

BIOTA

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DEPARTMENT OF BIOLOGICAL SCIENCES

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Patricia O. McCarroll, *Editor*



FROM THE DESK OF THE CHAIR,
DR. JOE CLOUD

DEAR FRIENDS,

We have had a number of changes in the department this year. In August, Larry Forney made the decision to step down as department chair in order to invest more time in research and teaching. I, in turn, made the decision to exchange the position of associate dean of the College of Science for a more active role in the department. Larry and all of the faculty and staff have made this transition easy for me, and I am grateful to everyone for their patience. Also, in August, **Kevin Kelliher** joined our faculty from the University of Maryland. A summary of Kevin's research interests can be found in the latest issue of the alumni magazine and elsewhere in this newsletter. Currently, Kevin is establishing his research laboratory and teaching in the WWAMI program. In addition to Kevin, we are actively recruiting three more faculty members.

Our building has changed; the renovation of the fourth floor of the Life Sciences Building is now complete. Professor Eva Top has moved her laboratory to the northeast corner. The other two laboratories that are located in the central portion of the south side will be occupied by two new faculty members. In addition, we have dedicated space for a new imaging center, a library and a conference room. This renovation has improved the utilization of space in the Life Sciences Building and has provided much needed additional research space.

Our undergraduate enrollment has changed; the department experienced a slight reduction in the number of biology majors this year. As a result, we are increasing our efforts to insure that our students are spending an adequate amount of time on their education as opposed to

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a job to support their education. To this end, I have initiated a new scholarship fund to help students in their sophomore year. The rationale for this choice is based on my own experience as an undergraduate and the importance of the sophomore year to overall success. This new scholarship fund is the Biology 201 Memorial Fund.

If you are visiting Moscow or the University, please drop by my office for a chat and/or a tour of our building. Even though we have made a number of changes to the building over the years, Room 277 is still recognizable.

Warm regards,
Joe Cloud

NEW FACULTY MEMBER

KEVIN KELLIHER

KEVIN R. KELLIHER JOINED the Biological Sciences faculty as a new assistant professor in August 2006. He came to University of Idaho from the University of Maryland, Department of Anatomy and Neurobiology, where he was a postdoctoral fellow from 2001 to 2004 and an assistant professor from 2004 until his departure for Moscow.

Kevin is originally from Clifton Park, N.Y., just outside of Albany. He completed his undergraduate education at the State University of New York, Oswego, and earned a Ph.D. in biology at Boston University.

His research interests center on social behavior and specifically on how the brain controls social behavior in mammals. He is investigating how animals use olfactory cues to trigger social behavior, and thus, it is important to know what the olfactory cues are, how they are detected and how they are processed in the brain. There is not just one olfactory system operating within animals, but multiple systems. Different behavioral reactions may be dependent upon which of these systems is detecting the cue.

Kevin uses strains of knockout mice in his research. These are laboratory mice in which researchers have inactivated a gene by replacing it or disrupting it. The loss of the gene can change the mouse's appearance, other physical characteristics or behavior. He tests strains of knockout mice



Professor Kevin Kelliher

with specific non-functional olfactory systems to see how they react to olfactory cues. For more information on research in the Kelliher lab, see his Faculty Profile on page ____.

Last year, as he considered various open positions, the opportunity to participate in the WWAMI Medical Education program and the department's cooperative research with Washington State University were major factors in his decision to come to Idaho. He will teach Medical Neuroscience and the Head and Neck course for

the WWAMI program. He also will teach a course for graduate students every other year. For this teaching responsibility, he hopes to develop a new course in neuroendocrinology.

Kevin, his wife Lynn, and their daughter, Meghan, have acclimated very quickly to their new home. Surprisingly, they have found many similarities between northern Idaho and their former home in upstate New York. The Kelliher family enjoys activities like apple picking and hope to get back into camping as time permits.

Shortly after his arrival on campus, Kevin was notified that he had received the prestigious Frank A. Beach Award, given by the Society for Behavioral Neuroendocrinology. The award recognizes young investigators who show exceptional promise for making significant contributions to the field of neuroendocrinology.

THE END IS THE BEGINNING

AFTER THREE YEARS OF EFFORT, THE renovation of research laboratories and faculty office space in Life Sciences South has come to an end. Use of the entire new infrastructure can now begin. The occasion was marked by a ribbon-cutting ceremony and official dedication of the newly renovated fourth floor of the Life Sciences Building on Nov. 9, 2006. In attendance were faculty, staff and students from the Departments of Biological Sciences and Microbiology, Molecular Biology and Biochemistry, Facilities staff, University of Idaho administrators, and representatives from the architectural and engineering firms which executed the project.

Professor Larry Forney spoke during the gathering, briefly outlining the history of the renovation project. In 2002, the University of Idaho was notified that its infrastructure grant, submitted to the National Institutes of Health (NIH) for an upgrade of facilities in the Life Sciences Building, was funded at \$2 million with the stipulation that the university provide a dollar for dollar match. This amount was supplemented with bond funding to meet the total project cost of \$6.2 million. Construction began in February 2003.

The newly renovated space on the fourth floor includes three research laboratories, a library/conference room, a microscopy suite, new offices, a new herbarium and handicapped accessible restrooms. In addition to the work on the fourth floor of the Life Sciences Building, the project also included creation of laboratory space for a state-of-the-art DNA sequencing lab on the second floor, a facility for rearing zebrafish, a room to house two new

Conviron growth chambers, the creation of a new research lab on the second floor of Life Sciences South, and renovation of two laboratories in Gibb Hall, among other spaces. In total, 17,206 square feet of space was renovated. The renovated space will allow for growth and expansion of the department's research program, and provide new opportunities for students and faculty.

Forney expressed appreciation to Charles Hatch, emeritus vice president for Research, for his assistance in making this project move forward. He also thanked Rick Schumaker of the EPSCoR Office; Greg Bohach, former head of Microbiology, Molecular Biology and Biochemistry and current director of the Agricultural Experiment Station; and Brian Johnson, assistant vice president for Facilities. A very special thank you went to Norm Yandt, project manager, and Craig Eldredge, construction inspector, both of whom devoted countless hours to each phase of the design and construction process.

Gina Reid, management assistant for the Department of Biological Sciences, also was recognized for her contributions. She served as the liaison between the department, Facilities staff, the firms responsible for design

and construction, and the moving company.

Forney concluded by saying that he was struck by what it takes to renovate an 80-year-old building. Approximately, two-thirds of the money went into infrastructure – things that can't be seen – to bring the building up to modern standards.

Hatch was given the honor of cutting the ribbon, and tours of the new space followed.



Ribbon cutting ceremony



New Fourth Floor Lab



Fourth Floor Reading Room

THE RANDALL SEMINAR SERIES: WOMEN IN SCIENCE AT THE UNIVERSITY OF IDAHO, AN UPDATE.

by Professor Eva Top

IN 2004, THE DEPARTMENT OF BIOLOGICAL Sciences launched a seminar series, entitled “Randall Seminars: Women in Science at the University of Idaho.” This interdisciplinary project is sponsored by Professor Jan Randall, a behavioral ecologist at San Francisco State University and an alumna of the University of Idaho. Randall’s endowment of the seminar series grew out of her longtime desire to help promote women in scientific professions. We are grateful for her generosity.

Although the number of women who have leadership roles in the sciences has gradually increased over the years, the proportion of females among tenured faculty is still very small compared to the proportion of females in the student population at the undergraduate and graduate levels or even among postdoctoral fellows. By bringing to campus successful female scientists who may serve as role models, the Randall initiative contributes to building self-confidence among young women at the University and should, consequently, increase the likelihood that these students will pursue careers in science. Another benefit emerging from the seminar has been the discussion of changes needed in the culture of research institutions and academia if we are to increase the proportion of female scientists. First, we have to do a better job of attracting, hiring and retaining women with promising career potential, and second, we need to find ways to make successful academic careers compatible with fulfilling family lives for both men and women.

