, executed by flexing the shoulder, extending the elbow, while sustaining hand supination.

The motion of each punch was captured on 3Space Fastrak ® equipment utilizing two receivers. One receiver was fixed to the Olecranon Process of the right forearm and the second receiver was fixed to an exo-skeletal back brace representing the right Acromion Process. The exo-skeletal back brace was used to secure the shoulder joint position by avoiding clavicle rotation, and allowing for absolute angle measurements. Visualization software was developed in order to measure the yaw, pitch, and roll angles of the upper arm with respect to the joint in real-time. This software utilizes a mean point method to determine the elbow joint axis. This method constructs points along an arc, in this case the rotation of the forearm with respect to the elbow joint, and produces a least square calculation to locate the center of rotation. A corresponding vector perpendicular to this plane is used in world-coordinates to represent the elbow joint rotation axis. The shoulder joint

remains as a fixed 5 cm below the predefined Acromion Process. The shoulder coordinate system and axis are determined by defining two axes and utilizing the Gram-Schmidt method to identify the third. The defined axis orientation in relation to physiological movement dictates that yaw and pitch angle are related to horizontal flexion/extension and abduction/adduction of the shoulder joint, respectively. It is critical to note that roll angle is difficult to apply to human motion, in which it is commonly a combination of at least two of the predefined angles.

Each punch was performed six times by one subject: three at normal speed and three at slow speed. Both the execution and return of each punch were observed. A Boxing execution displays slight horizontal extension coupled with abduction. A Karate execution displays significant horizontal flexion coupled with slight initial adduction and following abduction. A Kung Fu execution displays slight initial horizontal extension and following horizontal flexion coupled with initial slight adduction and following abduction. Karate and Kung Fu utilize similar horizontal flexion motions during execution. However, Kung Fu possesses a unique profile in which it falls short of the horizontal flexion performed in Karate during execution by approximately 30 degrees, and then demonstrates further horizontal flexion and a more rapid extension during the return phase. Boxing begins in a horizontally flexed position and only provides limited horizontal extension. All three punches display similar abduction profiles with approximately equal angle magnitudes, however Karate and Kung Fu display a more pronounced initial adduction during execution. Both Boxing and Karate display symmetric behavior between execution and return, while Kung Fu displays a more unique motion, as described previously. All three punches display similar roll behavior, but this is subject to definition and requires further investigation.

Yaw and pitch angle are measured using a temporal coordinate system. However, due to the nature of Euler angles, near pole movements cause a flip of axis orientation, therefore a new coordinate system is developed to measure roll angle. Further research must be performed in order to more clearly define roll angle and account for Codman`s Paradox. Further study would involve investigation of the power and work output provided by each punch and why each sport chooses this particular punching motion (i.e., positive and negative aspects).

8. Please add your comments (if any):

I would like to deeply thank the following for making all of this possible and for providing this most highly valued research experience: Dr. Murakami, Dr. Sakai, and the Bionic Design Laboratory of Kyushu University, the National Science Foundation, and the Japan Society for the Promotion of Science.

RESEARCH REPORT

1. Name: Marek P. Michalowski (ID No.: SP04041)

2. Current affiliation:

Carnegie Mellon University, Robotics Institute

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
■ Interdisciplinary and Frontier Sciences

4. Host institution: Advanced Telecommunications Research Institute International (ATR)

5. Host researcher: Gordon Cheng

6. Description of your current research

I am currently working in the area of social robotics. I am interested in building robots that can naturally exchange social cues with humans in order to facilitate social interactions. My current research involves the perception and generation of attentive behavior by social robots; that is, giving robots the ability to detect humans in the environment and to determine the focus of their attention, as well as the ability to behave in such a way that humans can easily understand, to some extent, the state of the robot. At Carnegie Mellon I have been working on the development of a robotic receptionist that provides both information services and entertainment to visitors. We have developed various methods of detecting people through the use of cameras and laser scanners, and we are working to improve the interactive capabilities of the robot by giving her the ability to recognize the attentive behavior of her human partners.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

The recognition of pointing gestures on the robot DB

Description of the research activities:

I implemented a system that allows DB, a hydraulic humanoid robot, to recognize pointing gestures by humans and then to point in the same direction. The robot first finds a human in the environment by searching for a face and tracking it over time through the use of a skin color model. Using this same color model, DB locates the human's arms by looking for skin blobs to the left and right below the detected face. By fitting ellipsoids to these blobs, the robot can determine the general direction in which the arm is pointing. If the general shape and location characteristics of the arms are found to be within expected bounds, and the arms are not hanging vertically at the person's side, the robot estimates a location in which one of the arms is likely pointing. The robot then moves its own eyes and arm toward that point.

8. Please add your comments (if any):

There was a large body of existing code to control the robot's various subsystems. While this simplified many of the vision and motor control aspects of implementing this pointing task, it also took several weeks just to become acquainted with the existing system. I would like to have spent a longer time developing my own application, yet the time spent understanding other people's work was a worthwhile learning experience.

RESEARCH REPORT

1. Name: Matthew R. Milnes (ID No.: SP04042)

2. Current affiliation: University of Florida, Dept of Zoology

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences

□ Chemistry □ Engineering Sciences XX Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. Host institution: Okazaki National Research Institutes, Institute for Integrative Bioscience, Department of Bio-Environmental Science

5. Host researcher: Taisen Iguchi

6. Description of your current research

My primary research interests lie in examining the effects of environmental influences on reproductive and developmental physiology. Specifically, I am interested in how extrinsic factors such as environmental contaminants and nutrient levels affect maternal reproductive processes and development of the offspring in vertebrate wildlife species. I am currently examining the egg yolk biochemistry, embryonic and neonatal development of the endocrine system, and adult blood biochemistry in alligators from various lakes in Florida.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Expression of steroidogenic enzymes in *Alligator mississippiensis* exposed to environmental contaminants during embryonic development

Description of the research activities:

The goal of this project is to elucidate the mechanisms through which environmental contaminants alter the process of steroid hormone production, steroidogenesis, in alligators at the molecular level. The approach has been through the use of a descriptive and an experimental study in which alligators have been exposed during embryonic development to various environmental contaminants. The descriptive portion of the study consists of comparing gene expression and activity of steroidogenic enzymes in the gonads of alligators obtained from a contaminated site to animals from a reference site. The contaminated site, Lake Apopka, FL, has been subjected to nearly 40 years of heavy pesticide and nutrient runoff from adjacent agricultural operations and a large spill in 1980 consisting of dicofol (contaminated with DDT, and its derivatives DDD and DDE) and sulfuric acid. Previous studies have documented reduced egg viability (% of eggs that hatch), altered endocrine function and morphological abnormalities in alligators from this population. The reference site, Lake Woodruff NWR, has shown high egg viability rates relative to other Florida lakes, and is the recipient of minimal point-source contamination. The experimental portion of this study consists of similar comparisons of contaminant-treated and non-treated eggs collected from the reference site, Lake Woodruff NWR. The contaminants used for the treatment study were a representative mixture of 9 organochlorine pesticides detected in a recent analysis of egg yolks collected from Lake Apopka.

The first phase of this project has already been performed and includes egg collection, treatment, incubation, and tissue collection. Eggs were collected from Lake Apopka and Lake Woodruff NWR and were systematically assigned to one of two experiments. The first experiment is a comparison of 60 alligators from the two study sites (10 alligators/clutch; 6 clutches/lake), and the second experiment consists of treatments of eggs collected from the reference site, Lake Woodruff NWR. A 1.0x and 0.5x equivalent of the mean concentration of Apopka contaminants were used for the treatment study. Treatments were applied topically in 50 μl of ethanol. Upon hatching, alligators were housed under standardized conditions for a period of 13 months during which periodic blood samples were taken to compare plasma steroid levels to previously published values. After which, animals were euthanized, gonads were removed and flash frozen, and then prepared for quantitative RT-PCR (Q-PCR) analysis or steroidogenic enzyme culture.

The second phase of this project consisted of performing quantitative, real-time

PCR (Q-PCR) for steroidogenic genes and transcription factors to gain a better understanding of how embryonic exposure to contaminants alters steroid synthesis. This phase was performed in the laboratory of Dr. Taisen Iguchi at the Okasaki National Research Institute in Japan. Through ongoing collaborative efforts with Dr. Iguchi's lab and others, we have cloned and sequenced the genes for steroid acute regulatory (StAR) protein, aromatase (P450arom), and steroidogenic factor-1 (SF-1) in the alligator. Another goal of this project was to clone and sequence additional steroidogenic genes in the alligator including cytochrome P450 side-chain cleavage (P450scc), 3β-hydroxysteroid dehydrogenase (3β-HSD), and 17α hydroxylase (P45017) through cooperative efforts with Dr. Iguchi's lab.

Q-PCR was performed for the 6 genes described above using standard techniques currently validated for the American alligator. In short, total RNA from the right gonad was isolated with TRIzol reagent (Invitrogen), and purified with a RNeasy kit (QIAGEN). First strand cDNA synthesis was performed on 2 micrograms (in 20 µl reaction) of total RNA using SuperScript II RNase H- Reverse Transcriptase (Invitrogen) and random primer (Invitrogen). Primers for Q- PCR were designed from alligator coding sequences. A full sequence also has been obtained for the alligator ribosome L8 gene for the purpose of normalization, and primers were designed based on that sequence. PCR was carried out in the ABI prism 5700 according to the manufacturer's protocol with 15 µl of the reaction volume. PCR conditions were 2 min at 50°C, 95°C for 10 min and 40 cycles at 95°C for 15 sec, and 60°C for 1 min. Relative quantification of gene expression was calculated using the comparative C_T method according to the manufacture's protocol.

The final phase to be performed at the University of Florida, will compare specific enzyme activity of microsomal preparations of the left gonad from the same animals to allow a more thorough interpretation of the molecular data obtained through Q-PCR. Steroidogenic gene expression levels do not necessarily conform to enzyme activity levels. Gonad tissue homogenates will be incubated in culture medium with an appropriate substrate determined by the Q-PCR data. Following 12 hours of incubation at 32°C, culture media will be removed and assayed for the steroid(s) of interest using previously validated radioimmunoassays. The substrate used and end products measured will be determined based upon specific differences detected by Q-PCR. For example, if a difference in aromatase mRNA expression, the enzyme responsible for the

conversion of androgens to estrogens, is observed among treatment groups, then androstendione will be added as a substrate and estradiol will be measured in the culture medium.

The results of these studies will test hypotheses developed to explain the abnormalities reported in alligators living in contaminated lakes. In order to understand the full impact of sub-lethal exposure on wildlife populations, we must identify how these disruptions affect the physiology of individuals. This project will provide insight into the different modes of action that environmental contaminants have on gene expression and enzyme activity vital to normal endocrine function, in addition to determining how contaminant-induced effects persist beyond embryonic development in an aquatic vertebrate.

8. Please add your comments (if any):

Statistical analyses of the data generated during the program were not available at the time of this report.

RESEARCH REPORT

1. Name: Maysha Mohamedi (ID No.: SP04043)

2. Current affiliation:

University of California, Davis

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry Engineering Sciences X Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Riken Brain Science Institute

5. Host researcher: Dr. Shun-ichi Amari

6. Description of your current research

In 1962, Julesz was the first to ask whether his human subjects' ability to discriminate certain textures was related to the texture image statistics. Since then, similar experiments have been done on monkeys and honeybees, with results matching the first human experiments: some pairs of distinct textures are spontaneously discriminated. If we could isolate what is special about these textures then we could speculate how the underlying neural mechanism works to discriminate these textures. Until now, there has been a consensus that the underlying neural mechanisms responsible for this task utilize the textures' fourth order statistics so it becomes important to construct purely fourth-order patterns to confirm this hypothesis.

By using information geometry we can generate visual patterns that contain purely fourth-order correlations. The current research is focused on how to generate such images.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Texture discrimination and higher order correlations

Description of the research activities:

There are two main obstacles in generating purely fourth-order visual patterns:
1)Obtain a probability distribution with only fourth-order interactions and
2)Generating a pattern from this probability distribution.

The first obstacle involves using Information Geometry, a method used to study the structures of hierarchical systems of probability distributions. Using Information Geometry we can decompose the natural hierarchical structure of an exponential family (or higher order Markov chain etc.) of probability distributions.

Once the second obstacle is overcome we will have purely fourth-order visual patterns that can be used as the stimuli in honeybee pattern discrimination tasks.

RESEARCH REPORT

1. Name: Derek Nastase (ID No.: SP04044)

2. Current affiliation: University of California, Irvine

3. Research fields and specialties:

Engineering Sciences

4. Host institution: Urban Safety and Rick Management, IIS, Tokyo University

5. Host researcher: Dr. K. Meguro

6. Description of your current research

In the United States, my research is in the field of Civil Engineering, focusing specifically on the behavior of expensive, fragile equipment and hazardous material containers within a laboratory environment under seismic (earthquake) motion. Although these items are not designed as part of a building structure, they lead to significant monetary loss after an earthquake. In the Northridge earthquake of 1995, small pieces of glassware that were damaged or spilled led to several fires that destroyed entire laboratories.

Little research has been conducted to understand the behavior of these small, rigid, and oddly shaped objects under erratic seismic motion. Also of importance is the laboratory environment in which these items are placed. The exact type of motion that is delivered to the objects is critical to determining the behavior.

During the last school year and into this summer, while I have been in Japan, I have been working on an experiment within a full scale building. The office building, which was damaged in the Northridge earthquake, was opened to the University of California system as a test bed. Within the fourth floor of the building, we re-created three laboratory environments. Eccentric and linear mass shakers were mounted to the roof to excite the building in various types of motion. A compilation of this research and other previous laboratory and analytical testing will be used to develop fragility curves of the equipment of interest.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Understanding Japanese Non-structural Methodology

Description of the research activities:

Albeit a conglomerate of many different things, my research this summer focused on understanding the design and mitigation strategies that have been developed in Japan with regard to non-structural elements, and more specifically furniture. There were three key components to the research; interviews with experts in the field, exploration of Japanese literature on the subject, and implementation of element modeling.

Because Japan does not have a design code addressing non-structural elements as in the United States, the most direct route to obtain information on the subject was to interview the people who conduct research in this area. Three interviews were conducted; two formal, one informal, and all of them in person. The results of the discussions revealed that much of the known information on large pieces of furniture is the same, although the mitigation strategies are different. In Japan, the government is taking the initiative to use research on furniture restraint to educate the general population.

Exploring the world of Japanese research literature was probably a more frustrating component of the summer as many of the papers were in Japanese. Thankfully my host researcher made a great effort to afford me the luxury of research papers in English. I was fascinated to learn that the body of research on the subject of rigid body motion is very old due to the usage of tumbled gravestones in post-earthquake magnitude measurement. On the analytical side of rigid-body motion, the laboratory I worked in had developed computer simulation tools to understand behavior virtually. Unlike the Finite Element Method of analysis that I was used to, the program used what is called the Extended Distinct Element Method (EDEM). This distinction played a key role in the final chapter of my summer.

