Aurora Sporealis 2011

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THANKS

This edition of the *Aurora Sporealis* covers parts of years 2010 - 2011. The 2012 issue will debut in Fall 2012.

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LETTER FROM THE DEPARTMENT HEAD

Dear Alumni, Faculty, Students, Staff, and Friends,

Welcome to another addition of the *Aurora Sporealis*! If you haven't noticed, then I probably shouldn't mention that this edition is a little late. Consequently, most of the materials in this edition reflect activities prior to May 2011. The next edition, which is scheduled for publication in Fall 2012, will include content from June 2011 through July 2012. In the future, look to the *AS* being back on an annual schedule coinciding with the academic year.

It's been harder than usual to find words that adequately reflect the tone of the department over the past two years. Let me explain...

While the faculty, staff, students and I have maintained our optimism about the continued relevance of plant pathology in advancing science and solving real disease problems in the state and beyond, we have done so amidst a cloud of uncertainty: uncertainty about the future of the discipline and uncertainty about the future of our own department. These issues are topics of conversation across the U.S., not just in Minnesota. I encourage you to read the 2009 article by Ray Martyn, Past President of the American Phytopathological Society: "Where will the next Norman Borlaug come from? A U.S. perspective of plant pathology education and research" (*Plant Protect Sci.*, 45: 125–139). In it you'll find data, not just anecdotal evidence, on the demographic shifts taking place in plant pathology. The department's future will depend on the creation of a realistic vision that parlays its capacity for meeting real world needs into a clear action plan. If there is a need and we can meet it, therein lies opportunity.

Minnesota received considerable national attention in 2010-11 for its historic statewide government shutdown after the legislature failed to deliver a balanced budget to overcome a 5 billion dollar structural deficit. The University stayed open during the shutdown, but the impact of the final budget will be with us for many years. The University's funding for each year of the new biennium will be set at $545.3 million, which is about 10% less than in FY2011. In FY2011, the state allocation accounted for about 17% of the UMN budget with an additional 3% coming from state specials. Other key sources of revenues included tuition (~25%), grants (~11%), gifts (~11%), and sales (~22%). To offset reductions in state allocations in FY2012 and FY2013, the University will again increase tuition, decrease administrative and programmatic support at the university and college level, and raise employee contributions for retirement and medical plans.

At the department level, we've experienced decreases in base allocations for most of the past ten years. Since 2006, the department's allocated budget has shrunk by about 18%, which equates mainly to fewer faculty positions on the St. Paul campus and fewer graduate student assistantships. (Most graduate students are supported by research grants.) Fortunately, much of the FY2012 budget reduction will be managed at the college level.

The overall size of the department has remained constant over the past couple of years, but the net loss in four years of four faculty positions from the St. Paul campus creates undeniable challenges for the future. As of May 2011, there were 91 people in the department including 11 State-supported faculty on the St. Paul campus, two State-supported faculty located at Research and Outreach Centers (ROCs) in Crookston and Waseca, eight adjunct faculty, 11 professional and administrative staff, 20 civil service staff, 25 graduate students, and 14 emeritus faculty.

The faculty roster includes a couple of significant changes since the last edition of the *Aurora Sporealis*. Professor James Percich retired from the University after over 30 years of service. Jim's many contributions included teaching plant pathology to over 450 students, one of whom is now part of the faculty (Dean Malvick). The latest addition to the St. Paul faculty is Assistant Professor Kabir Peay, who officially started in August 2011. We hope to soon welcome another faculty member to the department once the currently advertized position for an Extension Specialist on small grains and canola at the ROC in Crookston has been filled.

We continue our commitment to remaining an independent plant pathology department focused on solving plant disease issues of local or global importance and educating the next generation of plant pathologists. One of our strategies has been to enhance the Plant Pathology Graduate Program. During a retreat in Fall 2010, PlPa faculty reviewed student feedback about their experiences as graduates in the department and then developed an action plan aimed at enhancing students' experiences. Several items were subsequently tackled, including renovation of the student offices in Stakman Hall, and implementation of curricular and course changes including four new/revised courses. I wish to thank Professor Ruth Dill-Macky for exceptional service as Director of Graduate Studies during the course of these events. Under her leadership, several changes were made to the graduate program resulting in improved mentorship and evaluation of graduate students. She's also left a future blueprint on how to better empower our students and encourage their professional development.