Since its inception, this program has featured two seminars per year by accomplished women in a variety of scientific fields. The seminars also include opportunities for undergraduate and graduate students and faculty to visit more informally with the speakers to talk about career and personal issues facing women in the sciences today. In 2004, Professor Randall gave the first lecture in the series. Her topic was “Drummers, Jumpers and Scent Markers: Sociality and Communication in Desert Rodents.” She was followed by forensic geneticist Professor Kim Nelson of Oregon State University who presented “Serial Killers of the Northwest: The Role of Mitochondrial DNA in Crime Scene Investigations.” In 2005, the speakers were Professor Marlene Zuk from the University of California,

Riverside, who presented “Sexual Selections: What We Can and Can’t Learn About Sex From Animals;” Mary Lake Polan, M.D., Ph.D., Stanford University School of Medicine, who spoke on “Evaluating Female Sexual Arousal: Defining a Protocol;” and Professor Eugenie C. Scott of the National Center for Science Education who discussed “Why Scientists Reject Intelligent Design.” Professor Scott spoke in the Administration Auditorium to a maximum capacity audience.

Professor Donna Holmes initially coordinated the seminar series with the help of Professor Holly Wichman. When Professor Holmes left the University in December 2005, Professor Deborah Stenkamp and I took over as co-coordinators. We were fortunate to be able to invite



Claire Fraser-Liggett President and Director of the Institute for Genomic Research

Professor Anne Yoder to campus in September 2006 with the help of Professors Jack Sullivan and Olle Pellmyr. Anne Yoder is the director of Duke University’s Lemur Center and professor of Biology and of Biological Anthropology and Anatomy. She attracted a large audience with her very interesting and entertaining presentation entitled “Historical Biogeography of Madagascar: Time is of the Essence.” On January 23, 2007, we had the pleasure of welcoming Professor Claire Fraser-Liggett, president and director of The Institute for Genomic Research (TIGR), whose topic was “The impact of microbial genomics on the definition of microbial species.”

During Fall 2006, Professor Celeste Brown joined me as one of the co-coordinators of the Randall series, and we are actively seeking suggestions of prominent women scientists to feature at future seminars. Please visit the Women in Science Web site at <http://www.webs.uidaho.edu/wisui/>.

HILLERY METZ, OUTSTANDING SENIOR

HILLERY METZ WAS SELECTED as the 2006 outstanding senior in the Department of Biological Sciences and, as such, also received the College of Science Dean's Award, consisting of a certificate and a monetary prize.

Hillery grew up in Moyie Springs, a small community near Bonners Ferry, and graduated from Bonners Ferry High School. She traces her interest in science back to her early childhood. She said, "I think I have been a scientist all my life. When I was a child, I was skeptical about Santa

Claus and the Easter bunny. [One Easter] I devised an experiment using loops of tape on the floor to get samples of hair when the Easter bunny came to fill our baskets. I was really investigative even at this age."

Before making a final choice as to what college she would attend, Hillery visited the University of Idaho and met with Professor Rolf Ingermann and Pat McCarroll. She found the campus atmosphere pleasant and the people very friendly. Since the University of Idaho was also close to her hometown, it was a good choice for her undergraduate education.

By her junior year at the University, Hillery had completed most of the requirements for the biology major. After some consideration, she decided to add a major in microbiology to her program. This worked well since the two degrees have similar basic courses and a good bit of overlap in upper division required and elective courses.

As an undergraduate, Hillery had a very eclectic research career and was involved in research in two laboratories at the University of Idaho and one at Washington State University. In summer 2004, she was a BRIN (Biomedical Research Infrastructure Network) Fellow working in Professor Kathy Magnusson's lab. Professor Magnusson's area of expertise is the aging of the brain and her research includes work with NMDA receptors. When activated, NMDA receptors in the brain open ion channels allowing the flow of sodium, potassium and calcium ions. This plays a role in synaptic plasticity,



Hillery Metz

a cellular mechanism for learning and memory. It is known that as the brain ages, the number of NMDA receptors in the brain region called the hippocampus decreases. This reduction correlates with spatial memory problems. Hillery participated in a study where the NMDA receptors in the dorsal and intermediate hippocampus in young mice were inhibited, and then the mice were tested for their ability to navigate using spatial memory. They found that while NMDA receptors in the dorsal portion are important for

spatial memory, the receptors in the intermediate portion are not.

Hillery said, "Research of this kind will help characterize the molecular basis of the problem so we can potentially prevent age-related deficits in spatial memory and other forms of memory." The results of this project were presented at the 2004 annual Idaho BRIN conference in Pocatello as well as at the 2004 University of Idaho McNair Symposium.

The following summer, Hillery received a Summer Undergraduate Research Fellowship (SURF) to work in Professor Raymond Quock's laboratory at Washington State University. She contributed to their effort to determine which specific brain regions are affected by chlordiazepoxide, an anti-anxiety drug. The Quock lab hopes to locate the active sites so that they can better study the signal transduction pathway that is activated by the drug. This study was presented at the WSU Presentation Day and at the April 2006 Experimental Biology Conference in San Francisco.

During her final year at Idaho, Hillery worked with a team of four students in Professor Greg Bohach's lab in the Department of Microbiology, Molecular Biology and Biochemistry on a project involving temperature regulation of genes in the bacterial pathogen, *Staphylococcus aureus*.

S. aureus is an opportunistic pathogen capable of causing human and animal disease. Previous work in the Bohach lab demonstrated that expres-

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sion of the lipase gene in *S. aureus* is temperature dependent. At low temperatures, the lipase gene is not expressed, but at the temperature of the human body, it is actively expressed. Lipase is an enzyme that breaks down lipids and probably plays a role in the infection of the host. Hillery's objective was to locate other genes which are involved in the temperature regulation process and in so doing, promote a better understanding of *S. aureus* pathogenicity and the development of more effective treatments of infections involving this organism.

In addition to undergraduate research, Hillery also took advantage of the opportunity to serve as a laboratory teaching assistant in the introductory biology course for non-majors and as a tutor with the Tutoring and Academic Assistance Program. Hillery found teaching the lab to be a bit stressful, but she became more relaxed in front of the class as the semester progressed. She said, "I found that even when I understand something myself, it is difficult to explain it to someone else."

When asked about courses that really stood out as excellent, she cited Animal Behavior taught by Professor John Byers. To Hillery, this course was especially interesting because it placed animal behavior and human psychology in the context of evolution, which truly changed her perspective on the world. Hillery also found Professor Rolf Ingermann's Comparative Vertebrate Physiology course to be outstanding. She said, "Dr. Ingermann is an excellent teacher, and it is very fascinating to study the intricate details of how the body works."

Hillery was the recipient of a number of scholarships during her time at Idaho, but the most significant award was the National Institutes of Health Undergraduate Scholarship. This award included a \$20,000 scholarship for her undergraduate education and a job for 15 months with NIH. She currently works with Dr. Susan Wray at the National Institute of Neurological Disorders and Stroke (NINDS) on a study of neuronal migration in development.

In describing her research at NINDS, Hillery said, "I am studying a small population of migrating neuroendocrine cells, the LHRH (luteinizing

In addition to undergraduate research, Hillery also took advantage of the opportunity to serve as a laboratory teaching assistant in the introductory biology course for non-majors and as a tutor with the Tutoring and Academic Assistance Program.

hormone releasing hormone) neurons, which are essential for reproductive function. LHRH neurons migrate from the nasal region into the brain along with the olfactory axons during development. If this migration event does not proceed properly, a genetic disease known as Kallman Syndrome occurs, with symptoms of delayed or absent puberty and an inability to smell."

One form of Kallman Syndrome is caused by defects in a gene that codes for a protein called anosmin. Hillery's work focuses on how the application of exogenous anosmin will affect the dynamics of LHRH migration.

While at NIH, Hillery will be applying to Ph.D. programs in biology. She hopes to pursue a career in academia because she loves the environment and the pursuit of knowledge.

In addition to her academic pursuits, Hillery, like many people from Idaho, loves outdoor activities such as camping, fishing, horseback riding and hiking. She also has taken flight lessons and hopes to get her license when she has the time and money to devote to this. She views relocation to the Washington, D.C., area as a wonderful opportunity to experience the eastern U.S., and she is taking advantage of all the cultural opportunities available in that area. In particular, she is delighted to be so close to the Smithsonian.

Rokyta Receives Honors as Top Graduate Student in the College of Science

DARIN ROKYTA, WHO COMPLETED HIS PH.D. in May 2006, is clearly one of the top graduate students ever to attend the University of Idaho. What follows are the reasons why this can be said with confidence.