As a last effort during the summer, I worked on continuing computer models from the United States for integration with the simulation software used in my host research institution. Despite my efforts, a lack of information flow with my laboratory in the United States slowed this process down such that I was not able to finish my computer model to an appropriate degree of accuracy. Therefore the model transfer has not been completed, although it could be implemented at any time in the future.

8. Please add your comments (if any):

The cultural experience of living in Japan and working as a Japanese researcher has been the most valuable part of my summer stay. My host institution was incredibly gracious to me, always extending invitations for me to participate in various events. Many of the students helped me with understanding the language, the culture, and even the research that I was trying to conduct.

RESEARCH REPORT

1. Name: Helen L. Ngo (ID No.: SP04045)

2. Current affiliation: University of North Carolina at Chapel Hill

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences

X Chemistry □ Engineering Sciences □ Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University

5. Host researcher: Professors Masamichi Ogasawara and Tamotsu Takahashi

6. Description of your current research

My research project in the Takahashi/Ogasawara group at Hokkaido University focused on the development of asymmetric catalysts using the remote control of the BINAP ligand. Lin et al. have recently reported that a family of ruthenium complexes of tunable 4,4'-substituted BINAP ligands, in particular, 4,4'-bis(trimethylsilyl)-BINAP (**L2**) are extremely active catalysts for homogeneous asymmetric hydrogenation of aromatic ketones and ketoesters.[1] On the basis of the work reported by Lin et al, we decided to examine the utility of the **L2** ligand in palladium- and rhodium-catalyzed asymmetric C-C bond formation reactions. We hope to rely on the 4,4'-substituents on the BINAP moiety to enhance the catalytic activity and enantioselectivity of these reactions.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

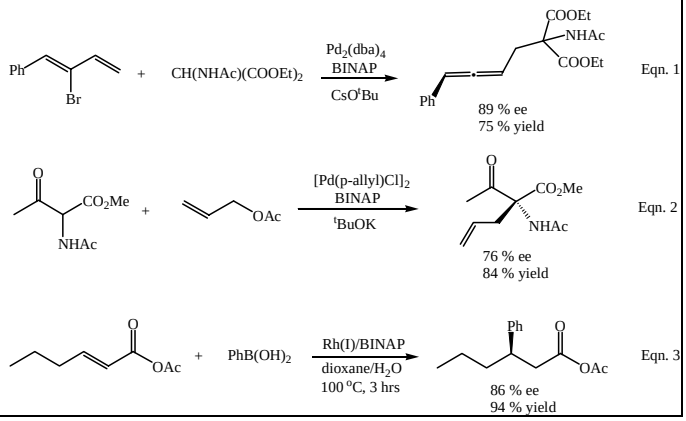
Development of New Asymmetric Catalysts Using 4,4′-Substituted BINAPs

Description of the research activities:

Introduction

The objective of this research project is to develop new asymmetric catalysts with high enantioselectivity and catalytic activity. For this project, we have chosen to target three different asymmetric catalytic reactions that are important for the formation of chiral molecules: 1) palladium-catalyzed asymmetric synthesis of axially chiral allenes; 2) catalytic asymmetric allylation of prochiral nucleophiles; and 3) rhodium catalyzed asymmetric 1,4-addition of arylboron reagents to α,β-unsaturated esters. We have characterized the catalytic activity and enantioselectivity of these catalysts with Nuclear Magnetic Resonance (NMR) spectroscopy and High Performance Liquid Chromatography (HPLC), respectively.

Scheme 1



The area of asymmetric catalysis has undergone tremendous growth over the past two decades, and many highly enantioselective catalytic reactions have now been developed. New catalytic asymmetric synthetic methodologies are still needed for the efficient synthesis of chiral compounds for the pharmaceutical, agrochemical, and fragrance industries. Synthesis of axially chiral allenes, for example, has recently been sought after because of

their distinct characteristics and their usefulness as synthons in synthetic organic chemistry. Ogasawara et al. have recently reported an effective method for the catalytic asymmetric synthesis of chiral allenes. They reported ee values of up to 89 % for the formation of chiral allenes, which is the highest ee in the literature (Scheme 1, Eqn. 1).[2] Another important reaction for the formation of chiral C-C bonds is catalytic asymmetric allylation with a chiral π-allyl-palladium (II) complex. Ito et al. reported an enantio-selective allylation of up to 95 % ee of prochiral nucleophiles using palladium-BINAP (L_1) complex (Scheme 1, Eqn. 2).[3] For the summer research project, we have also examined carbon-carbon bond formation reaction via conjugate addition of arylboron reagents to α,β-unsaturated esters using rhodium catalysts.[4] (Scheme 1, Eqn. 3).

Results and Discussion

Enantio-enriched chiral allenes (**3**) were prepared by the following procedures (Scheme 2). First, a mixture of the **L**2 ligand and 0.5 equiv. of $Pd_2(dba)_4$, CsO^tBu, and $CH(NHAc)(COOEt)_2$ (**2m**) was cooled down to 0 °C prior to the addition of dichloromethane. The dichloromethane mixture was then allowed to stir at rt for 10 minutes followed by the addition of 2-bromo-1-^{t}butyl-1,3-butadiene (**1a**). The resulting mixture was allowed to stir at rt for 24 hours and was then passed through a short-alumina. After removal of the organic solvent under reduced pressure, the residue was further purified using alumina column chromatography. The purity of the desired product was determined by ^{1}H NMR and the enantioselectivity was determined by chiral HPLC.

Scheme 2

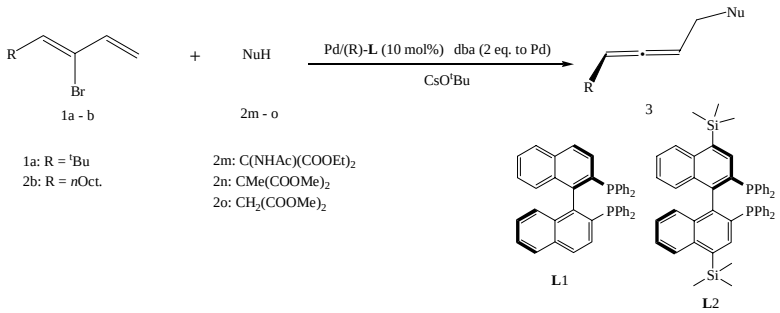


Table 1 shows the results for palladium-catalyzed asymmetric allene syntheses using both the **L**1 and **L**2 ligands. It can be seen from Table 1 that there is an enhancement in ee values with the **L**2 ligand. The preliminary results have thus shown that the Pd-catalyzed allene synthesis can benefit from the bulky substituents on the 4,4′-positions on BINAP. More work is needed to establish the generality of such a beneficial substituent effects on BINAP for the Pd-catalyzed allene synthesis.

Table 1

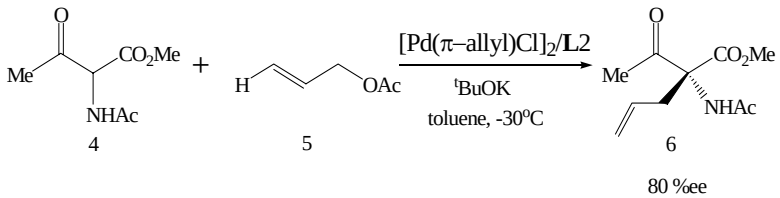
Ligand	Diene	NuH	Temp.	Yield %	% ee (lit.)
L1	1a	2m	RT	70	74 (75)
L2	1a	2m	RT	72	85
L1	1a	2n[a]	RT	——	70
L2	1a	2n[a]	RT	——	80
L1	1b	2o	RT	——	32
L2	1b	2o	RT	86	50
L2	1b	2o	0°C	——	60

a = Base is NaH.

We have extended our studies to the asymmetric allylations of α-acetamido-β-ketoesters **4** with allylic substrate **5** for the formation of an optically active allylation product, **6**. Chiral allylation product was prepared in a similar fashion to the reported procedure.[3] Our first attempt for asymmetric allylation of methyl 2-(N-acetamino)-3-oxopentanoate **4** with allyl acetate was carried out in toluene at –30 °C in the presence of palladium and (*R*)-**L**2. The reaction was successfully carried out in 24 hrs with 70 % conversion and 80 % ee (Scheme 3). Such a level of enantioselectivity is higher than that observed for the allylation product reported by Ito et al.

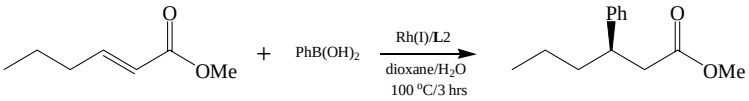
Encouraged by the performance of Pd(**L**2)-based catalysts for asymmetric synthesis of

Scheme 3



allenes and allylic alkylation reactions, we have also examined how the 4,4'-TMS BINAP ligand will perform in asymmetric rhodium-catalyzed 1,4-addition of arylboron reagents with α,β--unsaturated esters (Scheme 4). In this case, we observed only 2 % ee enhancement.

Scheme 4



Conclusion

We have successfully demonstrated that 4,4'-TMS-BINAP ligand with both palladium and rhodium metals are active catalysts for three different asymmetric catalytic reactions. Our preliminary results show that 4,4'-TMS-BINAP ligand exhibit higher ee values than the parent BINAP for all three catalytic asymmetric reactions that we have examined. More work will be directed toward examining the generality of such a remote substituent effects and ultimately designing practically useful new asymmetric catalysts.

Acknowledgments

I wish to thank Professor Wenbin Lin of University of North Carolina at Chapel Hill for his help and NSF/JSPS for financial support.

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8. Please add your comments (if any):

I wish to thank Professor Wenbin Lin of University of North Carolina at Chapel Hill for his help and NSF/JSPS for financial support.

9. (If any) Advisor's remarks:

This is my first experience to host an awadee of the JSPS/NSF summer program. Although time available for research has been limited to 6-7 weeks, Helen could achieve something potentially publishable mainly because she worked very hard and very efficiently. At the same time, we also encountered difficulty to complete the project within such a short period of time. We have decided to continue out project as a collaboration between Hokkaido University and University of NorthCarolina where Helen is from after discussing with her advisor at UNC. I believe that with an additional few weeks she may accomplish the project. I strongly believe that if JSPS and NSF expected participants of the program to accomplish something in theirscientific research, the period for the research works should be longer (3 months at least).

If I could have another chance to host a foreign student through this program, I would certainly like to accept it.

RESEARCH REPORT

1. Name: Philip ORDING (ID No.: SP04046)

2. Current affiliation: Columbia University

3. Research fields and specialties: Mathematics, Knot Theory

☐ Humanities ☐ Social sciences ☒ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Gakushuin Daigaku

5. Host researcher: Professor NAKAJIMA (official host), Mikami HIRASAWA, Hitoshi MURAKAMI

6. Description of your current research

My research is in the mathematical theory of knots. A knot is --- to a topologist --- an embedding of the circle in the three-dimensional sphere. The general aim of knot theory is to classify knots. Two knots are said to be equivalent if we can continuously deform one into the shape of the other in finite time. Given two knots, it is a difficult problem to determine whether or not they are equivalent. One way to simplify this problem is to consider only knots that may be embedded in a given surface in the three-sphere. This restriction of the classification problem has been solved in the case where the surface is a torus. The goal of my current research is to classify knots in the connect-sum of two tori, the so-called double torus.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Turning Double Torus Knots Outside-in

Description of the research activities:

- Studied articles on double torus knots and tunnel number, especially the work of Kobayashi, Morimoto, Murasugi, Hill and Penner
- With Hirasawa, proved theorem concerning certain equivalence (the “outside-in formula”) among double torus knots.
- Presented research at KOOK International Graduate Student Workshop on Knots, Osaka City University
- Attended KOOK International Conference on Knots, Awaji Island
- Prepared research article to be submitted for publication.

RESEARCH REPORT

1.) Name: Thomas Takeo Osugi （ID No: SP04047）

2.) Current affiliation: University of Nebraska- Lincoln

3.) Research fields and specialities: Mathematical and Physical Sciences

4.) Host Institution: Riken at Wako, Saitama

5.) Host Researcher: Dr. Takahiro Koishi

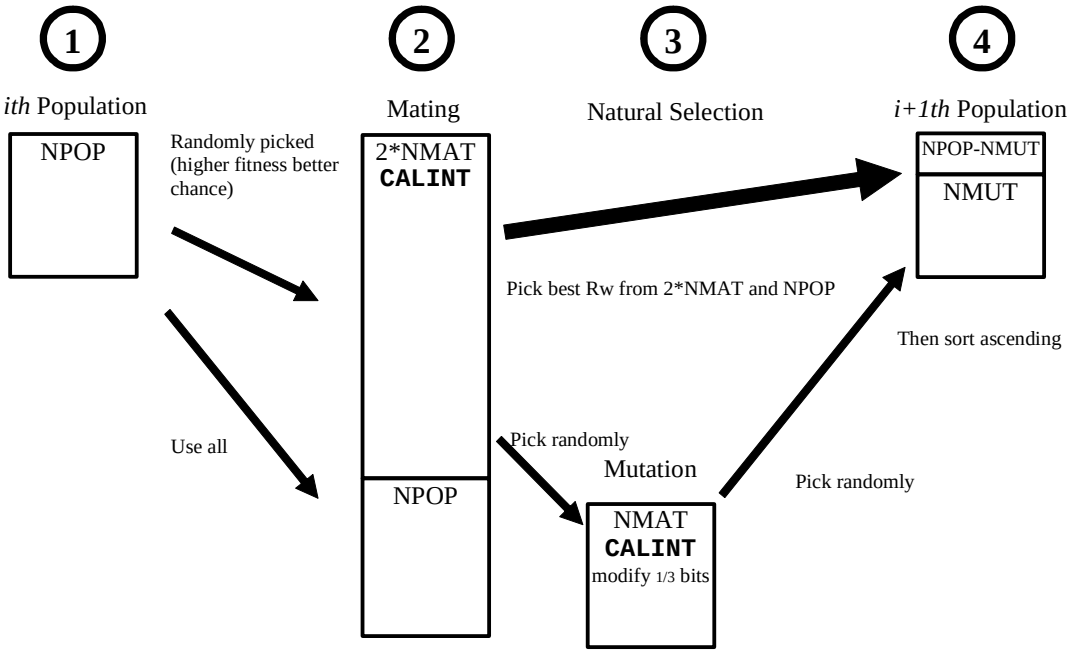
6.) Description of Current Research

Protein molecules are nano-scale machines that perform various complicated functions including chemical reactions as enzymes in living cells. 3D structure information can help us understand the functions of these proteins. This is useful in medicine and biotechnology applications such as protein engineering and structure-based drug design [1].