Over the past six years, the department has intentionally gone about increasing its visibility within the University and expanding its national and international recognition. Along the way, it has become clear that the rich legacy of cereal rust disease research contributed by faculty and former students from the department and by adjunct faculty in the USDA/ARS Cereal Disease Lab is a very compelling story, worthy of telling on a large, public scale.

It started with small steps around the time of the department's Centennial. Shortly thereafter came Dr. Borlaug's memorial service and other events that would put the department in the spotlight. In the past two years, the department has been featured in the college's magazine, the university's news report, and several local, national and international news outlets. Most of the attention has centered on wheat stem rust, especially Ug99, the family of races that is virulent on over 85% of the world's wheat.

Little steps have become longer strides. The department became host to some very special guests, each of who have raised the visibility of the department. Susan Dworkin, author of the biography of UMN alumnus Sir Bent Skovmand: *The Viking in the Wheat Field*, gave a special guest lecture and book signing. Susan's visit had the unexpected bonus of attracting the attention of a producer from Minnesota Partnerships tpt Twin Cities Public Television. From that came a contract for a 30-minute documentary on rust research by UMN scientists. The documentary, Saving Wheat: Rusts Never Sleep, was aired on television in October 2011. It was also featured on August 30, 2011, during Minnesota Roots of the Green Revolution: A Legacy of Greatness, an event recognizing the completion of the digitization of the Green Revolution archival documents.

The department became a stop-off for several dignitaries associated with the university's Global Food Initiative. Those coming to the St. Paul campus to learn more about rust research and training programs included: The Honorable Jacques Diouf, then Director-General of the Food and Agriculture Organization of the United Nations; Ambassador Ertharin Cousin, U.S. Ambassador to the Rome-based U.N. Agencies for Food and Agriculture; Ambassador William John Garvelink, former U.S. Ambassador, Democratic Republic of the Congo, Africa, and Deputy Coordinator for Development, Feed the Future Initiative (USAID); and Mr. James Nyoro, Managing Director for the Africa Region, Rockefeller Foundation. Our programs and facilities, especially the biosafety level 3 greenhouse, have impressed all.

A big leap came recently during the gathering of over 350 people from around the world for the St. Paul Campus Field Day, held on June 13, 2011, in conjunction with the Borlaug Global Rust Initiative Workshop. The event was co-hosted by the department and the USDA/ARS CDL. The highly successful day was the culmination of several months of work on the part of over 50 volunteers. I can't thank each of them enough. I will be forever indebted to Anne Lageson, Carol Anderson, Marty Carson, and Jacki Morrison for their assistance in organizing the many events of the day. I also thank Ronnie Coffman, Director of International Programs, Cornell University, and the staff of the BGRI for holding the BGRI Workshop in St. Paul and facilitating the tour to the St. Paul campus. It was a great opportunity to showcase our outstanding facilities, programs and people to the international community.

During the BGRI opening ceremony, Professor Brian Steffenson and I were pleased to announce the launch of the new Stakman-Borlaug Cereal Rust Center. The center was borne from the philosophy of matching needs with capacity. For more information go to http://rusts.umn.edu/. Many thanks go to Emeritus Professor Richard Zeyen and Sarah Morean for developing the website. I also want to acknowledge that Richard has been a key contributor to the activities leading to the SBCRC, the MN tpt documentary, and the digitization of the Green Revolution Archives. Bringing ideas like the SBCRC to life takes a lot of energy and perseverance and the scale of SBCRC's success will ultimately depend on its ability to attract funding and investments in its goals. Several development activities are underway to ensure the center's success. Stay tuned...

While a lot of attention in this letter has been given to rust-related events, I must emphasize there are many other achievements and accomplishments that are equally noteworthy, and you can read more about them in this edition. The department remains one of the top research units within CFANS. Our faculty have shown great agility in obtaining grants from highly competitive agencies like National Science Foundation, USDA-AFRI, MN Small Grains Initiative, U.S. Wheat and Barley Scab Initiative, Bill and Melinda Gates Foundation, and many others. Faculty continue to tackle a broad range of research subjects from plant and fungal genomics to the application of science for near-term results. The Plant Disease Clinic is going strong under the leadership of Dimitre Mollov. The department was awarded an $875,000 grant to renovate the autoclave room in Borlaug hall. That project will be completed by the end of fall semester 2011.