Two articles published from his dissertation research in highly respected journals have garnered exceptional praise from reviewers. The *Journal of Bacteriology* featured one of his papers on their cover, and *Nature Genetics* highlighted the other in the News and Views section of the journal. In addition, a portion of Darin's research was the basis for a National Institutes of Health grant proposal submitted by Paul Joyce, professor of mathematics, and Darin's major professor, Holly Wichman. The proposal was funded at \$1.3 million over the next five years, and the work of this one graduate student will serve as the entire foundation for a new line of interdisciplinary research at the University of Idaho. And, if all this weren't enough, his academic performance was stellar.

Darin comes from Port Lavaca, Texas, located on the Gulf coast south of Houston. He completed a bachelor's degree in zoology at the University of Texas, Austin, and was an undergraduate researcher in the laboratory of Professor Jim Bull, one of Professor Wichman's collaborators. Darin became familiar with Wichman and her work through Professor Bull, and it was Wichman's research that attracted him to Idaho.

Darin works with a family of bacteriophages (viruses that infect bacteria) known as the Microviridae. The Microviridae include phiX174 which has been used extensively as a model system to study genetics, molecular biology, and viral assembly and replication.

"We study these bacteriophages because they grow quickly enough that evolution may be observed in real time," Darin said. "As an organism, their biology has been worked out in detail, but in terms of what is happening in nature, there was basically very little information about them. Part of my research program includes extensive examination of the natural diversity of the microvirid family."

For this portion of his research, Darin isolated and characterized 42 new, distinct bacteriophag-



Darin Rokyta

es, including full genome sequencing. Only a handful of other genomes from this family had been described since 1977. Besides being an impor-

tant analysis of the phylogenetic relationships among this family of bacteriophages, this work also expanded the collection of phages available for experimental work. Parts of the collection have already been shared with other institutions.

The main focus of Darin's research, however, is the interplay between theoretical models and empirical studies of adaptive molecular evolution. This has involved testing the predictions of a model for the genetics of adaptation known as the mutational landscape model. This model attempts to describe mechanisms involved in the evolution of populations of DNA sequences.

"By repeatedly observing the first step in adaptation for one of the newly isolated bacteriophages, we showed that the model provides reasonable predictions, provided it is slightly adjusted to reflect the biology of the system," explained Darin.

Rigorous mathematical modeling is essential to the understanding and analysis of data from evolutionary studies, and the experimental work is used to expand and refine the theoretical models relevant to the bacteriophage system. Darin said, "My goal is to develop a reciprocal relationship between theoretical efforts and experimental efforts, using each as a guide for the other."

The mathematical modeling work is relatively new and may, in the future, have applications in medicine to aid in drug development, either predicting or avoiding the evolution of resistance. This work, published in *Nature Genetics*, will form the basis for research at Idaho for many years to come.

To Darin, the work that he has done at University of Idaho, which spans both biology

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and mathematics, would not have been possible at most universities. He split his time between Professor Wichman's lab group and Professor Joyce's group in the Department of Mathematics and had unlimited access to the expertise in both departments. This gave him the opportunity to become both a biologist and a mathematician.

In recognition of his outstanding record as a graduate student, the College of Science honored Darin at the May 2006 commencement with the Diane Haynes Memorial Award, given each year to the most outstanding graduate student in the college. In 2005, he also received two major awards. The first was for the Best Poster at the Annual Gordon Conference. The second was the Idaho Alumni Award for Excellence. Professor Wichman

also was honored by the Alumni Association as his most influential professor.

During this academic year, Darin is finishing several projects that he is doing with other Idaho students, and he is applying for postdoctoral positions. He hopes to pursue a career in academia.

For further information on Darin Rokyta's research, refer to the following publications:

Rokyta, D.R., C.L. Burch, S.B. Caudle and H.A. Wichman. 2006. Horizontal gene transfer and the evolution of microvirid coliphage genomes. *Journal of Bacteriology* 188:1134-1142.

Rokyta, D.R., C.J. Beisel and P. Joyce. 2006. Properties of adaptive walks on uncorrelated landscapes under strong selection and weak mutation. *Journal of Theoretical Biology* 243:114-120.

Rokyta, D.R., P. Joyce, S.B. Caudle and H.A. Wichman. 2005. An empirical test of the mutational landscape model of adaptation using a single-stranded DNA virus. *Nature Genetics* 37: 441-444.

ALUMNI NEWS

1970s

R. Kent Schreiber (Ph.D., 1973) retired in January 2005 after 27 years with the U.S. Department of the Interior. His most recent position was assistant director for the Leetown Science Center in West Virginia. Schreiber also served as a research scientist for five years at the Oak Ridge National Laboratory in Tennessee.

1990s

Todd D. Ray (B.S., 1998) completed a bachelor of science in nursing at Lewis-Clark State College, Lewiston, in 2000. He currently is living in Issaquah, Wash., and is employed by Harborview Medical Center as an assistant nurse manager of the Coronary Intensive Care Unit. Previously, he lived in Salt Lake City, Utah, and worked for the University of Utah in the Medical Intensive Care Unit. While in Utah, he taught classes for new graduate nurses entering critical care and coordinated the Critical Care Nurse Internship. Mr. Ray is now pursuing a master's in nursing at the University of Washington. He also works with the Brian Ellis Memorial Foundation, raising money for Idaho students and cystic fibrosis research. He is the proud father of a beautiful five-year-old daughter, Kaitlin Ray.

Lt. Col. **Donald E. Trummel**, M.D. (Ph.D., 1992) became the medical director of the Department of Pathology and Laboratory Services at the 3rd Medical Group Federal Hospital on March 29, 2006. The facility is located at Elmendorf Air Force Base, Anchorage, Alaska. Dr. Trummel is a pathologist, board certified in anatomic and clinical pathology. He also was recently appointed as an associate medical examiner for the Office of the Armed Forces Medical Examiner, Washington, D.C. In this capacity, he serves as the lead agent for the investigation of active duty forensic deaths in the Alaska region.

2000s

Jennifer Ann Feldman Brunworth, M.D. (2000) completed her medical education at Saint Louis University School of Medicine, St. Louis, Mo., in 2004. Dr. Brunworth is now an anesthesiologist at the University of Colorado Hospital in Denver.



NEWS BRIEFS

ON SEPTEMBER 27, AT THE PLASMID BIOLOGY 2006 conference, **Masahiro Sota**, postdoctoral scientist working with Professor Eva Top in the Department of Biological Sciences, won the Brian Wilkins Memorial Fund Prize. This is the major prize offered by the International Society for Plasmid Biology, honoring the late plasmid biologist Brian Wilkins. First awarded in 2004, its goal is to encourage outstanding scientists at the start of their careers who already are demonstrating, like Brian, an enthusiasm and commitment to the study of plasmids and other mobile genetics elements. The prize consists of \$1,000 in support of the winner's scientific career.

Victor Eroschenko, professor emeritus of zoology and professor of anatomy in the first-year Medical Education program, was the recipient of the 2006 WWAMI Distinguished Teacher Award. He received the award in June at the University of Washington. Recipients are nominated by WWAMI students and selection is based on the students' written assessments of teaching. Eroschenko has been teaching in the WWAMI program for more than 30 years.

Steven J. Brunfeld, professor of forest resources, passed away on October 6, 2006, following an 11 year battle with cancer. Brunfeld's research focused on molecular systematics of woody plants, conservation biology, phylogenetics and vegetation ecology. A memorial service and celebration of his life was held in the Administration Auditorium on October 14. Brunfeld is survived by his wife, Pam, who is the director of the Stillinger Herbarium, his daughter, Courtney, of St. Louis, Mo., and his sons, John and Nicholas of Moscow.

Dorothy Schell, wife of Stewart Schell, professor emeritus of zoology, passed away on March 19 in Spokane. Mrs. Schell graduated from the University of Kansas in Lawrence, Kan., with bachelor's and master's degrees in entomology. She worked as a research assistant in the University's Department of Bacteriology and was a longtime supporter of the Northwest Children's Home in Lewiston. She is survived by her husband and their daughters, grandchildren and great-grandchildren.