X-ray crystallography data is used extensively to determine the structure of these proteins. One of the problems of this data is that phase information is lost, or in other words, our 3D data is flatten into 1D space. Our approach to solving this problem is called the Direct Space (DS) method. We compare the intensity of each X-ray diffraction spot with a corresponding Bragg reflection calculated by Fourier transformation from an assumed atomic model. Parameters of the molecules (positional coordinates and orientation angles) are determined by our Genetic Algorithm (GA). This is called the GA-DS method. This approach has been successful for small molecules [2]. For large molecules of interest, proteins, this method requires significant computational resources.

Genetic Algorithms are search techniques that are based upon the mechanics of natural genetics. We want to find the best positional coordinates and orientation angles (x,y,z,a,b,g) such that our atomic model matches the diffraction data. We call the difference between the two, the Reliability Factor (Rw). Our GA finds the best (x,y,z,a,b,g) that result in the smallest Rw. There are four steps to Nishibori's GA: creation of initial population, mating, mutation, and natural selection [3].

Nishibori's GA



For the 0th population, we create NPOP strings of randomly chosen (x,y,z,a,b,g). We then calculate the Rw value for each string. Rw is dynamically scaled from 0 to 1 to represent "fitness" of each member in the population.

In **1->2**, we randomly choose a pair of strings from the *ith* population (higher fitness ones have a better chance). Randomly, values from each string are swapped (crossover process), and the resultant children are entered into an intermediate pool (2). We create *2*NMAT* children. In addition, we also put the parents into the pool.
Rw is calculated for each of these 2**NMAT* children.

In **2->3,** NMAT strings are taken from the intermediate pool to be mutated. Approximately, 1/3 of the values in each string are changed to a random number. Rw is calculated for the the newly mutated strings.

For *i+1th* population (4), *NPOP-NMUT* members of highest fitness from intermediate pool (2) and *NMUT* members from mutated pool (3) are selected for the new population. The member with the minimum Rw value is then determined. Steps 1-4 are repeated until we have a satisfactory solution (Rw of 0.20 - 0.40)

7.) Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Optimizing Genetic Algorithm for Determining Protein Structures

At Riken, I have been researching better ways of using genetic algorithms. Of the three proteins structures, 201.pdb, T189.pdb and 156.pdb (which can be downloaded from http://www.rcsb.org/pdb/), because of the two month time constraint, only 201 results can be reported. Experiments were executed using four nodes on the special purpose cluster,

MDM (Molecular Dynamics Machine). Over the research experience, I explored three areas.

1.) Determining values for *NPOP, NMAT, NMUT* which result in a fast and reliable convergence. Values below have been determined for one CPU (15 Trials each).

NPOP	*RUNTIME (s) (MEAN)*	*RUNTIME (STDEV)*	*% Convergence*
100	921.53	480.67	60
500	**1049.02**	**415.31**	**93**
1000	1914.3	794.86	93
5000	7671.06	3557	100

Without a significant degregration in performance, *NPOP* of 500 seems to an effective population for determining good structure. It is 93% successful which is acceptable for most applications. Because of lack of computational resources, best *NMAT* and *NMUT* could not be determined (10s of trials would be needed).

2.) Determining whether GA is successful for determining structure for various resolution data (50 trials).

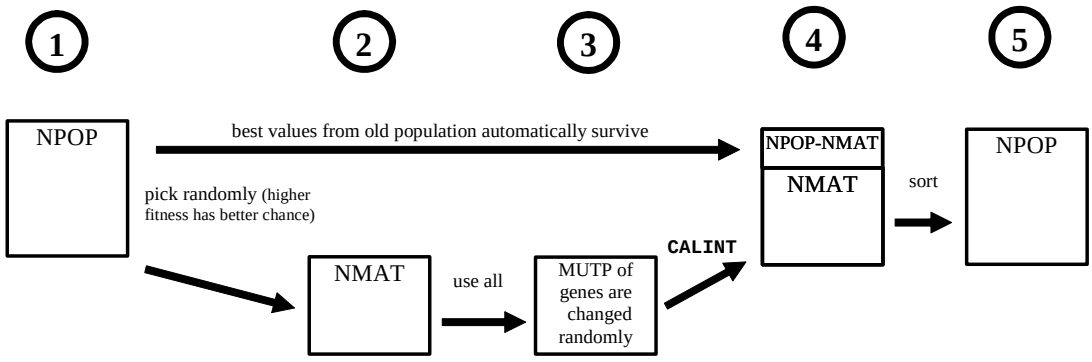
D-spacing (A)	*Best Rw*	*RUNTIME (s) (MEAN)*
1.5	0.4659	6578
2.0	0.4441	4130.9
2.5	0.4489	2120.9
3.0	0.4160	3236
3.5	0.3999	1910
4.0	0.4290	1525
4.5	0.5061	1246
5.0	0.6240	1180

As we can see, DS-GA is ineffective for data with resolution 4.5A and 5.0A. Optimal Rw value is around 0.42. Significantly different Rw values indicate that positional coordinates and the orientation angles are off.

3.) Streamlining the GA process and comparing it to the original version

Approximately 95% of execution time for the GA program is spent calculating Rw values. In Nishibori's source code, the method that calculates Rw is called `CALINT`. Note that `CALINT` is called *3*NMAT* times. Rw information is lost between **2** and **3** because bits are randomly changed within each string during the mutation process. Some information calculated in **2** are not used in the $i+1^{th}$ population. Not all values in NMAT in **3** are used towards **4** (since typically $NMUT < NMAT$).

Optimized GA (Osugi)



By reducing the number of CALINT calls, we can dramatically reduce execution time. At first glance, the new process seems to blindly pick members (**1->2**). However, similar to the original GA, it relies on fitness information for natural selection. For the mating process, we only create an intermediate population of *NMAT* vs. *2*NMAT* in Nishibori's process. Little information is gained by sampling twice in his process although there is a significant performance hit. **3->4** in the new process is the only time CALINT is called. Every Rw value in the optimized process is used towards the new population. Note that the total number of calls to CALINT is *NMAT*. In **1->4, s**imilar to Nishibori's GA, an elite strategy is employed. This ensures that minimum Rw always descends.

The following table shows convergence time using the optimized process. Although the data is preliminary, results are promising. For the best *NPOP*, *NMUT* and *MUTP*, the optimized process is over two times as fast (429.27s vs. 1049.02s). Although not shown, the following population also has 90% convergence success.

Optimized GA, Protein 201.pdb, NPOP = 500, NMUT 410-490, Ten Trials for single CPU

MUTP	*RUNTIME (s) (MEAN)*	*RUNTIME (STDEV)*
0.01	700.72	219.87
0.02	581.89	242.91
0.05	493.38	145.39
0.1	428.33	101.04
0.15	**429.27**	**85.92**
0.2	444.48	92.42

For one protein, 201.pdb, the data shows that the new process works very well. In the future, it would be important to show that the optimized process works on more complex protein structures. Because the structure of 201.pdb is relatively simple, the global minimum is relatively easy to find.
This makes it an especially good candidate for debugging. On the other hand, the two

proteins, 156.pdb, and T189.pdb using the old process on average take 24-48 hours for one run. Due to severe time contraints, it was not possible to find parameters, *NPOP, NMUT* and *MUTP* that result in successful convergence for the new algorithm. If we could find good settings for the optimized process, having a two times speed increase would have clear benefits.

[1] K. D. M. Harris, M. Tremayne, and B. M. Kariuki, Contemporary Advances in the Use of Powder X-Ray Diffraction for Structure Determination., Angew. Chem. Int. Ed. 40, 1626 (2001).
[2] K. D. M. Harris, R. L. Johnston, and B. M. Kariuki, The Genetic Algorithm: Foundations and Applications in Structure Solution from Powder Diffraction data., Acta Crystallogr. A54, 632 (1998).
[3] Eiji Nishibori, Takahiro Koishi, et al. "A 28.5 Tflops X-ray Protein Structure Determination with a Special-Purpose Computer: MDM." Department of Applied Physics, Nagoya University. Ebisuzaki Computation Astrophysics Laboratory, RIKEN. In submission.

RESEARCH REPORT

1. Name: Kenneth Oswald (ID .:SP04048)

2. Current affiliation: University of South Carolina, Department of Biological Sciences, Columbia, SC.

3. Research fields and specialties: Population Genetics

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences X Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Sokendai, Hayama, Kanagawa, Japan

5. Host researcher: Dr. Yoko Satta

6. Description of your current research

My research centers upon the ascertainment of species – level evolutionary processes via use of population genetics. Specifically, I study the evolutionary histories of natural populations of fishes within the southeastern United States. Thus, my research combines both applied and theoretical aspects of population genetics. Patterns of genetic diversity surveyed from both nuclear and mitochondrial DNA sequence data are employed to infer not only population structure, but also, historical demography.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Molecular evolution and theoretical population genetics

Description of the research activities:

My NSF/JSPS East Asia and Pacific Summer Institute research focused upon two main areas of study. First, the molecular genetics of the capsaicin receptor gene were studied in chimpanzee (*Pan troglodytes*) and human (*Homo sapien*). Second, computer simulations were investigated to yield insight into the evolution of neutrally evolving genetic loci.

The capsaicin receptor is partially responsible for heat sensation in vertebrates. Thus, nucleotide variation in the capsaicin gene is of use to study as thresholds of heat-induced pain vary amongst human individuals. Patterns of genetic variation within this gene were studied via use of data from publicly-available on-line databases. Furthermore, evolutionary patterns of genetic variation were investigated by comparison of genetic variation between human (*Homo sapien*) and chimpanzee (*Pan troglodytes*) capsaicin genes.

Secondly, to ascertain expected patterns of genetic variation under the neutral theory of molecular evolution, computer simulations of such evolutionary processes were designed and partially created. Design was focused upon the role of time (as measured in numbers of generations) and rate of DNA mutation. Ancestral DNA sequences were constructed and random mutational schemes were considered in the evolution of such ancestral sequences. Computer simulations were executed using the C and FORTRAN computer programming languages.

8. Please add your comments (if any):

I feel that in every aspect, the EAPSI Summer Program 2004 was an outstanding program and have benefited greatly from the experience. In addition to learning a great deal about population genetics, the program has also provided me the opportunity to initiate life-long connections with world - renowned researchers.

Furthermore, I feel that the program was run in a first – class manner. Every detail was covered and provided for by NSF and/or JSPS. I give my deepest thanks to all involved who helped make this program such a positive experience. In the future, I will encourage all graduate students, regardless of academic discipline, to apply to this program

RESEARCH REPORT

1. Name: Meris Anne Ota (ID No.: SP04049)

2. Current affiliation:

Stanford University

3. Research fields and specialties:

□ Humanities □ Social sciences □ Mathematical and Physical Sciences

□ Chemistry □XX Engineering Sciences □ Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. Host institution: Building Research Institute

5. Host researcher: Hiroshi Fukuyama

6. Description of your current research

Though my current academic program does not include a research component, I have had several opportunities during my undergraduate and graduate experiences to conduct small-scale experiements and assist with labwork. During this time, much of my work was related to high performance fiber-reinforced cementitious composites (HPFRCCs). As these materails are currently the subject of much research in Japan, the EAPSI program has provided the perfect opportunity to learn more about the topic and meet leading researchers.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

High Performance Fiber Reinforced Cementitious Composites: Mechanical Properties and Structural Applications

Description of the research activities:

Because the Building Research Institute (BRI) in Tsukuba is always abuzz with research activity, I was able to wittness or assist with a variety of experiments.

The original project which I had intended to join involved the application of HPFRCC dampers and shear walls for sesimic retrofit. While the design intent of the former was to increase the stiffness and damping of concrete structures, the aim of the latter was to reduce the additional seismic mass associated with shear wall retrofits. A collection of specimens was fabricated, with several modeled after retrofitted walls, and the others modeled after unretrofitted walls. At the time of my departure from BRI, nearly half of the specimens had already been tested.

In addition to the aforementioned study, I was able to assist with an investigation on the optimization of ductile hybrid fiber-reinforced concrete. Differing blends of synthetic fibers and steel cords were incorporated into the same base mortar, and the mixes were evaluated in terms of workability, tensile and compressive strengths, and toughness.

Finally, I had the rare opportunity to witness on-site lateral loading tests of existing shear walls. The specimens were portions of housing complexes which were approximately forty years old and were about to be demolished. The test methods and considerations associated with this test were of great interest.

RESEARCH REPORT

1. Name: Kirt Anthony Page (ID No.: SP04050)

2. Current affiliation: The University of Southern Mississippi

School of Polymers and High Performance Materials

118 College Drive #10076

Hattiesburg, MS 39406

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☒ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Keiichiro Adachi

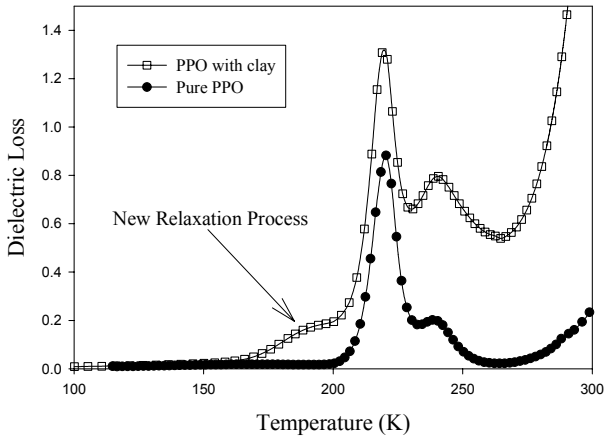
6. Description of your current research: The overall theme of my project is to investigate molecular dynamics and physical properties in nano-structured materials. More specifically, the goal of the project is to develop a fundamental understanding of the link between the chain dynamics (motions) of Type-A polymers adsorbed onto nano-particles (i.e., silica nanospheres and clay) and the viscoelastic properties of these materials. Type-A polymers are ones in which the principle dipole is aligned in the direction parallel to the chain backbone (e.g. poly(isoprene) (PI) and poly(propylene oxide) (PPO)). These materials have been shown to exhibit dielectric normal mode relaxation as a result of fluctuations in the end-to-end vector. The data obtained from dielectric spectroscopy on the normal mode relaxation can yield information about the large-scale motions of the polymer chains (i.e., global chain dynamics). These same global chain motions are reflected in the viscoelastic relaxation processes occurring in polymers during long time scales. Aside from long-range motions, dielectric spectroscopy of the segmental mode of relaxation can provide information on the local, segmental chain motions. The interactions between the Type-A polymers and the nano-particle are expected to have a measurable impact on the chain dynamics and rheology when compared to the pure polymers. Through the use of dielectric measurements, rheological techniques, and nuclear magnetic resonance, it is possible to understand

how the polymer-particle interactions affect global, as well as local, chain dynamics, which ultimately give rise to macroscopic properties. Due to the growth of nanotechnology and the use of polymers in this field, it is important to understand what role chain dynamics—on several length-scales—plays in determining both the macroscopic and nanoscopic properties of these materials.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: **Dielectric and Viscoelastic Studies of the Chain Dynamics of Type-A Polymers Adsorbed onto Nanoparticles**

Description of the research activities: Although the overall goal of this project was not achieved in its entirety, we did make some interesting findings, which will serve as a basis for continuing collaborative work on this project. We used dielectric spectroscopy to probe the molecular motions of three types of polymers (polyisoprene, polypropyleneoxide, and polybutyleneoxide) blended with silica nano-particles and clay particles. The dielectric measurements were performed using RLC bridges (QuadTech models 7600 and 1693, Maynard) over a frequency range from 10 Hz to 2 MHz and a temperature range from 80 to 380 K. One interesting outcome of these experiments is that we were able to observe a new relaxation process for these polymers in the presence of clay particles. The figure to the right is a graph of dielectric loss versus temperature (in Kelvin) for one of our polymer-clay systems. When compared to the pure polymer, the polymer-clay system exhibits a new peak at a temperature below the α relaxation region. Although we cannot make a conclusion about the molecular origins of this new relaxation, this process reflects motions of PPO faster than the segmental motions of pure PPO and is probably a result of fast, local motions. Detailed analysis of the data is being conducted in order to further characterize and fully understand all three relaxation phenomena. In the future, rheological data will be collected in order to characterize the viscoelastic properties of these materials and to correlate this behavior with our understanding of the chain dynamics as measured by dielectric spectroscopy.