As mentioned in the last newsletter, past issues of the *Aurora Sporealis* are available electronically at the UMN Digital Conservancy site: http://conservancy.umn.edu/handle/817/. You can also reach the site by going to http://plpa.cfans.umn.edu/AlumniFriends/StayConnected/index.htm on the "Stay Connected" link under "Alumni and Friends" subheading of the new departmental website http://plpa.cfans.umn.edu/. To search for specific people, places or events, first go to the searchable index http://conservancy.umn.edu/handle/44443. Once you've located an item of interest in the searchable index, go to the UMN Digital Conservancy site to read the article. Enjoy!

If you would like to donate to any of the many worthy causes in the department, please go to the departmental website for further information on how to make a gift and information on specific funds. As always, please feel free to contact the CFANS Development Office or me for further information.

The department remains dedicated to continuing the legacy of Dr. Borlaug and the many other luminaries from our past. At the same time, we are forward-focused, looking for the needs and providing our expertise where and when we can. I continue to be humbled by the many accomplishments of those around me. It is an honor serving you.

Yours truly,
Carol

Global Plant Pathologists

On average:

- Faculty have lived in 7 places
- Staff and postdocs have lived in 4 places
- Students have lived in 5 places

Research done in the Department of Plant Pathology impacts the world and we conduct our research in many diverse locales. Department members are also a diverse group with wide-ranging interests.

Almost two-thirds of the members of the Department speak more than one language.

When we relax we like to visit many different places including France, Sweden, Scotland, Italy, Uruguay, Panama, Honduras, New Zealand and Indonesia. Favorite vacation spots in the U.S. include New Mexico, the Pacific Northwest, Hawaii, and the Outer Banks of North Carolina. A large number of us like to spend our vacation time out of doors exploring national parks, the Boundary Waters Canoe Area Wilderness, and beaches. We like to fish, hike, camp, ski, swim, wind surf, canoe/kayak, ride bikes, watch birds, botanize and enjoy nature!

The members of the Plant Pathology Department come from:

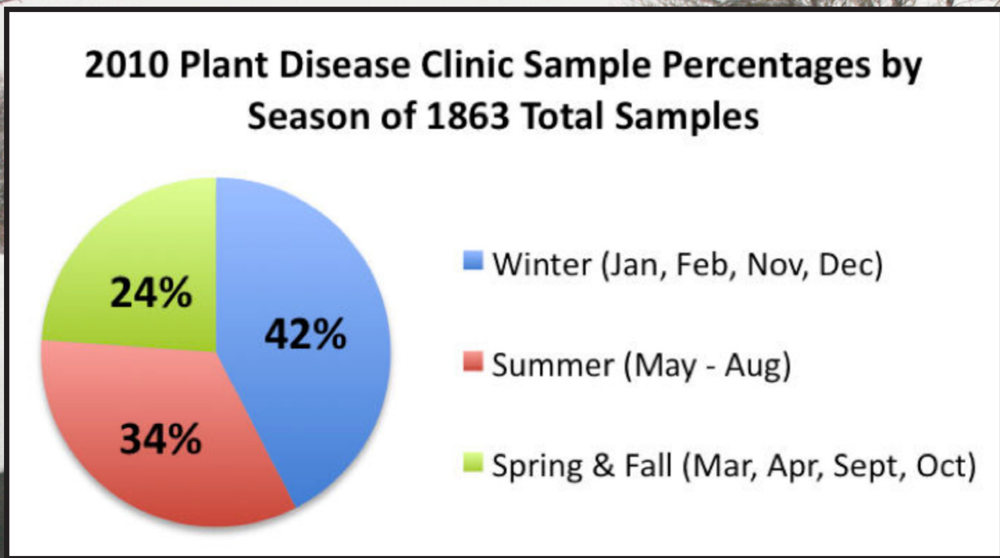
- 16 different countries on 6 continents
- 16 states within the United States
- 17 cities within Minnesota