In April 2006, President Tim White announced that the University of Idaho is now operating on a high-speed, fiber-optic 2.5 gigabit-per-second network connection. White applauded the efforts of Professor **Michael Laskowski**, director of the NIH Idaho INBRE program, and Harvey Hughett, director of information technology and his staff for making this resource a reality. The new bandwidth and network connection is provided by the Pacific Northwest Gigapop and was made possible through a five-year, \$10 million grant from the National Center for Research Resources awarded to Professor Gwen Jacobs of Montana State University and Professor Ron Johnson of the University of Washington. The grant supports network access for biomedical researchers in the western U.S. The network connections in aggregate are known as the Lariat Network. Access to the Lariat Network will allow faculty at Idaho to collaborate with colleagues around the world, sharing their research instantly. The WWAMI Medical Education Program will be able to use the network to work with instructors and researchers worldwide and to watch medical procedures in real time with high definition clarity. The University of Idaho's Information Technology Services provided \$700,000 to make improvements to its Internet infrastructure to support the new bandwidth.

Dr. Todd Kuiken, Idaho alumnus and director of the Neural Engineering Center for Artificial Limbs and the Center for Bionic Medicine at the Rehabilitation Institute of Chicago, has pioneered the development of a computerized prosthesis being referred to as a bionic arm. In amputees, the four main nerves that normally connect the brain to the missing arm are rerouted from the stump to muscles in the chest. Even after the loss of the limb, these nerves continue to carry the electrical signals from the brain that would normally control the arm. By placing sensors over the nerves, these nerves can be used to operate the patient's prosthesis. Following this procedure, patients have an amazing amount of control over the artificial limb

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and can accomplish tasks that were previously not possible with artificial arms. The bionic arm was developed primarily with funding from the National Institutes of Health. Research in this area is moving into a new phase as the Defense Advance Research Projects Agency works to revolutionize prosthetic devices for amputee soldiers.

NEW GRANTS IN 2006

National Institutes of Health; \$130,208; Feb. 1, 2006 – Jan. 31, 2007; Professor Holly Wichman

National Park Service; \$7,050; Feb. 13, 2006 – Mar. 15, 2008; Professor Olle Pellmyr

Indiana University Research Agreement; \$28,000; Apr. 1, 2006 – Mar. 31, 2007; Professor Barrie Robison

National Science Foundation; \$133,241; May 15, 2006 – May 31, 2007; Professor Scott Nuismer

Procter & Gamble; \$33,618; May 24, 2006 – May 24, 2007; Professor Larry Forney

Procter & Gamble; \$48,288; May 31, 2006 – May 31, 2007; Professor Larry Forney

Procter & Gamble; \$51,605; May 31, 2006 – May 31, 2007; Professor Larry Forney

Procter & Gamble; \$17,549; Oct. 15, 2006 – Oct. 15, 2007; Professor Larry Forney

Oregon State University; \$97,130; June 21, 2006 – Aug. 20, 2007; Professor James Nagler

National Oceanic and Atmospheric Administration; \$60,156; Jul. 11, 2006 – July 30, 2008; Professor Joseph Cloud

Washington State University; \$35,000; Sept. 14, 2006 – Sept. 14, 2008; Professor James Nagler

National Science Foundation; \$360,000; Nov. 1, 2006 – Oct. 31, 2008; Professor Eva Top

The Glaucoma Foundation; \$50,000; Jan. 1, 2006 – Dec. 31, 2007; Professor Deborah Stenkamp

VISITING SCHOLAR PROFESSOR BENTLEY FANE

DURING FALL SEMESTER 2006, PROFESSOR Holly Wichman's lab and the Department of Biological Sciences had the pleasure of hosting visiting scholar, Professor Bentley Fane. Fane is on the faculty of the Department of Veterinary Science and Microbiology at the University of Arizona and is one of Wichman's collaborators.

Professors Fane and Wichman became acquainted through their mutual interest in the bacteriophage, phiX174. Wichman and her lab are using phiX to decipher the laws that govern evolution. Fane and his lab are interested in the molecular mechanisms by which the virus is assembled within the host. Although it may not seem so at first, these areas of research overlap considerably.

"We start with this virus to answer different questions, but so often in research when you are addressing one question, you have to open your eyes a little bit and realize that you are addressing some other questions as well," said Fane.

When the Wichman lab evolves a virus under certain conditions, they examine how the virus changes. Fane can look at those changes and relate them to a particular stage in the assembly of the virus. From this they may be able to determine that a certain stage in assembly may have been a bit of an Achilles heel and this, perhaps, is the reason why the ancestor with which the Wichman lab started was less fit.

In many viral systems the assembly of the virus is dependent upon a group of proteins referred to as scaffolding proteins. "It is very analogous to scaffolding used in building construction. If you are going to build a skyscraper in the middle of New York, you put up a scaffolding first, you build the building, and then you take the scaffolding down," said Fane.

Most viruses only have one scaffolding protein, but the microviruses, which include phiX174, are very unusual in that they have two – an internal and an external scaffolding protein. One reason that Fane came to Idaho to work with the Wichman lab was to develop some approaches to help answer the question, "Why two scaffolding proteins?"

Fane's lab has already started to make some inroads into this question. Over approximately a

five year period, they evolved a virus to lose one of the scaffolding proteins. As they evolved the virus, they had two major goals. They were attempting to discover the function of the protein that was being lost, and they were observing the way in which the virus compensated for less and less scaffolding protein function.

From this work, they learned that the external scaffolding protein, which they maintained, was the more important and probably the newer one. When changes were made to the external scaffolding protein, most were very detrimental to the virus. But, the internal scaffolding protein was quite tolerant of change. Up to 70 percent of its amino acid sequence could be altered without loss of function. In fact, they could even get scaffolding protein from another virus to do the job of the internal scaffolding protein.

One interesting observation that the Fane lab made when they slowly took away the internal scaffolding protein was that the virus could survive, but it had to make considerably more external scaffolding protein. When the internal scaffolding protein is present, the external scaffolding protein and the virus coat protein have a greater affinity for each other, and the chemical reaction that builds the virus coat occurs more readily. Without the internal scaffolding protein, the coat protein has a little different shape and does not readily “stick” to the external scaffolding protein. To make it more likely that the external scaffolding protein and the coat protein will meet and bond in the absence of the internal scaffolding protein, the virus crowds the cell with external scaffolding protein. The researchers now know that the internal scaffolding protein assists in various steps of the virus assembly pathway but is not absolutely essential to this process.

Fane’s enthusiasm for his work is apparent from the minute he begins to describe his research,

and he truly enjoyed his time in Moscow. What has made his work with Professor Wichman’s lab so much fun is the interaction with the people and the opportunity to learn new methodologies.

“Being on sabbatical is great because, it is the first time I’ve been able to spend every day in the lab in a long, long time. You forget how much you enjoy actually doing the experiments,” said Fane. “As you get older and more senior, you spend more and more time in your office writing grants and papers. It’s great when your students come

in with data, and you are always really excited. But, there is something special about generating the data yourself.”

Moscow is not the only stop for Fane during his sabbatical. Following his time at Idaho, he will travel to the United Kingdom to work with another of his collaborators, Professor Ian Clarke, at the University of Southampton School of Medicine. Fane is involved in a project with the Clarke group in which they are attempting to genetically engineer a virus related to phiX174 to serve as a genetic transfer system in Chlamydia. After visiting the Clarke lab, Fane will return to the University of Arizona.

In addition to research, Fane teaches a variety of courses for his department. Over the years, these have included a general microbiology course for majors, microbial physiology, virology and biochemistry. He often includes bits and pieces of his research in the teaching labs. He feels that it is beneficial to give students something other than canned lab work. He prefers to challenge them with problems and questions for which no one yet knows the answer. It is probably safe to assume that his infectious enthusiasm for biochemistry makes these courses very enjoyable and may inspire some portion of his students to consider research careers.



Professor Bentley Fane



FACULTY PROFILES

PROFESSOR CELESTE BROWN has two research areas, how gene regulation changes in response to selection, and the evolution of disordered proteins. The link between these two disparate areas is that proteins involved in gene regulation often are disordered. The gene regulation studies involve laboratory-based research and the disordered protein studies involve bioinformatics approaches.

One question under consideration in the lab is how gene regulation of bacteriophage ΦX changes in response to selection. Studies of adaptive evolution of the bacteriophage ΦX_{174} consistently show changes in the phage's genome that do not affect its protein sequences. The research in Brown's lab centers on discovering whether these adaptive changes are affecting the rate of gene transcription, with the eventual goal of also studying mRNA stability and the rate of translation. This research is funded by research start-up support from the University of Idaho.