8. Please add your comments (if any): I have enjoyed conducting research in Adachi Sensei's lab very much. I believe that the work started this summer will lead to a fruitful collaboration in the near future. Due to this experience, I also plan on encouraging others to apply to this program because it is a wonderful opportunity for young scientists to experience research abroad. I think the most important thing is that through international collaboration young researchers learn to build a global scientific community. I believe in a global scientific community, where researchers work together to advance science in new directions and, in return, the individual grows with the science.

RESEARCH REPORT

1. Name: **Urvi M Parikh** (ID No.: **SP04051**)

2. Current Affiliation: **University of Pittsburgh**
Graduate School of Public Health
Dept of Infectious Diseases and Microbiology
S814 Scaife Hall, 3550 Terrace Street, Pittsburgh, PA 15213

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ **Biological Sciences**

☐ Agricultural Sciences ☐ **Medical, Dental and Pharmaceutical Sciences**

☐ Interdisciplinary and Frontier Sciences

4. Host Institution: **National Institute of Infectious Diseases, AIDS Research Center**
4-7-1 Gakuen, Masashimurayama, Tokyo, 208-0011

5. Host researcher: **Dr. Wataru Sugiura**

6. Description of Current Research

Understanding Drug Resistance in HIV-1

According to the World Health Organization as of December 2003, there are 40 million people living with HIV/AIDS, 5 million new infections in 2003, and 3 million HIV/AIDS deaths in 2003. With no vaccine or cure available, highly active antiretroviral therapy (HAART) is the only option for prolonging the life of those infected with HIV-1. Combinations of one class of drugs, the nucleoside reverse transcriptase inhibitors (NRTI) comprise a key component of HAART, but the high mutation rate of HIV-1 leads to rapid development of resistance to NRTIs (Loveday 2001). My graduate work at the University of Pittsburgh is focused on understanding the mechanisms underlying this resistance from a biological, biochemical, structural and clinical perspective.

Resistance to NRTIs results from mutations in the reverse transcriptase (RT) gene of HIV-1. As part of my dissertation project, I am studying how these amino acid changes affect the susceptibility of HIV-1 to numerous drugs currently in therapeutic use. For these studies, I primarily use drug susceptibility assays, which are performed using genetically modified virus generated in the lab tested against serial dilutions of an NRTI in a cell culture system. The concentration of drug that inhibits 50% of wild type virus is compared with the concentration of drug that inhibits 50% of mutant virus. If a particular mutant is drug resistant, a much greater concentration of drug will be required to inhibit the mutant virus compared to the amount of drug necessary to inhibit wild type virus.

From my studies and other reports, the lysine to arginine change at codon 65 of RT (K65R), has been implicated to be an important drug resistance mutation, because it can cause resistance to almost all currently available FDA-approved and investigational NRTIs (Zhang 1994, Foli 1996, Wainberg 1999, Bazmi 2000, Garcia-Lerma 2003, Parikh 2003). Most of the studies, however, have been performed using laboratory strains of HIV-1, and subtype B virus, which is predominant in North America and Europe. This collaboration with the AIDS Research Center at the National Institute of Infectious Diseases of Japan allows the determination of whether the mechanisms of resistance elucidated from cell culture studies would also apply to virus of varying subtypes from patient samples, tested in a more biologically relevant *ex vivo* experimental system.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Clinical Relevance of the K65R Mutation in B and non-B Subtypes of HIV-1: Analysis of a Japanese Cohort.

Description of the research activities:

Public Health Significance

HIV-1 is a genetically diverse virus. The majority of infections are caused by group M virus, which is further classified into 11 subtypes or clades that are often clustered geographically (Stebbing 2003). Subtype B virus generally affects North America and Europe, while other subtypes including E are more prevalent in Asia. Of new HIV-1 infections in 2000, only 12% were subtype B (Kantor 2004), however the majority of resistance research is conducted using clade B virus. Additionally, the same drug therapy is used for all subtypes of HIV-1. As antiretroviral therapy becomes increasingly available to countries in which non-B HIV-1 is predominant, it is important to understand the clinical significance of known drug resistance mutations in other clades.

The National Institute of Infectious Diseases (NIID) in Tokyo has a database of >5000 clinical isolates (B and non-B) from >1000 HIV/AIDS patients from various regions in Japan (Sugiura 2004). Few studies have been done to look at the differences of Clade B versus non-B resistance profiles, although preliminary evidence suggests that differences may exist (Montes 2004, Kantor 2004, Parkin 2004, Jorgensen 2003, Yagyu 2002, Caride 2000). No studies have been done to examine the impact of the K65R mutation on NRTI resistance specifically.

Japan's Role in Subtype Research and the Global Epidemic

Working at the NIID was an excellent opportunity for me to expand my current research to include analysis of resistance in other subtypes, as well as to meet with researchers who are interested in studying HIV in a global context. Although subtype B virus is also predominant in Japan, Japan is in proximity to countries in which non-B infections are endemic, and it has the resources to address these problems. My time in Tokyo coincided with a 6-week training course conducted by the NIID, that brought physicians and scientists from developing countries in Africa and Asia to Japan to learn new technologies and procedures they may use in their home countries for the diagnosis and management of HIV infection. Along with speaking to training course attendees about the different strategies, successes and challenges they faced to deal with HIV in their populations, I was able to sit in on some of their classes and attend a tour of two Japanese biotech companies, SRL Laboratories and Fujirebio, Inc, to learn about Japan's new HIV diagnostic technologies from an industrial perspective.

My host researcher, Dr. Wataru Sugiura, is an active leader in the training course, as well as in pioneering research to create inexpensive assays for analyzing drug resistance for use in developing countries.

Analysis of Drug Resistance in Japanese Patient Samples

The objectives of my research were to study drug resistance in HIV from Japanese patients, and to determine whether mutations that cause resistance in subtype B also played an important role in causing resistance to virus of other subtypes. The study was conducted using two methods: (A) testing patient-derived virus in a drug susceptibility assay using human PMBCs (peripheral blood mononuclear cells); and (B) analyzing the frequency of mutations from subtype B patient samples compared to non-B patient samples from a Japanese clinical database.

A. Drug Susceptibility Studies

The first task was to culture virus in PMBCs. PBMCs from a healthy donor were

infected with virus from 7 different HIV-1-infected patients that had the K65R mutation (4 subtype E, 3 subtype B). PMBCs were also infected with two control viruses, a wild-type and mutant (K65R) subtype B lab strain, both which I had sent from my home University. All of the subtype B viruses grew to high titers in 7 days and we harvested them for use in the drug susceptibility assays. Only one of the subtype E viruses replicated to a high titer after 12 to 17 days in culture. This study suggested that the same methods used to cultivate subtype B virus cannot be used to cultivate subtype E virus, and further study is needed to develop techniques for studying non B HIV-1.

Secondly, an assay using PMBCs was developed to test the subtype B patient samples in collaboration with Dr. Shingo Kato from Keio University. I had the opportunity to visit his laboratory, and see how research conducted at a medical university differs from a governmental institute. Dr. Kato was also very generous in helping us learn the assay for our drug resistance studies.

Due to time constraints, we decided to only test two subtype B patient samples and the mutant lab strain against three different NRTIs for comparison with the wild type lab strain. The resistance profile differed for all three mutant viruses tested. To explain why each virus sample was resistant to some NRTIs but susceptible to others, the sequence of the reverse transcriptase gene from the patient isolates must be compared to the sequence of the wild type virus, and the changes in the sequence analyzed. We plan to continue our collaboration on these studies after I return to the University of Pittsburgh.

B. Patient Database Studies

From the Japanese database of patient virus sequences, we wanted to determine whether specific mutations or combinations of mutations known to cause drug resistance occur more frequently in subtype B virus compared to non-B virus in drug treated and untreated patients. The database was a challenge to navigate, because all of the text and search commands were in Japanese! Learning a few Kanji characters became necessary to undertake this work. We found that although the same drug resistance mutations appear to be selected in patients of different subtypes, initial analysis suggests that the patterns in which these mutations occur may differ among the subtypes. We tested single mutations, and double and triple combinations of mutations, but detailed statistical analysis and the testing of combinations of 4 and 5 mutations is needed to continue this study.

Future Work

Two months is a short time to do biological experiments, because cells need time to grow, and it could take weeks for some virus isolates to replicate. More than just learning specific experimental protocols, my time here was a wonderful experience in meeting professionals in my field at several universities, companies and government institutes, in learning how there is more than one way to do the same thing, and in making some permanent friends-- people who I expect I will see again at international meetings and conferences. Much of the work done here was an expansion of my dissertation work as well as the beginnings of new projects that I expect to continue in the future.

Acknowledgements

I would like to especially thank my host researcher Dr. Sugiura, and two post-doctoral researchers, Dr. Fujino and Dr. Nishizawa for all of their time, guidance, and generosity that enabled me to conduct this work. My host lab was a wonderful group of people who tried very hard to make me feel welcome, to help me navigate the lab, and to patiently communicate with me in English. I would also like to thank my Ph.D. advisor Dr. John Mellors, for supporting my pursuit of this fellowship.

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RESEARCH REPORT

1. Name: Oleg Pishnyak (ID No.: SP04052)

2. Current affiliation: Liquid Crystal Institute and Chemical Physics Interdisciplinary Program, Kent State University, Kent, OH, 44242-0001, USA

3. Research fields and specialties:

☐ Humanities ☐ Social sciences x Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Department of Electrical and Electronic Engineering, Akita University, 1-1, Tegata Gakuen-machi, Akita-shi, 010-8502 Japan.

5. Host researcher: Prof. Susumu Sato

6. Description of your current research

I am involved in design of liquid crystal (LC) beam steering devices. Beam deflectors are in a great demand in space communication, optical fiber communications, optical switches, scanners. The goal of our research is to create a fast LC-based deflector, which would be superior as compared to traditional beam steering devices such as mechanically driven mirrors.

LC materials can be easily filled in any geometry (large prisms, array of microprisms etc.) and possess large birefringence, provide fast response to the applied small-magnitude external electric or magnetic fields. Thus, LCs are very attractive for possible passive (non-switchable) as well as active (switchable) applications.

We developed fast switching twisted nematic cells for infrared, which show the response time of few milliseconds. The significant reduce of the response time in comparison with conventional TN cells is possible due to special alignment geometry and usage of dual-frequency nematic having different sign of the dielectric anisotropy for different frequencies. The application of special electric signals with different frequencies allows fast switching time of the TN cells of order of few milliseconds.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Design of liquid crystal-based tunable microlenses with improved switching characteristics

Description of the research activities:

Conventional lenses are among the key optical elements widely used in science, industry and even in our daily life. Possible applications include a variety of products from usual photo cameras to complicated microscopes and telescopes. Design of electrically-tunable (with a variable focal length) liquid crystal (LC) lenses [1-3] is a very important and challenging task as it will allow, for example, to easily adjust the focal length of glasses for vision correction or to provide a fast optical communication between the required channels at a given time period etc.

The sketch of LC-based tunable lens is shown in Fig.1. It consists of two glass plates: one has a continuous indium tin oxide (ITO) electrode, another has an aluminum (Al) electrode with a round hole. Diameter of the lens, which is equal to the diameter of the hole, and the cell thickness are 300 and 110 microns respectively. Hole-patterned electrode provides bell-like distribution of the electric field inside the LC layer, which causes non-uniform reorientation of LC molecules. Thus, a variable gradient of the refractive index distribution is realized, and the light passing through the system experiences lens effect [1-3]. One of the lens substrates (the bottom substrate in Fig.1) has a high-pretilt angle of molecular orientation with respect to the substrate provided by oblique SiO deposition. Another substrate is covered by rubbed polyvinyl alcohol (PVA). The cell is filled with dual-frequency nematic material MLC-2048 (Merck), which has different sign of dielectric anisotropy $\Delta\varepsilon$ at different frequencies f of the applied electric field. In particular, $\Delta\varepsilon<0$ at f=50kHz and LC molecules reorient to the planar state (parallel to the substrates); at f=1kHz, $\Delta\varepsilon>0$ and LC molecules reorient to the homeotropic state (perpendicular to the substrates). A high-pretilt angle at the substrate increases the dielectric torque on nematic director, eliminates the threshold of reorientation and possible disclination line appearance, and yields a strong restoring torques that facilitate reorientation from both the homeotropic and the planar states [4].

In the experiments we used double-lens design, which consist of two LC lens shown in Fig.1. The holes in Al electrodes are placed exactly one above another. Such

a design allows to eliminate the problem of off-axis light focusing, which is present in single-lens approach due to nonzero pretilt angle, and to decrease significantly the lens focal length. In Fig.2 we show the voltage dependence of focal length of the designed system. Thus, it behaves as electrically-tunable lens, which focal length can be varied in a broad range from infinity down to 0.9 mm. Further experiments on response time measurements are required.

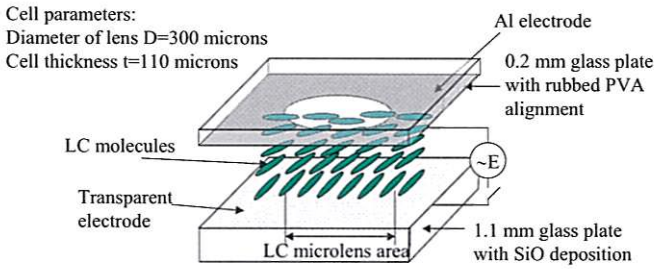

Fig.1. LC-based microlens design.