Our hometowns include:

Arcola, Illinois *Former broomcorn capital of the world*
Concord, Massachusetts *Home of Henry David Thoreau and location of Waldon Pond*
Duluth, Minnesota *Which has the most inland port in the U.S. connected to the ocean, and has the world's largest fresh water sand bar with beautiful beaches*
Fairfax, Marin County, California *Where mountain biking was invented*
Gaithersburg, Maryland *Headquarters of the National Institute of Standards and Technology*
Green Bay, Wisconsin *An industrial city with several meat packing and paper plants, home to the National Railroad Museum and the University of Wisconsin–Green Bay. Oh, and also a football team*
Hatvan, Hungary *Named for a noble family but it also means sixty in Hungarian and it is 60 km from the capital of Hungary*
Isfahan, Iran *Which is famous for its Iranian & Islamic architecture, with many beautiful boulevards, covered bridges, palaces, mosques, and minarets*
Kalamazoo, Michigan *Known as the "Mall City" because it is home to the nation's first (outdoor) pedestrian shopping mall and also home to Bell's Brewing Company*
Medina, Ohio *Where manufacturing beehives, beekeeping equipment, and candles were once important industries*
Montivideo, Uruguay *Southernmost capital city of the world*
Nitro, West Virginia *Where nitroglycerin was produced within the borders of the town in an ammunitions factory during World War I*
Southport, Queensland, Australia *Most northerly beach of 21 beaches that are collectively referred to as the Gold Coast and span over 70 km along the SE Queensland coast*
Wolliso, Ethiopia *114 km from Ethiopia's capital, Addis Ababa, on the way to Kaffa-Jimma, the "birthplace of coffee"*
Xinyang, Henan Province, China *Located by the Yellow River*
Xiaonao, Inner Mongolia *Like western North Dakota, with wide-open prairie and rolling hills*

PLANT DISEASE CLINIC: "WINTER, IT'S THE NEW BUSY SEASON"

by Jennifer Flynn, Junior Scientist



Previous authors of this column often mentioned a busy summer. For 2010, it was a busy winter! There are several reasons 42% of the 2010 samples arrived in January, February, November, and December. One reason is the popularity of our Seed Testing service for the ID of storage molds. Over 1000 seed samples were processed in 2010, mostly during the winter. Another reason for increased winter business is the Plant Disease Clinic's (PDC) capabilities in virus diagnostics. The PDC, directed by Dimitre Mollov, along with Dr. Ben Lockhart's Virology Lab have gained a national reputation that is stronger than ever for virus analyses. Thus, samples from greenhouses, other diagnostic labs and regulatory agents arrive year-round and from coast-to-coast for virus testing. In December, Dimitre and Dr. Lockhart put their virus expertise toward outreach and hosted a 4 daylong virology workshop for diagnostians and government officials from the North Central Region of the National Plant Diagnostic Network (NPDN). With winter as the new busy season, the ten-day budget-saving University closure from December 24th until January 3rd upset the workflow. The year 2011 began with 64 samples arriving Jan 3rd. This backlog of samples was compounded with the typical large number of January samples and all staff struggled until Jan 19th to catch-up. Unfortunately, some customers who shipped samples in late December waited almost a month for results that they normally receive in a week. Samples for nematode analysis also contributed to winter work because Dr. Dave MacDonald wrote a factsheet about corn nematodes for the Minnesota Crop News that stressed, "Autumn is the preferred time to collect soil samples for plant nematode analysis." Therefore, samples for nematode analysis arrived into December. Despite being retired since 2009, Dr. Dave MacDonald is still analyzing nematodes for the PDC and his continuing service to the PDC, as well as to students and outreach activities beyond the University, is widely recognized and appreciated by many.

FOCUS OF SOYBEAN PATHOLOGY TURNS TO SUDDEN DEATH SYNDROME

by Jim Kurle and Dean Malvick

Soybean production in Minnesota is a remarkable story. Approximately 7 million of the state's 19 million acres of cropland are planted to soybean, producing 30% of Minnesota's farm income. This change in crop preferences has taken place in less than 60 years as soybean replaced wheat, barley, oats and forage crops in importance in the state. Only corn is planted on more acres statewide. Because of soybeans' importance to Minnesota's economy, diseases that threaten soybean yields are the focus of substantial research efforts.