A second question being studied is whether or not disordered proteins evolve differently than ordered proteins. Disordered proteins are proteins or parts of proteins that do not fold into fixed 3-dimensional structures the way ordered proteins do. Recent interest in disordered protein has led to overwhelming evidence of its functional importance in many biological systems. Previous research by Brown and co-workers at Washington State University showed that there are important differences between ordered and disordered protein in the rate at which they evolve and in the way that they evolve. She is continuing this research by defining the evolutionary forces that lead to these differences. She has a graduate student majoring in Bioinformatics and Computational Biology who is working on this program. Continuing collaborations with colleagues studying disordered protein led to recent publications in Biochemistry, Protein Science, and Bioinformatics.

Brown also is the Bioinformatics coordinator at the University of Idaho. She facilitates the use of the bioinformatics tools, both software and hardware, within the University and across the state of Idaho. This position is funded by COBRE and INBRE grants from the National Institutes of Health. Her work in this area led to recent publications in the Journal of Medical Microbiology, and Applied and Environmental Microbiology.

PROFESSOR JOHN BYERS continues his 26 year study of pronghorn at the National Bison Range in

northwestern Montana. The current focus of his work is on behavioral and genetic responses to a recent dramatic reduction in the size of this population. In particular, Byers and his graduate students will use genetic information on paternity amassed over the past five years to assemble a complete pedigree of the population. They then will investigate whether female pronghorn are able to avoid mating with close relatives, and whether degree of inbreeding is associated with offspring performance. The pedigree also will be used to show how well genetically based indices of relatedness predict actual relatedness.

Byers also continues his study of population and behavioral interactions among wolves, coyotes and pronghorn in Yellowstone National Park, funded by the Rocky Mountain Cooperative Ecosystem Studies Unit and by the National Geographic Society. Byers is initiating another large research project related to his longstanding interest in play behavior. A team of anthropologists with established study sites in Africa, Asia, South America and Australia will observe children who are not influenced by societal institutions such as school, to assemble the world's first natural age-rate curve for human locomotor play.

Byers gave an invited talk at the National Science Foundation and was a lecturer in the Keck Distinguished Lecturer Series at North Carolina State University. He presented a paper at the biennial pronghorn workshop in Idaho Falls. He served on the editorial board of the journal *Animal Behaviour*. He published an invited book chapter on pronghorn in "Wild Mammals of North America," a paper in the proceedings of the pronghorn antelope workshop, and published a highly acclaimed paper in *The Proceedings of the National Academy of Science*. During the 2006-2007 academic year, Byers has been on leave to serve as the Program Director for Animal Behavior at the National Science Foundation. (<http://www.sci.uidaho.edu/biosci/faculty/byers.html>; jbyers@uidaho.edu)

PROFESSOR MICHAEL CANTRELL studies mammalian retrotransposons, or retroelements. They can be viewed as the smallest mammalian parasites, yet at the same time constitute the most abundant type of DNA sequences in mammals. There is wide agreement that these retrotransposons, or DNA sequence elements, affect gene expression and the evolution of all mammalian genomes in major ways, but widespread disagreement on where they lie in

the spectrum from genomic parasites to mutualists providing essential functions for their hosts. Cantrell is collaborating with Professor Holly Wichman to increase our understanding of how these self-replicating elements evolve within their hosts, and how they affect the genomes of those hosts.

LINE-1 elements are the most common type of retroelements. Their widespread activity has made it difficult to test some of the alternate views on their place in mammalian genomes, but the lab had previously identified a group of South American rodents in which LINE-1 activity has ceased, giving rise to an important model system for asking questions about the effects of these elements on genomes. The group identified a new type of endogenous retroviruses that they call mysTR elements, which they showed to be present at unprecedented copy numbers in the South American rodents lacking LINE-1 activity. This past year, Issac Erickson, a graduate student in the lab, has studied the copy numbers and phylogenetic relationships of these elements in a larger number of rodent species related to the South American group. He has found extremely high copy numbers of recently deposited mysTR elements throughout these species irrespective of their LINE-1 activity.

Although the South American rodents lacking LINE-1 activity continue to be an important model system for asking questions about the effects of these elements, from a larger perspective they represent only one of nature's experiments on the evolutionary consequences of life without LINE-1 activity in mammals. The lab also has identified a second extinction of LINE-1 activity in the megabats and now has found that this extinction event covers all of the present day megabats, having occurred in a common ancestor of the entire group more than 24 million years ago. In this study, which includes work by technicians LuAnn Scott and Armando Martinez, the group has found that two independent LINE-1 lineages simultaneously lost activity and that this change in control of the retroelements was probably caused by mutation in the host control machinery. The group is eager to find out how loss of LINE-1 activity has affected the evolution of megabat mammalian genomes. (See Professor Wichman's profile for more details on these projects and other related projects.)

The lab recently has published articles in *Cytogenetic and Genome Research* and the *Journal of Virology*. Presentations on different aspects of the work were given at the Evolution Meetings this past year in Stony Brook, New York. The group obtained renewed funding this past year from the National Institutes of Health. Cantrell will retire this coming year but plans to continue his close collaboration with the Wichman lab to give input on continuing projects.

Professor Joseph Cloud's laboratory continues to focus on the reproductive biology of fishes, with an emphasis on gonadal development and the physiology of the resultant gametes. Present research projects include in vitro culture of gonads, cryopreservation and surgical transplantation of sexually immature gonads, and the development of histocompatible recipients for organ transplantation. Continued funding for these projects comes primarily through grants from the USDA and the National Institute of Environmental Health Sciences. A new grant from NOAA entitled "Preservation of Female Germplasm from Redfish Lake Sockeye Salmon" recently was awarded to the laboratory; this new project is a collaboration with Penny Swanson at the Northwest Fisheries Center in Seattle and Goro Yoshizaki at the Tokyo University of Marine Science and Technology with the objective of improving the genetic conservation of this population. Additionally, the lab has cooperative projects with both the Nez Perce Tribe and the Kootenai Tribe of Idaho to develop and maintain germplasm repositories for local populations of steelhead, chinook salmon and white sturgeon that are native to our state.

Results of some of the lab's activities were presented at the annual meeting of the Society for the Study of Reproduction this past summer in Omaha, Neb. One paper entitled "Production of Histocompatible Recipients for Gonadal Transplantation" was presented by Joe Cloud and a second paper entitled "Effects of a Xenoestrogen, Ethynylestradiol, on Male Rainbow Trout Reproductive Success" was presented by Kim Brown, a postdoctoral fellow who has a joint appointment between the Cloud and Nagler labs. (<http://www.sci.uidaho.edu/biosci/faculty/cloud.html>; jcloud@uidaho.edu)

PROFESSOR MARK DESANTIS' research interests are in the fields of human anatomy, medical/graduate education and neuroscience. Current projects being done with others include studies of human adult auditory ossicles (middle ear bones) and development of sensory receptors in extraocular muscles. He is co-author of recent publications in the following journals: *Psychology*, *Advances in Physiological Education*, *New England Journal of Medicine (Letter)*, and *Psychological Reports*. DeSantis co-teaches Anatomy and Embryology, and Nervous System for first year medical students in the WWAMI Program. He also participates in graduate courses associated with the Neuroscience Program. DeSantis is the faculty adviser for the local chapter of Phi Sigma Society and a member of the on-campus review committee for student Fulbright fellowships. ([---

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uidaho.edu/biosci/faculty/desantis.html; starfish@uidaho.edu)

PROFESSOR LARRY FORNEY'S laboratory centers its research efforts on the diversity and distribution of prokaryotes. Both field and laboratory studies are done to explore the temporal and spatial patterns of community diversity, as well as factors that influence the dynamics of inter- and intra-species competition and how environmental conditions might influence the tempo of adaptive evolution. Most of these studies are highly interdisciplinary in nature, and done in collaboration with mathematicians, statisticians, computer scientists, geologists, environmental engineers, physicians and clinical scientists. He receives funding from the National Institutes of Health and the Procter & Gamble Co., and during the past year has published in a number of different peer-reviewed journals.

His studies of microbial community ecology heavily rely on the use of cultivation-independent methods based on the analysis of terminal restriction fragment length polymorphisms of 16S rRNA genes, as well as phylogenetic analyses of 16S rRNA gene sequences. These methods are used to explore the diversity and ecology of microorganisms in a wide variety of habitats. For example, studies are done on the ecology of bacterial communities of the human vagina to address several important questions, including whether there are fundamentally important differences between women in different racial groups, whether differences in community composition account for differences in the likelihood of acquiring yeast infections, HIV and other sexually transmitted diseases, and to understand the changes in community composition and function that accompany menarche. Other research done in the lab aims to characterize spatial and temporal patterns of bacterial diversity along a chronosequence in a glacial foreland of the high Arctic in Spitsbergen. These glacial forelands offer an opportunity to study early colonization events in soils, because vegetation cover is sparse and chemical weathering has not occurred to a significant extent. Moreover, very little is known about soil ecosystems in the high Arctic.