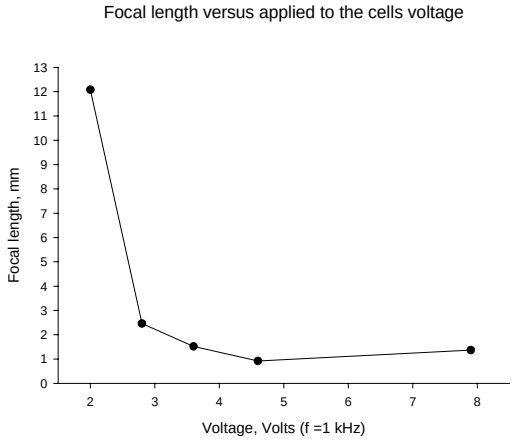

Fig.2. Focal length of the designed double lens versus applied to the cells voltage.

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4. A. B. Golovin, S. V. Shiyanovskii, O. D. Lavrentovich, *Appl. Phys. Lett.*, **83**, 3864, (2003).

8. Please add your comments (if any): I want to thank Prof. Susumu Sato for hosting me in Akita University. Many thanks to Dr. Marenori Kawamura and everybody who helped me in my research. I want to acknowledge JSPS and NSF for given opportunity and support.

9. (If any) Advisor's remarks: Mr. Oleg Pishnyak has been studying and working hard in his stay at Akita University. I think his research results are important and valuable in the field of liquid crystal optical devices. In addition, he participated in traditional Japanese local events and also did communication and cultural exchange positively with the students as well as the researchers of our laboratories.

RESEARCH REPORT

1. Name: Michelle Pribbernow (ID No.: SP04053)

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

3. Research fields and specialties:Cultural Anthropology of Japan; gender and identity

☐ Humanities **X**☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Waseda Univeristy

5. Host researcher: Glenda Roberts

6. Description of your current research

Gender and identity are coded and created through a number of behaviors, including dress. Costuming and performance are spaces in which individuals may consciously create and present a specific gendered identity, potentially strikingly different from normally expected gender presentations. Understandings of gender and identity may be developed through the examination of performative fashion, particularly in cross-dressing. Dressing to create a stage persona is a conscious utilization of cultural ideas about gender and how clothing expresses a gendered identity. Performers in Japan, from Kabuki to Takarazuka to Enka singers, have used cross-dressing to create staged identities. Japanese J-rock performers and the fans that imitate them are modern examples of the lively and imaginative art of cross-gender performance and identity play. A study of this group of fans and musicians reveals ideas of multiple possibilities for gender. Fans themselves become performers when they emulate their favorite musicians, usually men portraying women, and display themselves publicly. The fans often present a type of femininity that is non-active, child-like, and belonging to a non-present, non-Japanese imagined world through the practice of same-sex cross-dressing. This fantasy is further elaborated as an impermanent world of continuing youth and escape that is entered by assuming a temporary identity through the use of costume. This work intends to add to an understanding of Japanese notions of gender and identity as externally constructed and performed concepts.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Costumed Selves on Display: Gender and Identity Performance in Harajuku, Japan Youth Culture

Description of the research activities:

Research was primarily participant-observation and interviewing of cos-players displaying themselves in Harajuku on Sundays. Observation sessions were conducted every week and interviews were conducted during two Sundays, via a native Japanese speaker. Additional observation was conducted at nearby shops were cos-players purchase their costumes. This was performed both on Sundays, the peak shopping time, as well as other times during the week to best observe both consumer behavior and the goods available. Fan merchandise, such as magazines, novelty goods with performers' images and reproduction costumes, were noted and analyzed for content. Other individuals participating in or observing bridge activities were observed and interviewed. These included amateur photographers, tourists, and foreigners visiting and to some degree participating in cos-playing. Background literature was surveyed through the host institution's facilities.

RESEARCH REPORT

1. Name: Christopher J. Renedo (ID No.: SP04054)

2. Current affiliation: graduate student – Oregon State University – Master of Ocean Engineering Program

3. Research fields and specialties: tsunamis

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Port and Airport Research Institute

5. Host researcher: Mr. Ken-ichiro Shimosako Dr. Taro Arikawa

6. Description of your current research: see below

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Evolution of a tsunami wave over a moderate slope and impact on a dry seawall

Description of the research activities:

Research on tsunami waves dates back to the middle of the last century. Substantial progress has been made developing our knowledge of their generation, propagation, and run-up onto coasts. Efforts to characterize mathematically the evolution of a tsunami wave have necessarily been rather academic. Numerical models have been constructed from wave theory and sometimes validated by small-scale laboratory experiments. Historical accounts and modern case studies of tsunami events have been accessed to try and link actual observations with theory. But representative, large-scale laboratory experiments remain nascent. Without question, this is due largely to the small number of facilities capable of performing large-scale tsunami research.

Large-scale research and design for tsunami impact on highly developed coastlines should be made an imperative. Industrial and commercial ports provide a major source of income and goods necessary for the survival of, not only oceanic countries, but all nations. The world's population is increasing rapidly with a majority of these people living on the coast. It should be apparent from these two observations alone that the advanced design of coastal harbors and communities is vital. Planning and construction for the mitigation of tsunami impact requires the coordination of coastal engineers,

seismologists, government officials, and business executives. It is an all-encompassing objective that prepares our coastal infrastructure for any natural disaster. In addition, such foresight encourages economic efficiency and the protection of human lives and the environment. Therefore, tsunami mitigation should be made a priority in this new millennium.

In preparation for any project, it is important to review previous studies relevant to the topic(s) being researched. As mentioned previously, the work done in the area of large-scale tsunami experimentation has been quite limited. Novel, large-scale research requires not only the appropriate facilities, but insight and the assimilation of fundamental theories to plan an effective investigation. It is my objective as an engineer/investigator to design and learn from innovative research that can produce significant results and lead to applied science. With this in mind, case studies of past tsunamis that caused extensive damage have been paramount in developing a sense of how we should better prepare for such a powerful natural disaster.

Tsunami events can be divided into two categories based on their generation and impact: near-source and transoceanic. Tsunamis are usually generated by submarine seismic activity. When a tectonic plate is uplifted, it displaces a large volume of seawater which then propagates as a very long wave. If the epicenter is nearshore, the tsunami may only strike the nearby coastal region. Or, if it is a very large seismic event in deep water, a tsunami wave may be generated that travels in both directions – directly onshore and across the ocean to strike a distant coastline. Not all submarine earthquakes generate tsunamis. But seismic events, submarine and terrestrial, may also trigger landslides that can generate huge, localized tsunamis. This most often occurs from coastal land masses sliding violently into the ocean creating an enormous splash. The largest tsunami run-up ever recorded occurred in Lituya Bay, Alaska on July 7, 1958 as the result of a huge landslide. A magnitude 8.0 earthquake triggered a landslide into the bay which produced a local tsunami of frightening size. Directly opposite the landslide, a giant splash of water ran up a headland stripping the point clean of vegetation approximately 524m above sea level! Submarine landslides are occasionally suspected to have produced localized tsunami waves. Though, independently or in concert with tectonic motion, it is uncertain.

Simulation of a transoceanic tsunami is relatively straight forward in a wave flume or basin. Acceptable results can be achieved in a laboratory environment, both at PARI and Oregon State University, by producing a stable, solitary wave. It has been found that this phenomenon is representative of a transoceanic, fully-developed tsunami wave. Very large, unstable, solitary waves can also be effected which break offshore and resemble a tsunami bore advancing onshore. Both methods of replication are important in the study of tsunami impact, scour, and run-up. However, research has remained very general in the hope of establishing a broad summary of tsunami events in the coastal region. Specific research is long overdue considering the extensive destruction and loss of life incurred by two historical, transoceanic tsunamis – 1946 Aleutian Tsunami and 1960 Chilean Tsunami.

Near-source tsunami events have occurred even more frequently in the past. Such incidents tend to cause a greater loss of life in addition to widespread destruction. This is due to the short time period that separates an earthquake and generation of a tsunami wave and its ensuing impact on the nearby

coastal region. Leaving residents with little or no warning and the chance to evacuate. These events often strike within 30 minutes of the generating earthquake. Whether due to wave fission or repeated uplifting of the sea floor, near-source tsunamis often occur as a series of several large waves. These waves are usually preceded by a rapid withdrawal of the ocean from the shoreline – technically referred to as a leading depression N-wave. Two recent, destructive near-source tsunami events have been observed and analyzed closely, providing researchers with new information – 1995 Manzanillo (Mexico) Tsunami and 2001 Peruvian Tsunami.

A real challenge is presented here in attempting to reproduce a leading depression N-wave in the large hydro-geo flume at PARI. But the opportunity to establish some distinctive findings is quite attractive. Preliminary tests in the wave flume indicate that an accurate simulation of leading depression N-waves (both cohesive and split) is feasible. By retracting the wavemaker and then pushing it forward with uniform speed, it has been observed that a strong withdrawal of water occurs over the section of the flume where the mild slope and model quay wall shall be constructed. This retreat is quickly followed by the arrival of a clean solitary wave(s) or a turbulent bore, dependent on period and length of wavemaker stroke. These findings are very encouraging. A variety of realistic, near-source tsunami wave impacts can thus be modeled ranging from a stable, leading depression N-wave(s) to a tsunami bore preceded by the rapid withdrawal of the model shoreline.

The attainment of applicable knowledge should be the objective of this research. This can be accomplished by simulating the occurrence of a tsunami in an industrial/commercial harbor. Consideration of the economic importance of our supply and trading centers merits such investigative focus. This is not to mention the improved safety and welfare of human life as well.

RESEARCH REPORT

1. Name: Jeremy Robinson (ID No.: SP04055)

2. Current affiliation: University of California- Berkeley

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry **x** Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Keio University

5. Host researcher: Kohei Itoh

6. Description of your current research

My current research efforts have been in understanding the growth dynamics of germanium (Ge) on silicon (Si) via molecular beam epitaxy (MBE), with an emphasis on Ge island growth using Au as a metal catalysis. We have found for a square array of Au dots, a two-dimensional square lattice of Ge islands extending over hundreds of microns can be produced. Unlike the previously reported pyramids and domes that assemble on Si(100), islands that grow in the Au patterned region have a truncated pyramidal (TP) shape. A dynamic growth model involving diffusion, concentration, and strain gradients is proposed to explain the resulting nucleation and growth at the (½, ½) lattice sites of the original Au pattern, with the conditions for nucleation being established during growth. Unlike other substrate patterning techniques, the approach studied here is a fast, effective and versatile method to manipulate island growth kinetics and thereby direct their assembly over large areas.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Directed assembly of isotopically pure Ge islands using Au patterned Si(100) and nano-dimple patterned Si(100)

Description of the research activities:

My research activities at Keio University have consisted of the following growth and characterization techniques: 1) Au deposition by thermal evaporation. 2) Ge deposition by molecular beam epitaxy (MBE). 3) In-situ surface analysis using Reflection High Energy Electron Diffraction (RHEED) 4) Nano-oxidation and surface imaging using atomic force microscopy (AFM). 5) Optical characterization by Raman spectroscopy.

It typically takes about two days to complete one growth run, which consists firstly of either Au evaporation through a mask or nano-dimple formation via AFM and secondly, Ge evaporation via MBE. Ge coverages between 3-15 mono-layers (ML) were studied. My first goal was to reproduce results obtained at my home university using isotopically pure 76Ge and 70Ge. Using isotopically pure Ge (available at Keio), we can obtain much sharper Raman spectra and make better calculates on the strain state of the Ge islands.

After a growth run, samples were imaged using AFM. These images provided a 3D measurement of surface features, allowing one to analyze Ge structures by surface area, volume, etc... Samples were then characterized using Raman spectroscopy. This technique is advantageous in determining the strain state of Ge islands. Spectra of several different samples have been taken but have not yet been analyzed. At Keio I have reproduced some of my previous results, which was a great success and encouraging for future research plans. A full analysis of the results has not been completed at Keio, but will be finish upon returning to my home institute.

8. Please add your comments (if any):

In all, my research experience at Keio University has been very rewarding. I have become familiar with the nano-oxidation technique used by researchers here to study self-assembly processes. I have also learned the use of Raman spectroscopy as an optical characterization technique.

9. (If any) Advisor's remarks:

Mr. Robinson's visit to our research group has brought more than just research collaboration. His presence has promoted awareness of importance of diversity among students and provided confidence that they can work in equal basis with a student from one of the best universities in the world. It was truly nice to see my students teaching and learning many aspects of research with Mr. Robinson.

RESEARCH REPORT

1. Name: **Anna Scott** (ID No.: SP04056)

2. Current affiliation: **University of Utah**

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences **X Biological Sciences**
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: **RIKEN Genomic Sciences Center**

5. Host researcher: **Peter Guentert**

6. Description of your current research

(see attached)

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

NMR Structure of the SH2 Domain of the human FES protein

VPS4 Structure and Function in HIV-1 Budding

My research focuses on the structure and function of the human VPS4 proteins, VPS4A and VPS4B, in the context of HIV-1 budding. HIV-1 does not encode the machinery necessary to bud through the plasma membrane and, therefore, must recruit cellular proteins for this purpose. We and others have demonstrated that proteins normally involved in the vacuolar protein sorting (Vps) pathway also play a part in virus budding.

Our current model for virus budding is that HIV-1 hijacks the Vps machinery that is normally used to form vesicles that bud into the late endosome (creating a compartment called the multivesicular body or MVB) and relocalizes it to the plasma membrane for viral egress. MVB formation is best understood in yeast, where there are fifteen "class E" proteins required for MVB biogenesis. Most "class E" proteins function in one of three ESCRT (Endosomal Sorting Complex required for Transport) complexes. The final complex, ESCRT-III, forms a lattice associated with the membrane. ESCRT-III also recruits another "class E" protein, Vps4p, which is required for the disassembly of ESCRT-III. Vps4p is the only "class E" protein with ATP activity and is member of the AAA ATPase family of proteins. In general, other AAA ATPases are responsible for multiple remodeling functions in the cell (such as protein unfolding and translocation) and they function by applying force to bound substrates using the energy of ATP binding and/or hydrolysis. In a similar manner, we hypothesize that VPS4 either unravels the protein complexes that cause vesicle scission (resetting them for multiple rounds of fusion) or generates the force necessary to cause fusion of the vesicle neck.

Yeast Vps4 has two human orthologs, VPS4A and VPS4B (which share 80% sequence identity). Mutants of VPS4A and VPS4B that cannot bind or hydrolyze ATP are dominant negative inhibitors of HIV-1, Ebola and Murine Leukemia Virus budding and cause arrest at a late stage in viral egress.

I have been studying the structure of VPS4 using X-ray crystallography and NMR. I have determined the crystal structure of monomeric VPS4B (119-444 aa) and am working on the NMR structure of the N-terminal domain (residues 1-122) of VPS4A. Determining the structure of VPS4 will help us understand this important protein and how it functions in viral budding.