Originally relatively free of major disease problems, soybean production has been challenged by a variety of new pests and pathogens. Soybean Cyst Nematode, introduced into the U.S. in 1940, reached Minnesota in 1978 and has since become a widespread and significant problem across the state. The introduction of Asian Soybean Rust to the southern United States in 2004 sparked a national response that included a system of sentinel plots, a forecast and reporting system, testing and clearance of numerous fungicides, and intensive resistance breeding efforts. Fortunately this disease has not yet become a problem in the Midwest, and has not been detected in Minnesota. The most recent and potentially most serious threat to soybean production across much of Minnesota is Sudden Death Syndrome (SDS). SDS was known in southern Illinois in the early 1980's, but was not confirmed in Minnesota until 2002 when it was found in two southeastern counties. Since then it has been confirmed in 37 counties throughout the southern half of the state.

SDS is a devastating soilborne disease caused by the fungus *Fusarium virguiliforme*. Disease development begins with root infection that usually takes place early in the growing season. Infection is favored by low soil temperatures and high soil moisture, typical conditions occurring in spring. The infection leads to root rot and reduced plant productivity; however, the first obvious symptoms are usually seen as leaf chlorosis and necrosis in early-August. These foliar symptoms are due to a toxin translocated from infected roots. In areas where foliar symptoms are severe, yield losses exceeding 60% have been observed. The explanation is unclear for the apparent rapid spread of SDS across Minnesota. It may spread with soil movement by both wind and water, and disease appearance may be a consequence of buildup of inoculum under intensive cropping of corn and soybeans. The severity of SDS also appears to

increase in the presence of soybean cyst nematode.

Reducing losses to SDS is proving to be a complex problem. Although cultural practices provide some relief from the risk of SDS, their effectiveness is limited. Delayed planting to allow soil warm-up and drying to reduce the disease can also result in reduced yields in Minnesota's short growing season. Where soil compaction is a problem, deep tillage can reduce the risk of SDS but the practice can be costly. Crop rotation is not effective because *Fusarium virguiliforme* persists in the soil and on crop residues, and has a broad host range. Tammy Kolander (M.S. 2010), working with Jim Kurle and Dean Malvick, demonstrated that the host range of *F. virguliforme* is wider than previously known, and includes alfalfa and clovers. The wide host range of the pathogen emphasizes the importance of cultivar resistance as a means of limiting losses to SDS.

In Minnesota, plant pathologists Drs. Dean Malvick and Jim Kurle, have focused research efforts on identifying resistant varieties adapted to Minnesota, evaluation of seed treatments to limit disease development, determination of the distribution of SDS, and assessment of the role of symptomatic and asymptomatic hosts in inoculum production and persistence. Resistance evaluations conducted in the field and in the greenhouse in collaboration with plant pathologists and plant breeders across the North Central States have documented useful levels of resistance in a number of varieties and breeding lines. Another project is focused on soil and field factors that enhance SDS. Determining the prevalence of SDS requires the collaboration of soybean growers, crop consultants, and Extension Educators who have been trained in symptom recognition and are willing to provide plant and soil samples for analysis in the laboratory. Samples are diagnosed based on symptoms, and the presence of *F. virguliforme* is confirmed with specific PCR (DNA) tests and isolation of the pathogen.

The research on SDS at the University of Minnesota has had several significant outcomes. One is to demonstrate that the range and risk of this disease is much greater than anticipated a few years ago, which has led to increased efforts to introduce resistant soybean varieties to Minnesota and to develop other management practices. Much of the work on other potential management practices such as rotation, fungicide seed treatments, and tillage has shown they currently have limited value, and soybean producers need not put money and effort into using them to manage SDS. The knowledge of increased host range not only documents some of the crops that should not be grown in rotation with soybean where SDS occurs, but also documents that other important crops can be at risk of significant damage from the same pathogen. The soybean disease situation in Minnesota is constantly changing, which is exemplified by the increases in spread and importance of SDS. Thus ,we routinely refine our research efforts on this and other diseases to maintain profitability of the soybean crop, as well as to answer interesting and significant questions on the biology and ecology of diseases that have broader impacts.