The spatial heterogeneity of environments is important to the development and maintenance of biological diversity. Several projects in the laboratory use microbial systems as models to explore this phenomenon. One study is designed to explore how spatial differences due to physical heterogeneity can lead to the apparent co-existence of distinct genotypes of the same species, while other studies explore the adaptive evolution of bacterial populations in microbial biofilms where environmental gradients are

pervasive and complex. The latter study has shown that genetic differentiation occurs rapidly and is quite extensive, resulting in the existence and persistence of variants that are markedly different in terms of their phenotypic characteristics. As part of these investigations, researchers determine the frequency of mutations, and the fitness of mutants under defined growth conditions. The information from these studies will help explain how competitive exclusion is avoided, and provide an understanding of factors that allow high levels of prokaryotic species diversity to persist in various environments.

(<http://www.sci.uidaho.edu/biosci/faculty/forney.html>; lforney@uidaho.edu)

PROFESSOR JAMES FOSTER joined the Biological Sciences department in 2005, after 15 years in the Computer Sciences Department. He is a professor of Bioinformatics and Computational Biology (BCB), and directed the BCB program until January 2006. Foster is an adjunct professor of both Philosophy and Computer Science at Idaho, and of Medical Informatics at the University of Washington School of Medicine. He also is a member of the University's Initiative for Bioinformatics and Evolutionary Studies (IBEST), which is a grass-roots initiative of faculty and students to research how evolution works and how we can analyze the products of evolution (living things). He directs the IBEST Bioinformatics Core facility, which provides state-of-the-art computational support for analyzing biological data.

Foster's research areas include evolutionary computation, development of algorithms for analyzing genetic data and microbial diversity. He is a leader in the field of evolutionary computation, which uses evolutionary simulations to design algorithms, hardware and other complicated artifacts, or to solve difficult optimization problems. He has been funded by the National Institutes of Health (NIH), the National Science Foundation (NSF), Procter & Gamble, the National Security Agency and the Ballistic Missile Defense Office. He has been program chair of both the Genetic and Evolutionary Computing Conference (GECCO), and the European Conference on Genetic Programming (EuroGP), the primary U.S. and European conferences in this field. Together with Wolfgang Banzhaf, he began the GECCO workshop on Biological Applications of Evolutionary Computation (BioGEC), now in its fourth year.

Foster is a member of the Biomedical Data Analysis (BMDA) study section at NIH and has served on several NSF panels. He is an associate editor for every major journal in evolutionary computation: IEEE Transactions on Evolutionary Computation, Genetic Programming and Evolvable Machines, and

the Journal of Evolutionary Computation. (<http://www.ibest.uidaho.edu/~foster/index.htm>; _foster@uidaho.edu)

PROFESSOR ROLF INGERMANN is investigating the reproductive physiology of lower vertebrates at the cellular and organismic levels. Current research activities focus on various physiological aspects of the gametes of fishes, including those of threatened or endangered salmonids, sturgeon and burbot. Experiments also have begun with the zebrafish, a convenient and manipulable fish model system. The lab seeks to elucidate the biochemical events associated with the onset of sperm motility, and the extent to which factors such as pH, carbon dioxide, metals and nitric oxide interfere with or enhance this motility *in vitro*. Further, the influences of carbon dioxide, anesthesia and exercise on motility of salmonid sperm are being examined *in vivo*. Since sperm motility is directly correlated with fertility, these efforts seek to clarify and elucidate the role(s) of potential stressors and perturbations on gamete quality and reproductive success. In conjunction with the Columbia River Inter-Tribal Fish Commission, the quality of eggs from reconditioned, spawned steelhead trout versus virgin spawners is being examined. The larger question being pursued is whether artificial reconditioning of spawned females can increase the reproductive output of endangered steelhead trout without compromising egg quality.

Recent work also has examined the impact of stress on the composition of the peritoneal fluid of Chinook salmon and white sturgeon. These studies are part of a larger project to use implanted monitors within the peritoneal cavity to non-invasively assess fish stress. Current research is being supported by the U.S. Department of Agriculture and the Columbia River Inter-Tribal Fish Commission. Ingermann's most recent publications have appeared in *Theriogenology*, *Journal of Fish Biology*, *Comparative Biochemistry & Physiology*, *Fish Physiology & Biochemistry* and *Aquaculture Research*.

Professor Ingermann is chairman of the Allied Health Studies Committee and is the pre-medical/pre-dental/pre-physical therapy adviser for the University of Idaho. (<http://www.sci.uidaho.edu/biosci/faculty/ingermann.html>; rolfi@uidaho.edu)

PROFESSOR KEVIN KELLIHER joined the Biological Sciences department in July 2006. His research program is focused on understanding the neural mechanisms of social behavior. In this regard, he uses olfaction as a tool for understanding these mechanisms. The olfactory system, more so than any other system, has anatomical and functional connections

to subcortical processes that mediate social behaviors and emotional displays. Research projects in the lab utilize behavioral, anatomical, immunohistochemical and electrophysiological techniques to elucidate how the brain controls chemosensory mediated behaviors. Studies include the use of transgenic mice with targeted deletions of genes critical for signal transduction in different chemosensory neurons. For example, mice with a deletion of the transient receptor potential channel subunit 2 (TRP2) have strongly impaired pheromone responses in the vomeronasal organ, while mice with a targeted deletion of the cyclic nucleotide gated channel subunit 2 (CNGA2) exhibit no odor responses in olfactory receptor neurons. Specific lines of research getting underway include: studies of social dominance and neonatal behaviors in chemosensory impaired transgenic mice, neuronal activation in central nuclei of the chemosensory pathway in chemosensory impaired mice, influences of the neuropeptide vasopressin on chemosensory responses and social behavior, and a study of Major-Histocompatibility (MHC) related odors and the conveyance of genetic individuality through chemosignals present in body fluids.

Kelliher recently has published articles in *Hormones and Behavior*, *Journal of Neuroscience* and *European Journal of Neuroscience*. He was the 2006 recipient of the Frank A. Beach Award in Behavioral Neuroendocrinology. This award is given by the Society for Behavioral Neuroendocrinology to an outstanding young assistant professor working in the area of behavioral neuroendocrinology. (<http://www.sci.uidaho.edu/biosci/faculty/kelliher.html>; kelliher@uidaho.edu)

PROFESSOR MICHAEL LASKOWSKI studies the development of the nervous system, specifically attempting to understand cues used by developing and regenerating neurons in selecting their appropriate targets. Techniques used include tissue culture, electrophysiology, confocal microscopy and molecular biology. Laskowski recently has published articles on his current work in the *Journal of Neurobiology*, *Journal of Neuroscience*, *Neuron*, *Developmental Biology*, and *Experimental Neurology*. (<http://www.sci.uidaho.edu/biosci/faculty/laskowski.html>; mlaskow@uidaho.edu)

PROFESSOR JAMES NAGLER studies the reproductive biology of fishes. The major foci are studies to understand the endocrine events that coordinate fish gonadal development and how environmental contaminants affect fish reproduction. Several diverse research projects are underway. A major ongoing study, funded by the National Institutes of Health, is

looking at low-level transgenerational effects of ethynylestradiol in the male rainbow trout. A significant environmental contaminant, ethynylestradiol derives from human birth control pharmaceuticals and has been shown to affect fish at low concentrations. Kim Brown, a postdoctoral fellow in Nagler's lab group, is coordinating these studies with collaborators at Washington State University and Battelle's Marine Sciences Laboratory. Another area of research that has been pursued for several years is variable reproductive performance of female rainbow trout in aquaculture. Some females produce egg batches that are sub-fertile, but an understanding of why this happens is not known. Research on this topic is being pursued by graduate student Heidi Hugunin, funded by USDA's University of Idaho/WSU Aquaculture Initiative, in collaboration with Troutlodge, Inc., of Sumner, Wash.