NMR Structure of the SH2 Domain of the human FES protein

The human FES (feline sarcoma oncogene) protein is one of two members of a family of non-receptor tyrosine kinases. FES was originally isolated as a retroviral oncogene in avian and feline retroviruses. Genetic analysis identified its cellular homolog, *fes/fps*. The function of FES in the cell is still not fully understood, however, it is known to be involved in the growth and differentiation of myeloid hematopoietic cells, vascular endothelial cells and neurons. It is also implicated in the regulation of cytoskeletal rearrangement. FES contains multiple domains: Fps/Fes/Fer/CIP4 homology, Src homology 2 (SH2), coiled coil, and tyrosine kinase. Of particular interest is the SH2 domain (residues 450-550), which is implicated in maintaining FES in an inactive state.

Additionally, SH2 domains typically regulate the kinase activity of their full length proteins by phosphotyrosine-dependent interactions with kinase substrates.

The SH2 domain was first identified in FES in 1984, but its structure has not yet been solved. However, this domain has been well characterized and its structure determined in several receptors including c-Src, c-Abl, Syk, Cbl and Fyn (to name only a few). Understanding how the FES SH2 domain structure differs from that of its family members will help elucidate how it regulates FES activity.

The RIKEN Genomic Sciences group expressed and purified the SH2 domain of the human FES protein. David Pantoja-Uceda in Peter Guentert's lab conducted the NMR experiments and processed the NMR data for this domain. With David's assistance, I determined the backbone and sidechain assignments and solved the structure of this domain (see Figure 1). I used Peter Guentert's software, CYANA, for the automated NOESY assignments and the structure calculations. Additionally, I assisted in updating the CYANA software manual.

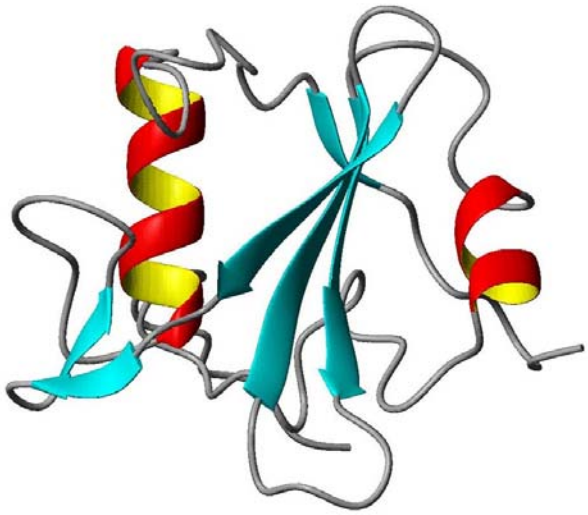

Figure 1. FES SH2 domain NMR structure.

Currently, there are two methods for determining atomic level resolution protein structures: X-ray crystallography and NMR. X-ray crystallography involves crystallizing the protein and then examining the diffraction pattern of X-rays to determine the protein structure. In contrast to crystallography, NMR solves the structure of proteins in solution. NMR capitalizes on the different electron energy levels that are induced in a strong magnetic field for ^{1}H, ^{15}N and ^{13}C. Proteins used for NMR study, are typically recombinant protein that are produced (either grown in minimal media containing ^{15}N and ^{13}C or made in a cell free system with these isotopes) as isotopically labeled proteins. These proteins are subjected to a strong magnetic field (600 to 800 MHz) in the NMR spectrometer. A set of standard experiments are used to allow the proton, carbon and nitrogen "locations" to be calculated. These experiments all involve through bond excitation of the atoms. Additionally, through space interactions can be measured by a set of experiments referred as NOESY (nuclear Overhauser enhancement spectroscopy) experiments. When the NOESY data is coupled with the atom "locations" determined by through bond interactions, the 3D structure of the protein at atomic resolution can be solved.

Peter Guentert's group has been instrumental in developing software for NMR structure calculations. Recently, his group has produced the software, CYANA, that automatically assigns the NOESY spectra. For a well resolved protein, it takes about one month to assign the proton, carbon and nitrogen "locations". Assigning the NOESY data takes

about three months (or longer). CYANA is able to do the NOESY assignments and produce the protein structures in approximately two weeks. This is a substantial reduction in time and allowed me to determine a protein structure in seven weeks.

This summer, in addition to solving the SH2 domain, I learned how to use CYANA for automated NOE assignment and structure calculations. This will directly impact my thesis work, since I will now be able to use CYANA to calculate the structure of VPS4A 1-122. Finally, this summer I assisted in updating the existing DYANA manual to contain relevant information for CYANA operation. My research in Japan should result in two journal publications: one for the completion of the backbone and sidechain NMR assignments and another for the protein structure.

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Takashima, Y., Delfino, F., Engen, J., Superti-Furga, G., Smithgall, T. (2003) *Biochemistry*, **42**, 3567-3574.

RESEARCH REPORT

1. Name: Tom Sullivan (ID No.: SP04057)

2. Current affiliation: University of California, San Diego

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry X Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo University of Technology

5. Host researcher: Dr. Kunihiko Fukushima

6. Description of your current research

My current research is focused on computational models of the visual system. The goals are two-fold: we can learn something about the operation of the brain by creating models of one of its important areas, and we can use the knowledge we gain to engineer more useful computers. For example, one of the end goals of this research is to create computers that can recognize individual people or cars that can recognize pedestrians.

The visual area of the cortex (a part of the brain) is arranged in a hierarchical fashion. The information from the eyes is first processed in the Primary Visual Cortex (V1), then by the area known as V2, etc. Understanding the details of how this hierarchy is put together will go a long way toward attaining our goals.

The particular emphases in this research area has been the incoming connections to the complex cells of V1 and feedback between V2 and V1. I am creating detailed models of how these connections are learned, and how they behave after learning. If I am successful, we will be able to incorporate these two pieces of the puzzle into computer vision systems.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Filling In Missing Information with Cortical Feedback

Description of the research activities:

The neurons of the primary visual cortex (V1) are known as feature detectors. They detect features such as orientation, spatial frequency, and color. Research in this area has revealed much about the processing role of the pathways from the retina to V1, as well as their role in development. There is much less research into the role of feedback pathways from higher visual areas - connections from V2 to V1, for example. One function that this pathway seems to perform is ``filling-in" missing information. For example, a higher visual cortical area may be able to provide a reasonable guess as to what is behind an occluding object.

In this research, we created a simple computational model that demonstrates the ability of higher visual areas to fill-in missing information. To do this, 16 V1 cortical regions were constructed that connect to one V2 region (all embodied within a computer program). Each V1 region consists of two layers that represent the feedforward pathway. The simple cell layer has Gabor filters arranged in an organized map. The complex cell layer is formed by having a limited number of incoming connections from nearby simple cells. A sparse representation is forced by lateral inhibition.

The feedforward and feedback connections between the V1 regions and the V2 region are all-to-all (all possible connections are made). A Hebbian learning rule with weight normalization is used to train connections going in both directions. The feedforward path is trained first, followed by the feedback path. An alphabet of 26 characters is used as the training set.

After training, the ability of the feedback connections to fill in missing data was demonstrated. One of the test images was presented to the network with some of the neuron activity erased. The V1 and V2 representations form based on the input. The resulting V2 representation sends feedback to all V1 areas, including the one responsible for coding the region with missing data. This feedback recreates the missing information on V1 to reform.

At this stage the results are promising, but should be considered as a pilot study. More collaboration will hopefully take place in the coming months so that we may more rigorously implement our ideas.

RESEARCH REPORT

1. Name: Quan T. Tran (ID No.: SP04058)

2. Current affiliation: Georgia Institute of Technology

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry X Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Yamanashi University (Kofu campus)

5. Host researcher: Professor Kentaro Go

6. Description of your current research

Everyday memory recall remains a real and open problem especially among common household chores ranging from forgetting whether medication has been taken today to recalling how many scoops of laundry detergent of the five scoops required has been added. In this research, we aim to explore this problem space of everyday memory slips. We hope to document a series of real-life scenarios from which smart home technologies can be comparatively evaluated. In doing so, we hope to construct a new blend of investigative methods and procedures that may be applied to different domains to produce further test cases.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Pair-wise Photo Probes

Description of the research activities:

We designed and deployed Pair-wise Photo Probes, a new survey technique to collect real-life evidence of memory slips at home. We first screen for pairs of participants by distributing a short background questionnaire. We leverage the social checks and balances inherent between pairs of people who know each other's daily habits and routines to produce more robust survey results than self-reporting has.

The goal of this survey is for the participant to photograph many different real situations at home for them or for their partner when a task could not be determined as finished or unfinished because they

- were interrupted (by a phone call, visitor at the door, and so on),
- were distracted (by children, outside alerts, and so on),
- were multitasking (by entertaining guests, cooking, and so on),
- just simply forgot what they were doing.

The survey also includes short response forms to gauge the perceived cost of these memory slips and the consequent perceived need for a memory aid to remedy these situations.

Although this survey technique will yield rich probing data at minimal maintenance cost to the researchers, the data yield is highly unpredictable. Subject participation is completely voluntary, and the photo assignment is nontrivial. Therefore, we have no guarantee on data return. At this point, we are still awaiting data results.

8. Please add your comments (if any):

All survey forms were translated in Japanese.

RESEARCH REPORT

1. Name: Jimmy Triplett (ID No.: SP04059)

2. Current affiliation: Iowa State University, Ames, Iowa, U.S.A.

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences **X** Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University, Department of Botany

5. Host researcher: Dr. Noriaki Murakami

6. Description of your current research

The primary goal of my research is to contribute to our understanding of the diversity and evolutionary history of the giant grasses known as woody bamboos (Grass family: Bambuseae tribe). Woody bamboos are represented by over 1,300 species worldwide and are a major component of forests in Southeast Asia, the Indian subcontinent, Australia, Africa, Madagascar, and the Americas. In spite of their ecological and economic significance, however, fundamental questions have yet to be answered regarding their biology and evolution. This is particularly the case for the North Temperate clade, a monophyletic group of more than 500 Old World species, plus 2-3 species native to the southeastern United States. Although the group is known to have an ancestor that is distinct from that of the tropical bamboos, evolutionary studies to date have provided little or no resolution among species in the North Temperate clade.

My work focuses on the genus *Pleioblastus*, encompassing 42 species of dwarf and arborescent bamboos native to Japan and China. The genus is part of the *Arundinaria* complex, a group of genera that is critical to our understanding of evolution in the North Temperate clade. I intend to perform a cladistic analysis of molecular and morphological data in order to answer the following questions: (1) Is *Pleioblastus*, as currently recognized, a monophyletic group? (2) If so, what are its unique derived characters and other delimiting features? (3) What are the phylogenetic relationships among species in this genus? (4) What is the position of *Pleioblastus* relative to other genera in the *Arundinaria* complex? This research will provide not only the first classification of the genus based on an explicit phylogenetic hypothesis but also a basis for comparison with other groups within the *Arundinaria* complex and the North Temperate clade. As such, my study will contribute to ongoing efforts to elucidate the evolutionary history of woody bamboos while providing taxonomic stability for a group that has troubled botanists and horticulturalists alike.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

A taxonomic study of the genus *Pleioblastus* in Japan.

Description of the research activities:

An essential step in the revisionary study of any taxonomic group is to examine the material that forms the basis for the nomenclature. Type specimens are the fundamental elements of plant taxonomy: every named species is associated with a particular specimen that is the recognized name-bearer for that species. The primary focus of my research in Japan was to conduct a thorough examination of herbarium specimens, including types, in order to document morphological variation, distribution, and phenology in *Pleioblastus*. At Kyoto University Herbarium (KYO) I dedicated approximately 4 weeks to extensive data collection from over 50 type specimens plus numerous other representatives of woody bamboo. This data will be an important part of my taxonomic revision of *Pleioblastus*. I spent one week at the Herbarium Universitatis Tokyoensis (TI) at Tokyo University, where I examined specimens and was permitted to consolidate materials for a loan that will be sent to my home university for long-term study. This loan will give me the opportunity to carefully examine important material that would otherwise have been unavailable to me. While in Tokyo, I also visited the Makino Herbarium of Tokyo Metropolitan University (MAK), where I was able gather important data from specimens collected by Japanese botanists who first named many of the species in this genus. All three herbaria have extensive collections of temperate woody bamboos, and provided an excellent opportunity for me to study bamboo taxonomy in general. This extensive herbarium research at KYO, TI, and MAK herbaria directly contributes to the goals of my dissertation.

A study of living plants is essential for understanding the important morphological characteristics of bamboos. Rakusai Bamboo Garden near Kyoto maintains a major native bamboo collection and provided an excellent location to study living specimens of *Pleioblastus* and its relatives. This was also my primary site for collecting material for further morphological and molecular study. I spent five days at Rakusai and collected 35 specimens for use in my morphological and molecular analyses of *Pleioblastus* back at Iowa State University. At Rakusai, I was also able to make descriptive notes of important characters that are typically difficult to interpret from herbarium specimens, and I took extensive photographs to document morphology and habit of the species.

In addition to work directly related to my research, I also participated in several activities that were generally enriching to me as plant systematist. I visited several botanical gardens, including the Kyoto Botanical Garden and the Koishikawa Botanical Garden of Tokyo University. These were excellent resources for me learn about botanical diversity in Japan. Over the course of the EAPSI program, I also established important contacts for more extensive future fieldwork, with the goal of collecting material from natural populations of bamboos.

The EAPSI program provided the opportunity for me to participate in activities that directly enhance my research while learning about plant systematics in Japan and building a network of contacts for future collaborations. I am honored to have had this incredible opportunity, and I extend my deepest gratitude to JSPS, NSF, and everyone who contributed to the success of this program.

RESEARCH REPORT

1. Name: Laura Trunk (ID No.: SP04060)

2. Current Affiliation: University of Washington

3. Research Field: Mathematical and Physical Sciences

4. Host Institution: Institute for Study of Earth's Interior, Okayama University

5. Host Researcher: Dr. Minoru Kusakabe

6. Description of your current research

Crater lakes are unique in that they act as calorimeters, absorbing heat given off by intruding magma bodies, and integrating heat flow over space and time. Heat flowing out of the volcanic conduit under the lake causes an overall increase in the temperature of the lake. Determining how quickly crater lakes respond to this heat flux and how soon before eruption thermal signals may be seen could provide valuable insight into the processes taking place within the volcano. In this regard, satellite observations of crater lake water temperatures may complement other methods currently used to monitor volcanic activity. Thermal images taken by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) were analyzed in order to measure the temperatures of crater lakes. These temperature estimates are calibrated against lake water temperatures that have been collected on the ground. Data from fieldwork undertaken in the summer of 2004 at Lake Yugama in the crater of Kusatsu-Shirane volcano and a nearby non-volcanic lake in Japan allow a comparison of ground-truth data with ASTER imagery. It is hoped that results will lead to a better understanding of how intruding magma bodies affect the thermal history of crater lakes and may hopefully be useful in interpreting future warming of crater lakes on active volcanoes.