DAVE LONG RETIRES

After 40 years of service, Dave Long retired from the USDA/ARS Cereal Disease Laboratory located on the St. Paul campus of the University of Minnesota on December 31, 2010.

Dave is a native of Sturgeon Bay, Wisconsin, and earned a B.S. degree in Plant Pathology in 1967 from the University of Wisconsin-Madison. Dave then went to graduate school at Kansas State University. There, he obtained an M.S. in Plant Pathology and worked on epidemiology of wheat rusts with Dr. Charles Kramer.

Dave returned to the Upper Midwest in 1970 when he accepted a position at the USDA/ARS Cooperative Cereal Rust Laboratory, in St. Paul.

Dave initially worked with Dr. Alan Roelfs on the epidemiology of wheat stem rust, caused by *Puccinia graminis*. Dave's role gradually evolved as he became responsible for coordinating the annual USDA/ARS cereal rust disease survey. Working with Dr. Jack Schafer, in 1978 Dave started the annual virulence survey of *P. triticina* (wheat leaf rust fungus) in the United States. Dave was also involved with wheat breeding programs throughout the United States as he tested wheat cultivars and germplasm for leaf rust resistance and postulated the leaf rust resistance genes that were present. He was also responsible for testing barberry accessions from commercial nurseries for resistance to *P. graminis.* Additionally, Dave compiled the annual rust loss reports for the United States and wrote the Cereal Rust Bulletins that would appear regularly from April through July that described the current situation on the development of cereal rust epidemics in the United States. Dave and his wife Pat will be enjoying their retirement at homes in the Twin Cities area of Minnesota and in Door County Wisconsin with regular winter time trips to warmer climates.

RUSTY HINGES PREVAIL!

Congratulations to team Rusty Hinges on winning the "Distinguished" category of the CFANS Golf Scramble on July 8, 2011! Captain Richard Zeyen and teammates Yue Jin and Carol and Dan Ishimaru knocked out an impressive 63 for eight under par. Sure, they bought a few putts beforehand in the name of charity, but it was the combination of big drives and long putts that made the difference! It was an absolutely beautiful day for golf and the UMN's course was in great shape. Though she didn't win a prize, novice golfer Carol was very proud of capturing 2nd place in the women's longest drive. The team won matching black golf shirts, which they plan to wear proudly in next year's tournament.

E.C. STAKMAN SOFTBALL GAME

BACTERIAL LEAF STREAK OF WHEAT:
A cooperative research effort involving the University of Minnesota, North Dakota State University and South Dakota State University

by Ruth Dill-Macky

Amar Elakkad and Ruth Dill-Macky rating wheat lines for reaction bacterial leaf streak in St. Paul Nursery, July 2010. Photo Credit: Rebecca Curland

Bacterial Leaf Streak (BLS) of wheat has been evident in Minnesota, North Dakota and South Dakota in the past four cropping seasons. While generally sporadic in nature, the levels of BLS that have been observed suggest that this disease may be of increasing concern for wheat production in the Upper Midwest. Bacterial leaf streak is caused by the bacterium *Xanthomonas translucens* pv. *undulosa*. Infection with this pathogen results in distinctive symptoms on leaves and glumes. Although BLS can be severe, the impact on yield and quality of wheat is not well understood. As little research has been conducted on BLS in the Midwest in recent years, preliminary research was initiated in Minnesota in 2009 to determine the severity of the problem and work toward finding solutions. The main priorities of the research has been to develop techniques to work effectively with the pathogen, to determine the impact of BLS on grain yield and quality, to examine the structure of the pathogen population, and to initiate efforts to screen wheat lines for resistance to BLS with the goal of improving genetic resistance in wheat to BLS.

Pathologists Ruth Dill-Macky (UMN), Tika Adhikari (NDSU) and Lawrence Osborne (SDSU) have worked collaboratively to develop techniques for producing inoculum and inoculating plants in the greenhouse and field. Together they have identified a number of inoculation protocols that are effective in generating the disease in the greenhouse and field and have established scales for the visual assessment of the disease. These protocols have formed the foundation for ongoing research examining disease development and the impact of BLS on wheat, the pathogen population and for the evaluation of control practices.