Idaho INBRE Program funding has permitted a collaborative venture with Professor Goro Yoshizaki from Tokyo's University of Marine Science and Technology to produce a custom microarray to investigate genes involved in sex determination in the rainbow trout. Nagler is part of the Biological Applications for Nanotechnology (BANTech) program, an institutional initiative that received \$1.66 million over five years to support the development of bionanoscience on the Idaho campus.

Finally, the newest study is funded by the National Science Foundation, along with scientists from Ohio State University, University of Wisconsin, and the Battelle Marine Sciences Laboratory, to model the genes involved in the brain-pituitary-gonad axis regulating reproduction in the female rainbow trout.

Professor Nagler's most recent research findings have been published in *Aquaculture*, *Biology of Reproduction*, *Environmental Toxicology and Chemistry*, and *Journal of Fish Biology*. He teaches the upper division biology elective, Ichthyology, and graduate level courses such as *Reproductive Biology of Fishes* and *Seminar on Reproductive Biology*. (<http://www.sci.uidaho.edu/biosci/faculty/nagler.html>; jamesn@uidaho.edu)

PROFESSOR SCOTT NUISMER studies the ecology and evolution of species interactions using a combination of mathematical modeling and field experimentation. Theoretical work currently is focused on how the genetic architecture of host-parasite interactions shapes patterns of local adaptation and the likelihood of host shifts. Specifically, genetic models are being used to investigate the impacts of epistasis, dominance and ploidy level. This theoretical work dovetails with experimental and field studies of plant-insect interactions along the Salmon River.

These studies take advantage of naturally occurring polyploid populations of the plant *Heuchera grossulariifolia* to study the role genome duplication plays in the diversification of plant-insect interactions. Future work will continue to meld these theoretical and empirical approaches.

This research is supported by two grants from the National Science Foundation and has led to recent publications in the journals *Science*, *PNAS*, *PLOS Biology*, and *Evolution*. (<http://www.sci.uidaho.edu/biosci/faculty/nuismer.html>; snuismer@uidaho.edu)

PROFESSOR OLLE PELLMYR'S research interests are in the evolutionary ecology of species interactions and co-evolution, with foci primarily on pollination biology and herbivory. His most current work deals with the evolution and maintenance of mutually beneficial interactions, and for the last several years he has used one of the classical cases of co-evolution — yucca and yucca moths — as a model system for this purpose. His lab is divided in two work spheres to integrate fieldwork and lab-based analyses. Most projects combine ecological, behavioral, phylogeographic and phylogenetic tools that together can test hypotheses about micro- and macro-evolutionary aspects of plant-animal interactions. He has done fieldwork on most continents, with most active work going on in the North American deserts.

Yucca moths serve as the exclusive pollinators of yuccas. The moths actively pollinate the yucca flowers, and their larvae, in turn, require some of the developing seeds as the only acceptable food source. There are only a handful of known pollination systems with similar biology - trading "seeds for seeds" - and their specificity makes them very useful for addressing a range of general questions about the evolution and ecology of species interactions in general, and mutualism in particular. In currently funded work, lab members are experimentally testing the role of pre-adaptations versus emergence of novel traits in the evolution of interactions, and measuring the component of co-evolution in diversification between yuccas and yucca moths.

New funding from the National Science Foundation and from the National Park Service will focus on long-term consequences of climate change and range breakup in the charismatic Joshua Tree of the Mojave desert. This project aims at fundamental questions in evolutionary ecology, and providing immediate information for conservation biology.

The lab also is developing collaborative projects to explore how sensory cues, such as olfactory and visual stimuli, interact in mediating plant-pollinator interactions. In a longer perspective, Pellmyr hopes

to catalyze the formation of an informal consortium of laboratories that use complementary models to explore the ecological and evolutionary foundations of organismal diversification on different time scales.

The Pellmyr lab enjoys continued funding from the National Science Foundation in the form of two multi-year grants. In addition, the Consortium for Ecosystems Studies Units, an entity coordinating research on federal lands, will fund the lab for ecological work in Joshua Tree National Park over the next two years. In the last year, the lab has published papers in *Proceedings of the Royal Society of London B*, *Ecology*, *Evolution*, *American Journal of Botany*, *Systematic Entomology*, *Systematic Biology*, *Molecular Phylogenetics and Evolution*, and others. (<http://www.sci.uidaho.edu/biosci/faculty/pellmyr.html>; pellmyr@uidaho.edu)

PROFESSOR BARRIE ROBISON'S general research interests include animal behavior, quantitative genetics, genomics and conservation genetics. Specific areas of research emphasis in the Robison lab include examination of the genetic changes underlying domestication in fish, the evolutionary genetics of locally adapted phenotypes, and the genetic architecture of quantitative trait variation. Two model systems, the zebrafish and the rainbow trout, are used to investigate these issues.

One of the main projects in the lab is an examination of the genetic changes underlying the domestication process in the zebrafish. Zebrafish long have been a mainstay of developmental genetics, and conventional wisdom has held that although they are an excellent experimental system, there is little interesting variation at the organismal level. Recent work published in the *Canadian Journal of Fisheries and Aquatic Sciences* has shown that zebrafish collected in their natural habitat in India vary in behavioral, morphological and physiological traits when compared to their laboratory adapted counterparts. Another paper in review for *Behavioral Ecology* shows variation among zebrafish strains in several other behaviors, including boldness and aggression.

Research into the genetics of domestication in the zebrafish has substantial implications in the area of salmonid conservation genetics, which is another area of research focus in the Robison lab. Many of the conservation efforts for Pacific salmon have in the past involved some degree of hatchery propagation. This practice has become controversial, because the hatchery environment imposes an entirely different set of selection pressures from those present in the salmon's natural habitat. This new selection regime has, over multiple generations, resulted in the evolution of a domesticated phenotype in many hatchery

strains. This phenotype is often characterized by changes in behavior, such as an increase in surface orientation, decreased predator avoidance, and increased aggression. Current work in the Robison lab is aimed at using the zebrafish system to identify candidate genes that may play a role in the domestication process, and to test whether variation at these loci also underlies domestication in salmonids.

An equally important aspect to Robison's research is the identification of candidate genes mediating anxiety and aggression in the zebrafish. Robison's lab has identified a number of genes that are differentially expressed among behaviorally distinct zebrafish strains. These include genes involved in the production of the neurotransmitter GABA, as well as cell signaling and selenium metabolism. The zebrafish is an important biomedical research model, and identification of the genetic mediators of aggression and anxiety in this animal serves as an important complement to biomedical research using other vertebrate models, such as the mouse.

Robison's lab is funded through the NSF-EPS-CoR program as part of a collaborative effort to use zebrafish as a model organism for studying teleost behavior, metabolism and physiology. This project currently focuses on the changes in gene expression that are induced by changes in environment (diet, population density, etc). These changes in gene expression are monitored using DNA microarrays, and then correlated to resulting phenotypes, such as behavior and growth.

Professor Robison has recently published articles in *Canadian Journal of Fisheries and Aquatic Sciences*, *Transactions of the American Fisheries Society*, *Genetical Research*, *Methods in Cell Biology*, *Physiological Genomics*, and *Environmental Biology of Fishes*. (<http://www.sci.uidaho.edu/biosci/faculty/robison.html>, brobison@uidaho.edu)

PROFESSOR DEBORAH STENKAMP'S laboratory is interested in the cellular and molecular mechanisms of vertebrate retinal development and regeneration, with specific focus on the differentiation and aging of photoreceptors and ganglion cells. Zebrafish are the primary experimental models used in the lab, since they develop rapidly, have multiple photoreceptor subtypes that can be easily identified, continue to grow new retinal tissue throughout life and can be manipulated genetically.

The lab's major area of investigation currently is the involvement of specific factors such as the signaling protein, sonic hedgehog, and the Vitamin A derivative, retinoic acid, in regulating the differentiation of rod and cone photoreceptors. The aim is to better define the sources of these factors in the developing

retina, and determine their effects on photoreceptors and other retinal cells by using gain-of-function and loss-of-function approaches, including the examination of specific zebrafish mutants and the creation of transgenic zebrafish with inducible genes. The lab is funded by an NIH Ro1 grant from the National Eye Institute for the continued pursuit of this project.