7. Research Implementation and Results under the program

Title of your research plan: Thermal Response of Crater Lakes to Magmatic Intrusion: Applications for Eruption Forecasting

Description of the research activities:

My main objective during the summer of 2004 was to undertake fieldwork, which would provide data necessary for the completion of my master's thesis. As described above, my thesis work involves monitoring of active volcanoes through observations of crater lake water temperatures made with the ASTER satellite. The plan for my fieldwork was simple in concept: I would measure the temperature of Lake Yugama, in the crater of Japan's Kusatsu-Shirane volcano, as well as the temperature of a nearby non-volcanic lake, during the same period of time in which

the satellite would pass overhead and capture an image. Comparisons of the actual temperature as measured from the ground, and the temperature calculated using the satellite image would allow for calibration of future images taken by satellite. The fieldwork would lead to a better understanding of how factors such as air temperature, relative humidity, and wind speed affected the apparent temperature of the lake surface. In addition, measurements would be taken of the water temperature at depth to explore how the surface temperature related to the overall temperature of the lake.

As simple as the concept may have been, the fieldwork still required intensive planning and preparation, as well as a bit of luck as far as weather was concerned. Planning began months ago, while I was still working in my lab in Seattle. The first thing that needed to be accomplished was to submit a request for data to be acquired by the satellite as it passed over the lake. Once a date was set for the overflight, the fieldwork could be planned accordingly. Because my host institution is in Tottori prefecture, far from the volcano in Gumma, transportation and lodging needed to be arranged. Contact was also made with the researchers at KSVO, the local volcano observatory. Here, my host researcher was particularly helpful. He made contact with the observatory and made all the necessary arrangements, down to a rubber raft and field assistants.

When I arrived in Japan, the preparations continued. In particular, I needed to learn how to use the CTD, the instrument used for making temperature profiles at depth. Along with my sensei, I tested it in a lake near our institute. Other equipment was prepared and final travel arrangements were made, as I began to acclimate to life in my friendly new surroundings.

Once the fieldwork was actually underway and the careful plans moved into action, all that was needed was a bit of luck with the weather. There couldn't be too many clouds on the day of the overflight, or the satellite would not be able to see the lake. The first few days in the field didn't look promising, but the morning of the overflight dawned with only a partial cloud covering and we hoped for the best. Being in the lake to take the measurements was a great experience. It was incredible for me to be in the lake that I'd spent so many hours scouring on my computer screen at home.

Preliminary analysis of the data has been undertaken since I've returned from the field. However, it is not yet known whether the satellite image was acquired. Below, I've included a representative temperature vs. depth profile (Fig. 1) that was collected at the lake, along with a rough location map (Fig. 2) to show where the data was taken. For interest's sake, I've also included a few photographs from the field.

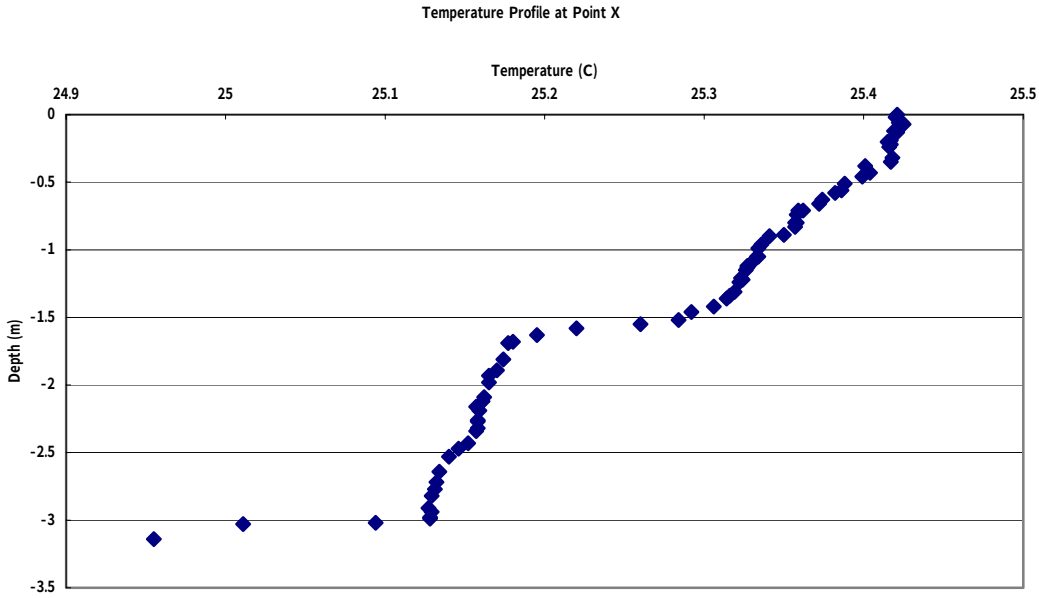

Figure 1. Representative temperature vs. depth profile taken at Lake Yugama, Kusatsu-Shirane volcano, on 28 July 2004

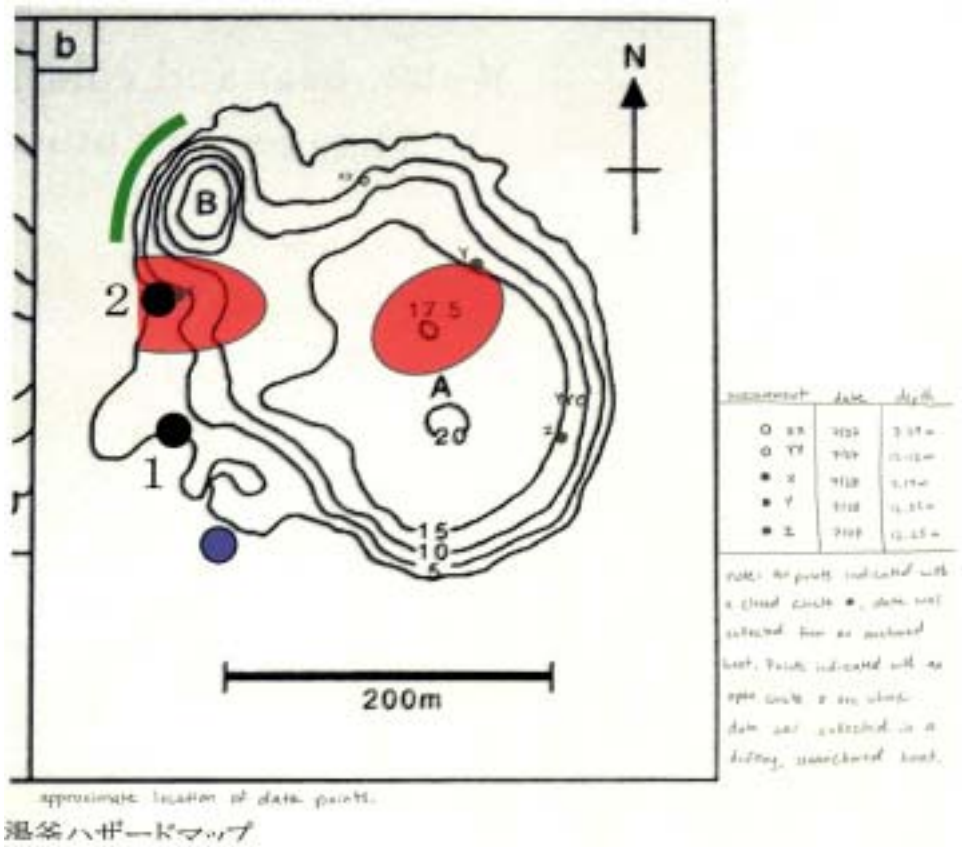

Figure 2. Location map showing data collected at Lake Yugama

8. Please add your comments (if any):

I am very grateful to the staff of NSF and JSPS who worked so hard to organize the 2004 EAPSI summer program. I am also thankful for the help I received from the staff and students of the Kusatsu-Shirane volcano observatory,

particularly my field assistants: Oikawa-san and Sawa-san. Finally, I am very grateful to my sensei, Dr. Kusakabe, whose kind and generous help made my summer very productive and enjoyable.

Clockwise: 1) Kusakabe-sensei measures the surface water temperature at the non-volcanic lake 2) Kusatsu-Shirane volcano 3) me in front of Lake Yugama 4) Kusakabe-sensei and Oikawa-san prepare to lower the CTD into Lake Yugama

RESEARCH REPORT

1. Name: Jocelyn Turnbull (ID No.: SP04061)

2. Current affiliation:

University of Colorado at Boulder, Boulder, CO 80309-0450, USA

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences

☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Tohoku University, Sendai

5. Host researcher: Dr. Takakiyo Nakazawa

6. Description of your current research

Measurement of ^{14}C in atmospheric CO_2

Recent increases in the atmospheric CO_2 concentration have been attributed to combustion of fossil fuels. However, the magnitude of the fossil fuel CO_2 flux is poorly known, and are usually based on economic inventories. CO_2 produced from fossil fuels has zero ^{14}C abundance, whereas other sources of CO_2 have ^{14}C concentrations close to that of ambient air. Thus ^{14}C is a direct tracer for fossil fuel CO_2 emissions. Until recently, sample size and precision have limited the use of ^{14}C for fossil fuel quantification. My research interest is in developing a method for high precision measurement of ^{14}C in CO_2 on small (2-5 liter) samples of ambient air.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Measurements of stratospheric ^{14}C over Japan

Description of the research activities:

Samples of stratospheric air were collected over Japan in 1994. The samples were collected from a balloon platform, using a cryogenic collection technique. CO_2 was extracted from these samples and a portion of this CO_2 was measured for ^{14}C concentration at the Nagoya University AMS facility.

I assisted with the sample preparation and measurement at Tohoku University and Nagoya University, then interpreted the results of the measurements. In addition, I toured the laboratory facilities at both Universities, and at the National Institute of Environmental Studies (NIES) in Tsukuba. I gave presentations on my doctoral dissertation research at Tohoku University and at NIES.

Measurement of ^{14}C in stratospheric CO_2
Jocelyn Turnbull, August, 2004
Research Report for JSPS Summer Program

Introduction

Anthropogenic perturbation of the Earth's carbon cycle has resulted in a ~35% increase in atmospheric CO_2 since industrialization. This increase is moderated by exchange of carbon between the atmosphere and other Earth system reservoirs. Improving our understanding of the interaction between these reservoirs is key to addressing future trends.

^{14}C is a rare, radioactive isotope of carbon. Uniquely among the carbon isotopes, it is produced in the stratosphere (and to a lesser extent, in the troposphere) by interaction of nitrogen with cosmic rays, reacting to form CO_2 and eventually making its way into all the Earth's carbon reservoirs. During the late 1950's and early 1960's, atmospheric nuclear weapons testing produced large amounts of anthropogenic ^{14}C, almost doubling the natural tropospheric ^{14}C concentration, and increasing the stratospheric concentration to much higher levels. This "bomb spike" in ^{14}C concentration has been traced through the various carbon reservoirs, as a tool to help understand exchange mechanisms. Knowledge of the changes in stratospheric ^{14}C concentration is needed, but only a few measurements have been made. We measured the ^{14}C content of CO_2 collected in the stratosphere over Japan, on August 31st, 1994, and compare the results with previous stratospheric measurements.

Methods

Samples were collected over Sanriku, Japan using a cryogenic balloon borne sampler and CO_2 was extracted at the Tohoku University Center for Atmospheric and Ocean Research (CAOS)[1]. The CO_2 was reduced to graphite and measured at the Nagoya University AMS facility in August 2004 [2]. The ^{14}C content is reported as $\Delta^{14}C$, such that

$$\Delta^{14}C = \left[\frac{\left({}^{14}C/{}^{12}C \right)_{sample}}{\left({}^{14}C/{}^{12}C \right)_{abs}} - 1 \right] \times 1000‰$$

where $(^{14}C/^{12}C)_{sample}$ and $(^{14}C/^{12}C)_{abs}$ are the ^{14}C:^{12}C ratio in the sample and absolute radiocarbon standard, respectively. Results are reported following the conventions of Stuiver and Polach (1977)[3], whereby they are normalized to a standard $^{13}C/^{12}C$ ratio and corrected for decay. CO_2 concentrations were measured at CAOS and are reported in parts per million by volume (ppmv).

Stratospheric profile

Figure 1 shows the profile for 1994, compared with those measured for 1989 and 1990 [4,5]. The 1994 profile was measured using the newer HVEE AMS system[2] which allows much higher precision measurements. The lowest point in the 1994 profile is inside the troposphere (tropospheric height was 16.5km on this date) and agrees well with ground-based tropospheric values measured at Vermunt Station in Germany during the same year[6]. The 1994 profile can be divided into two parts – the upper stratosphere, which has relatively consistent $\Delta^{14}C$, and the lower stratosphere, where values change rapidly, indicating mixing with tropospheric air. The upper stratospheric values range from 204-223 ‰, averaging 213 ‰. This is about 100 ‰ higher than the troposphere at the same time.

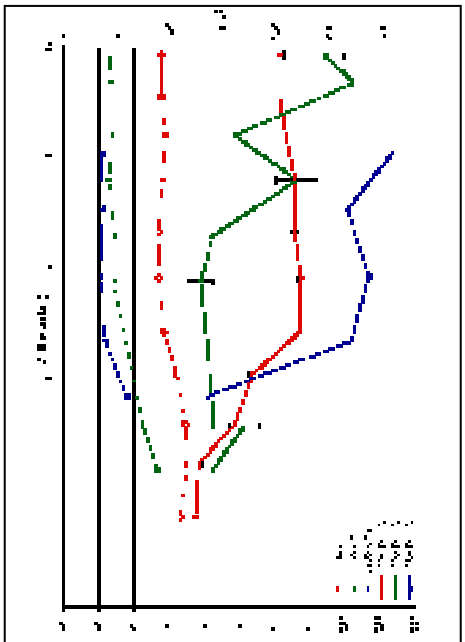

Figure 1. CO_2 (open symbols) and $\Delta^{14}C$ (closed symbols) for stratospheric profiles measured over Japan on Sept. 1st, 1989, June 4th, 1990 and August 31st, 1994. 1 σ errors are shown for $\Delta^{14}C$. Error on the CO_2 measurement is smaller than the symbol size.

The 1994 profile was collected on August 31st, and should represent the same season as the Sept 1st, 1989 profile. Although the 1989 measurements have more variability, this is likely due to the lower measurement precision. Both these profiles appear to be fairly stable through the upper stratosphere, and this is consistent with a stable summertime stratosphere. The June 4th, 1990 profile has more variability than the other profiles. In June, exchange between the troposphere and stratosphere should be fairly strong, resulting in a more varied profile. The $\Delta^{14}C$ values are lower than those for 1994, which also indicates mixing from the relatively depleted troposphere.

The 1994 $\Delta^{14}C$ values decrease at higher levels in the stratosphere. The residual bomb carbon effect would cause younger air to have lower ^{14}C values, suggesting that the upper stratospheric air is younger than the mid-stratospheric air at this time. This is also indicated by the CO_2 data – CO_2 concentrations are higher in the same upper air samples, consistent with younger, CO_2 enriched tropospheric air. This effect is not seen in the other profiles, so it is not clear whether or not this is a common occurrence.