Postdoctoral Fellow Craig Stevens, BCB Ph.D. student Sam Hunter and technician Ruth Frey all are working on these studies. Neuroscience Ph.D. student Bhavani Kashyap is doing related work on developing a zebrafish model for the microphthalmic effects of embryonic ethanol exposure. Neuroscience Ph.D. student Steve Nelson is collaborating with faculty and students in the physics and chemistry departments to develop gene knockdown approaches that utilize nanotechnology. At this time, there are several manuscripts in review supporting the aims of this grant.

Stenkamp's lab also receives support from two foundations: The Glaucoma Foundation, for the study of ganglion cell regeneration in zebrafish (work performed by Neuroscience Ph.D. student Tshering Sherpa); and The American Health Assistance Foundation, for the pursuit of a zebrafish model for age-related macular degeneration (work performed by technician Rosanna Satterfield). These both are exciting new directions for the laboratory as they apply knowledge of factors involved in development of retinal cells to the analysis and treatment of human visual disorders.

The laboratory has been fortunate to participate in several undergraduate research programs funded by NSF, NIH and by the Department of Biological Sciences. Current undergraduates in the laboratory are Leon Park and Kim Russo.

Professor Stenkamp is on the Editorial Review Board for Molecular Vision, www.molvis.org/molvis, a peer-reviewed and award-winning online journal of vision research. (<http://www.sci.uidaho.edu/biosci/faculty/stenkamp.html>; dstenkam@uidaho.edu)

PROFESSOR EVA TOP'S research is focused on the evolution and ecology of plasmids that transfer to and replicate in a broad range of bacteria. These plasmids play an important role in the rapid adaptation of their hosts to changing environments. A good example is the current epidemic of antibiotic resistance in human pathogens, which is in part due to the spread of drug resistance plasmids.

One research project is part of an NIH-funded COBRE grant that established the Center for Research on Processes in Evolution. The objective of this research is to discern patterns of plasmid evolution in bacteria through experimental evolution studies. The

main goals of the project are: to assess the tempo and mechanisms of adaptive plasmid evolution in a single host and during frequent horizontal transmission among phylogenetically distinct hosts; and to determine the molecular basis for the observed phenotypic changes that occur during such experimental plasmid evolution. Some of these studies are done in collaboration with Professors Paul Joyce and Zaid Abdo of the Department of Mathematics.

A second project aims at enhancing our understanding of the diversity and evolutionary history of the extant pool of broad-host-range (BHR) plasmids. This will be done by retrospective analysis of the complete genomes of 100 BHR plasmids. The DNA sequencing service is provided by Department of Energy (DOE) Joint Genome Institute (JGI), and the National Science Foundation provides funding to analyze and compare these genomes. Co-investigators in this project are Professors Celeste Brown, Larry Forney and Jack Sullivan, as well as Professors Frank Cronk and Jill Dacey from the Department of Art and Design.

The third project aims at developing mathematical models to predict the spatial dynamics of plasmid transfer and persistence, and is in collaboration with Professor of mathematics Steve Krone and funded by the National Institutes of Health. This research, unlike most previous studies, takes into account the fact that most bacteria in natural and clinical settings form biofilms attached to surfaces such as medical implants and the walls of intestines. It is fairly well established that spatial structure, like that found in these bacterial biofilms, can have profound effects on the ecological and evolutionary dynamics of populations. Therefore, the long-term goal of this study is to understand the population biology of self-transmissible antibiotic resistance plasmids in spatially structured microbial communities: How does the spatial structure affect the ecological and evolutionary dynamics of plasmid-bacteria interactions?

This year Professor Top has published articles in *Journal of Bacteriology*, *FEMS Microbiology Ecology*, and *Microbiology*. (<http://www.sci.uidaho.edu/biosci/faculty/top.html>; evatop@uidaho.edu)

PROFESSOR HOLLY WICHMAN'S lab continued looking at the evolution of transposable elements in mammals and molecular adaptation in bacteriophages. The lab is bustling, with many researchers at all levels involved in a variety of projects. Five undergraduates each have their own research projects which contributed to the overall goals of the lab. Nathan Marshall is a new doctoral student who did his master's with Professor Todd Reeder at San Diego State University; Reeder was Holly Wichman's first

graduate student. Darin Rokyta and Kim Pepin completed their doctoral degrees last summer. Rokyta is continuing in the lab as a postdoctoral fellow working jointly with Professor Paul Joyce in Mathematics, and Pepin is a postdoctoral fellow at New Mexico State University at Las Cruces. Issac Erickson is completing work on his master's degree. Erkan BuzBas did his rotation for the Bioinformatics and Computational Biology project in the lab this year, and former BCB rotation students Craig Beisel and Wei Wei continued to carry out hands-on research as part of their ongoing projects. Sarah Hird and Virginie Poullain are graduate students with Professors Sullivan and Nuismer, respectively, but are carrying out part of their research in collaboration with the Wichman lab. Senior lab personnel are Associate Research Professor Mac Cantrell and scientific aides LuAnn Scott and Jack Millstein. Melodie Rai provides administrative support.

The transposable element group continues to characterize LINE-1s and mysTR elements in mammals. Undergraduate student, Amanda Keys, is carrying out a survey of marsupial families to assess the activity of the major class of mammalian transposable elements, LINE-1. Similarly, undergraduates Eric Howell, Armando Martinez and others have now characterized LINE-1s in all families of bats. LuAnn Scott has direct oversight of both of these projects. Mac Cantrell has documented the extinction of LINE-1 activity in megabats, and also is working with master's student, Ike Erickson, in determining the phylogeny and distribution of mysTR, a retrovirus-like element which is present at unprecedented levels in a group of rodents that also lack active LINE-1s. These are the only two known cases of LINE-1 extinction in mammals, but together affect about 9 percent of all mammalian species. (For more details on this project, see Professor Cantrell's profile.) This year, Cantrell, Scott, Howell and Keys presented posters and Erickson gave a talk at the Evolution meeting in Stony Brook, N.Y. Keys presented a poster at Evo-WIBO in Port Townsend, Wash. Howell and Keys participated in a College of Science poster competition in the fall.

The phage group has several projects in progress. In collaboration with Paul Joyce in the Mathematics Department; Darin Rokyta, Craig Beisel, Lindsey Anderson, Erkan BuzBas, Marshall Wingerson and Nathan Marshall are gathering the data to test and refine theoretical models of molecular evolution, using ϕ X174 and ϕ X-like phage. These theories look for generalities in the evolution of beneficial mutations. Beisel is pairing individually beneficial mutations

together in genomes to look at the additive and/or epistatic interactions, which also will provide information about the underlying fitness landscape. Anderson, BuzBas and Marshall are isolating beneficial mutations which allow growth under temperature extremes. They are looking at the number, pattern and fitness effects of the mutations. Wingerson is looking at the effect of the genetic background on beneficial mutations by engineering mutations known to be beneficial in one genetic background into related phage. Rokyta is looking at the effect of genetic background on fitness in a pair of lab-adapted phage in which the major capsid genes have been switched. The hybrid phages have lowered fitness and are being evolved to determine how much fitness can be improved and what types of mutations improve fitness. Pepin concluded her research on clonal interference, pleiotropy and epistasis in bacteriophage ϕ X174 this summer.

Scientific aide Jack Millstein and undergraduate student, Zev Kronenberg, are studying the effects of phage on *Pseudomonas aeruginosa*, attempting to evolve phage on biofilm. *P. aeruginosa* is an opportunistic lung pathogen in cystic fibrosis patients. In collaboration with Jim Bull at the University of Texas at Austin, Millstein also is looking at the effects of competition on molecular evolution in chemostats.

This year, the lab published papers in the *American Naturalist*, *Genetics*, the *Journal of Bacteriology* (with cover photo), *Cytogenetic and Genome Research* and *Journal of Theoretical Biology*. These publications featured work of three graduate students, three undergrads, and a postdoc, along with senior lab personnel and collaborators. A number of other manuscripts are accepted, under revision or in preparation. The phage projects are funded by a COBRE grant from NIH, on which Larry Forney is the principal investigator and Wichman is project director, and an NIH grant on which Paul Joyce is the principal investigator and Wichman is co-PI. The work on mammalian transposable elements is funded by a grant from NIH which is currently in its 19th year.

In addition to her efforts in research, Wichman taught experimental biology and a graduate course this year. She serves on the NIH Genetic Variation and Evolution Study Section, as associate editor of *Genetica*, and is a member of a National Academy of Science committee to update the academy's position on science and creationism. She also makes numerous service contributions to the department and University.

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