Temporal changes in stratospheric ^{14}C concentration

The stratospheric ^{14}C concentration has decreased greatly over the last 30 years (figure 2) as bomb ^{14}C has been transported into the troposphere and other reservoirs. The data support an exponential decay of ^{14}C in the stratosphere since 1970 and a curve fit indicates that the stratospheric ^{14}C concentration should reach equilibrium at about 110-120 ‰ (assuming no further large unexpected perturbations). The tropospheric ^{14}C concentration also follows an exponential curve, but with slower decay than the stratosphere, as might be predicted from the larger reservoir size and continued influx of ^{14}C enriched air from the stratosphere. It should level out at about 10-15 ‰, slightly higher than the pre-bomb level. This model indicates that the average stratospheric ^{14}C concentration immediately following the end of major atmospheric nuclear weapons tests in 1963 was about 4200 ‰.

Predicted pre-bomb stratospheric $\Delta^{14}C$

If we assume that all ^{14}C produced by bomb testing was initially in the atmosphere, then the global average equilibrium $\Delta^{14}C$ can be approximated by

$$B_{g\_eq}C_g = B_{s\_1963}C_s + B_{t\_1963}C_t$$

Where B_{g_eq} is the global average bomb $\Delta^{14}C$ at equilibrium, C_g is the global carbon burden, B_{s_1963} and B_{t_1963} are the 1963 (maximum post-bomb) stratospheric and tropospheric bomb $\Delta^{14}C$ values, and C_s and C_t are the 1963 stratospheric and tropospheric burdens. The bomb ^{14}C component can be described by

$$B = \Delta^{14}C_{tot} - \Delta^{14}C_{nat}$$

where tot and natural are the total and natural ^{14}C burdens, respectively. These calculations ignore the effect of decay, as the contribution of decay over the next few hundred years is much smaller than other errors in this calculation.

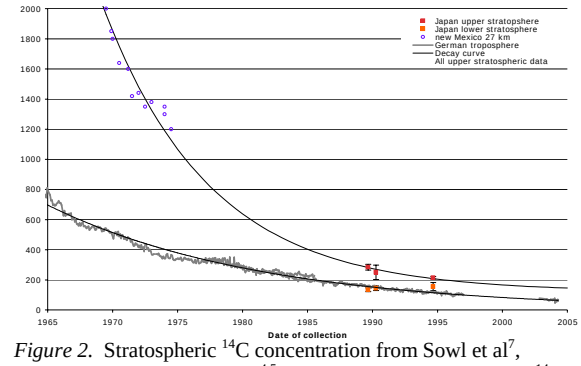

Figure 2. Stratospheric ^{14}C concentration from Sowl et al[7], Nakamura et al (1992, 1994)[4,5] and this study. Tropospheric ^{14}C concentration at Schauinsland and Vermunt (Levin and Kromer[6]) are also shown. Decay curve is the best fit for all stratospheric data (r^2=0.994, asymptote occurs at 110‰.

Extrapolating the stratospheric value gives a stratospheric $\Delta^{14}C$ of 4200 ‰ in 1963, and the Schauinsland tropospheric record shows the tropospheric maximum at 989 ‰[6]. Assuming that 15% of the atmospheric mass is in the stratosphere, and estimating the 1963 atmospheric carbon burden at 630 GtC, and the total global carbon burden at 40,100 GtC, then the equilibrium global average B_{g_eq} will be 22 ‰. The tropospheric data indicate equilibrium at a slightly lower 10-15 ‰. The difference is probably due to the addition of ^{14}C-free fossil fuel CO_2 to the troposphere since 1963. These estimates are based on the upper stratosphere data, and the lower stratosphere $\Delta^{14}C$ values appear to be lower, and this may also introduce some bias in the results.

Thus the pre-bomb stratospheric $\Delta^{14}C$ was about 100 ‰ higher than the tropospheric $\Delta^{14}C$. Currently the difference between troposphere and stratosphere is slightly less than this, due to the longer decay constant (and larger reservoir size) for the troposphere.

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7. Sowl, R.E., J. Gray, Jr., T.E. Ashenfelter and K. Telegadas, HASL-294, ed. E. Hardy, Jr., Health and Safety Laboratory, U.S. Energy Research and Development Administration, New York, p.20, 1975. Note that the values shown here are estimates only from the graphs published by Sowl et al.

RESEARCH REPORT

1. Name: Doug Van Hoewk (ID No: SP04062)

2. Current affiliation: Colorado State University

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry Engineering Sciences XX Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Riken Institute

5. Host researcher: Hideki Takahashi

6. Description of your current research

I study selenium metabolism in plants. Selenium is normally toxic to plants, but we have created transgenic plants that are better able to tolerate and accumulate selenium. This research could have applications in phytoremediation- the use of plants to clean polluted soils.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Genome analysis of NifS overexpressing plants grown on selenium.

Description of the research activities:

I performed microarray analysis on transgenic Arabidopsis overexpressing a selenocystein lyase enzyme, which prevents the toxic accumulation of selenium into protein. I grew wildtype and transgenic plants on media with and without selenate, and analyzed how the transcriptome changed. I was able to answer two questions: how does the genome change in response to selenium stress, and what benefits does overexpression ofNifS have in conferring tolerance to selenium.

8. Please add your comments (if any): Thank you very much for a great summer. The program was terrific, as well as all the food I have.

RESEARCH REPORT

1. Name: Cuong Vu (ID No.: SP04063)

2. Current affiliation: The Johns Hopkins University, School of Medicine

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences X Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo: Department of Orthopedic Surgery

5. Host researcher: Dr. Sakae Tanaka

6. Description of your current research

Osteoporosis is a disease where bones start losing their density, resulting in bones becoming fragile and easily able to fracture. It is one of the leading causes of disability among elderly individuals in the world and is becoming increasingly a problem in Asian countries. This is especially the case in Japan, where the population is aging and the diet consists of a smaller amount of dairy products.

Bone density is maintained by the balance of two opposing cells. Osteoclast resorb bone, while osteoblast lay down new bone materials. If this balance is disturbed it can result in an increased or decrease in bone density. My current research focuses on one of these cells, the osteoclast. By decreasing the activity of osteoclasts you can increase the density of bone. This mechanism has become the focus of some osteoporosis medications.

My current research focuses on one family of medication for osteoporosis that are called bisphosphonates. This medication works by either inactivating osteoclasts and/or by causing osteoclast apoptosis or programmed cell death. My research focuses on the mechanism by which Etidronate, a bisphosphonate, brings about osteoclast apoptosis. More specifically, my research project is to determine whether or not Bim, a pro-apoptotic protein, is necessary in Etidronate mediated osteoclast apoptosis.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

The role of pro-apoptotic protein bim in bisphosphonate mediated osteoclast apoptosis.

Description of the research activities:

The first and most important thing that we had to do was to culture osteoclast cells. This was done by culturing bone marrow cells, received from the hind limbs of mice, with primary osteoblast cells cultured from the calvaria of newborn mice. When these cells are cultured together in the presence of PGE_2 and Vitamin D_3, progenitor cells from the bone marrow begin to develop into osteoclasts.

These osteoclasts were used for a number of studies. The first study we did was to show that etidronate (the drug that we are studying) does in fact cause the programmed cell death of osteoclasts. We cultured the cells with varying concentrations of etidronate and then compared the amount of these cells with the amount of cells cultured in an etidronate free environment. We showed that etidronate does drastically reduce the number of osteoclasts in a dose dependent fashion.

Next, since we are studying whether or not the pro-apoptotic protein Bim is necessary for etidronate action, we incubated osteoclasts with or without etidronate and collected the cells' proteins to determine whether or not there was an increase in Bim protein in bisphosphonate treated cells as compared to untreated cells. The initial results showed an increase in bim protein for osteoclasts that were incubated with Etidronate in the presence of MCSF. However, there has been some difficulty in repeating these preliminary results.

After receiving the preliminary results we started studies using Bim knock-out mice. These are mice that do not have the protein Bim. We injected the mice with etidronate for 3 days and then observed histological samples received from this mouse and compared it with a normal mouse that was also injected with etidronate for 3 days. The initial results did not show a noticeable difference between these mice. The conclusion we drew from this is that 3 days was not enough time for there to be a noticeable difference in the tissues from these animals.

Along with the in vivo experiment with the Bim knock out mouse, we also did an in vitro experiment with another Bim knock out mouse. We did another survivor assay comparing the survival rate of etidronate treated osteoclasts with untreated osteoclasts. The results of this experiment were inconclusive and further experiments were needed.

After the end of the research period we concluded that more research needs to be done using knock out mice and further effort needs to be put in to reproducing the preliminary results of the in vitro experiments. However, our inability to reproduce the preliminary results and also the results of the preliminary studies with the knock out mice might suggest a rejection of our hypothesis, but further analysis needs to be done to ensure that this is the case.

After the end of the summer program further research will be done. This includes using more knock-out mice that will be treated for longer than 3 days and also further in vitro studies. I will keep in contact with my host laboratory and receive any new updates that they have regarding my research project.

8. Please add your comments (if any):

I just wanted to say that this program was an absolutely wonderful experience. I have thoroughly enjoyed working with the people at the University of Tokyo. I hope to remain in contact with them throughout my career. My only regret is that I was unable to complete my project within the allotted time, but this has been an incredible learning experience.

RESEARCH REPORT

1. Name: Andrew Ward (ID No.: SP04064)

2. Current affiliation: The Scripps Research Institute

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry Engineering Sciences X Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Yoshinori Fujiyoshi

6. Description of your current research

Intrinsic membrane proteins comprise ~30% of the genome of higher organisms. Their roles vary from import and export to cell signaling and communication. A large subset belong to the ABC family of proteins responsible for translocating substrates across membranes utilizing ATP as an energy source. In this study we employ electron crystallography to study a member of the ABC family. Electron crystallography, with reconstitution into near *in vivo* membranes and the small amounts of protein necessary, makes for an ideal structural determination platform. Here we have set out to determine the molecular mechanisms (conformational changes) underlying nucleotide driven substrate translocation in a bacterial transporter, MsbA, using cryo-electron microscopy (EM). With no stain and a near in vivo environment cryo-electron microscopy can be used to recreate accurate, continuous density maps of membrane proteins. Recent advancements in data collection and processing have also provided a path to produce high resolution helical structures of membrane proteins, providing molecular details about protein function.

MsbA is lipid flippase proposed to function as a homodimer, translocating Lipid A from the inner leaflet to the outer leaflet of the bacterial inner membrane. It is an essential bacterial transporter and knockout results in aggregations of Lipid A on the interior of the membrane, resulting in a lethal phenotype. It is targeted here as an important transporter sharing homology with human P-glycoprotein and MDR1 (proteins related to chemotherapy resistance). Overlap in binding sites and overall function in members of the ABC family suggest that MsbA will serve as a paradigm for other homologous nucleotide driven substrate efflux proteins and will provide insight into drug and chemotherapy resistance in bacteria and human cancer cells.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

High Resolution Cryo Electron Microscopy of Membrane Proteins

Description of the research activities:

I utilized a helium cooled 300kV electron microscope to collect high resolution images of membrane protein crystals. The specially designed specimen loading stage, along with the helium cooling (to 4K), create a stable, unmoving environment in which to image samples. Imaging at 300kV also contributes to image quality by reducing damage to the sample caused by slow moving electrons. These advances make the microscope at Kyoto University an ideal platform for pursuing high resolution structures. I was able to collect images that showed diffraction spots that extended further than 10A resolution. On a conventional microscope diffraction to 20A was the limit.

8. Please add your comments (if any):

This was an unbelievable opportunity to gain a different perspective on science and culture. I have benefited greatly from this experience, and built relationships for future collaboration.

RESEARCH REPORT

1. Name: Lisa Wesoloski (ID No.: SP04065)

2. Current affiliation: University of California, Los Angeles

3. Research fields and specialties:

☐ Humanities ☐ Social sciences X Mathematical and Physical Sciences
X Chemistry ☐ Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Materials Science (NIMs)

5. Host researcher: Dr. Masakazu Aono and Dr. Tomonobu Nakayama

6. Description of your current research

The goal of this project at NIMs was to broaden our understanding of ferromagnetic structures on HOPG (graphite). The study utilized the technique of a spin-polarized scanning tunneling microscope (SP-STM) to probe ferromagnetic manganese clusters using a ferromagnetic tip. The main emphases of the project were to image manganese clusters on graphite, measure the electronic structures of the observed species, and seek local magnetic surface effects.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

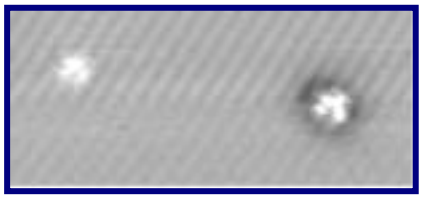
Imaging Manganese Ferromagnetic Nanoclusters on Graphite

Description of the research activities:

In order to deposit manganese properly on a graphite sample, we first installed a new 'Ferrovac, Gbhm' evaporator onto the Omicron Low Tempeture-STM system. Then, deposition conditions were refined after several stages of evaporating, annealing, and cleaving the sample surface. The most suitable cluster coverage for our purposes was a 5% Mn with sizes up to about 5nm. Images were first made

with a nickel tip and attempts were made later with platinum/iridium (Pt/Ir) and tungsten (W) tips.

Many interesting images of graphite were observed such as the moiré pattern on graphite and step edges covered with clusters. The most intriguing discovery was observing two types of Mn clusters on graphite, one with a dark ring and another



without. These clusters behave differently under varying tunneling conditions. With the fact that two types of clusters were observed, a bias-dependent vs. a bias-independent, in the same image, suggests the coexistence of varying magnetic clusters, i.e. ferromagnetic/anti-ferromagnetic clusters or parallel spin/perpendicular spin ferromagnetic clusters on the graphite surface. In addition, the atomic resolution of graphite was observed within the dark ring of the Mn cluster where its spectral measurements revealed a change in the graphite's electronic structure.

8. Please add your comments (if any):

The JSPS program has been an unforgettable experience. I had an amazing time scientifically, socially, and culturally. The stay was short, but I made sure for it to be compact with fun and exciting events. I enjoyed working in the Japanese lab and I feel I have made lasting Japanese and foreign friendships and collaborations.

9. (If any) Advisor's remarks:

Ms. Lisa Wesoloski has been engaged in our challenging project on an atomic-scale magnetism using low-temperature ultrahigh-vacuum scanning tunneling microscopy, as she has already described. To say honestly, I was a bit anxious for her participation to this project because, for a summer student, experiments seemed to be very difficult and frustrating. However, she was enough patient and did quite well much more than I expected. Actually, she finally obtained results which seem interesting. I would like to keep in contact with her since the results are worthwhile to be further studied. I really thank her not only for her contribution to the research but also for introducing an international atmosphere to my laboratory. She certainly belongs to a class of the brightest student.