Experiments are also being undertaken to establish the economic importance of BLS. This summer (2011) we have established field plots at St. Paul, Lamberton and Crookston that include inoculated and uninoculated plots. By comparing disease development, yield and quality of the harvested seed between inoculated and control treatments, we will begin documenting the impact of BLS on wheat yield and quality.

Dr. Carol Ishimaru and Rebecca Curland (UMN) have been examining the structure of the pathogen population. We know that there is considerable genetic variability in this pathogen, and their research efforts are helping determine if this variation is of biological importance to the disease. Determining if there are 'races' of the pathogen is critical to understanding if the pathogen is likely to change in response to disease control measures. In this work they have taken isolates from across the Upper Midwest and determined their ability to generate disease by inoculating plants in the greenhouse. They are also using a molecular approach 'Multilocus Sequence Typing' to help identify the sub-groups of the population and reveal the structure of the pathogen population.

Finally, cooperative screening nurseries are being used to screen commercially available wheat varieties and provide information on relative variety performance to growers. The nurseries planted this summer will screen material from both public and private breeding programs. In these nurseries we are also screening populations still under development in Dr. Jim Anderson's wheat breeding program (UMN). The lines that express resistance to BLS will ultimately facilitate the development of commercial wheat lines with improved resistance to BLS.

2010 HOLIDAY PARTY

JIM PERCICH RETIREMENT

Professor Jim Percich retired from the University of Minnesota Department of Plant Pathology on January 5, 2011. Jim obtained an M.S. degree in Biological Sciences from Michigan State University in 1969. After teaching high school biology in Detroit, MI, Jim returned to graduate school at Michigan State University where in 1975 he obtained a Ph.D. degree in Plant Pathology.

Following a post-doctoral fellowship at the University of Wisconsin, Jim joined the University of Minnesota Department of Plant Pathology as a research fellow in 1976 and was appointed as an Assistant Professor in 1977. In 1983 he was promoted to Associate Professor and in 1989 to Professor. His initial appointment focused on research into the diseases of wild rice, which was being domesticated as a paddy-grown crop. The focus of much of his research was management of foliar diseases of wild rice that were a consequence of intensive management practices applied in paddy production. From 1982 to 1986 he also conducted research on diseases of sugar beets. In 1987, Jim's research responsibilities expanded to include diseases of asparagus, peas and dry beans. In particular he focused on control of *Aphanomyces* root rot of peas. During the period 1987 through 2010 his research efforts emphasized the management of Fusarium root rots of dry beans that are a particular problem for growers in central Minnesota. In this effort he developed a network of collaborators that included faculty in the Department of Soil, Water and Climate and cooperating growers interested in integrated management approaches for improving dry bean yields. His research efforts resulted in publication of 68 peer-reviewed papers and more than 120 abstracts.

Jim was a dedicated and popular instructor who taught and advised graduate and undergraduate students for 33 years of his 34-year career at the University of Minnesota. As a graduate faculty member he advised six M.S. and 10 Ph.D. students and taught six different graduate level courses in applied plant pathology or mycology. These courses included Mycology, the Biology and Ecology of Fungi, Biology of Plant Diseases, Plant Protection Compounds, and Chemical Control of Plant Diseases. He was also a member of more than 70 graduate committees. Jim was a committed contributor to the department's and the college's undergraduate programs as well. From 1977 to 1994 he advised undergraduate students in the Plant Pathology Department's Plant Health Technology Program and Integrated Pest Management Program. Jim's teaching philosophy was based on his view of the plant pathologist as a practitioner of disease diagnosis and disease management methods. In this role he focused on plant pathology in practical "real-world" applications of mycology and plant pathology. This principle motivated his use of the teaching laboratory as an integral component of instruction in Plant Pathology. His reputation as a graduate instructor was reflected in the popularity of his courses among students in Plant Pathology, Agronomy and Horticulture.

In his retirement Jim plans to spend time in Michigan's Upper Peninsula, continue with his hobby as a photographer and participate in volunteer work with the Masons and other organizations. He's also made a commitment to continue the tradition of morning coffees that he helped initiate.

OBITUARY: Donald V. McVey

Dr. Donald V. McVey, retired USDA/ARS Research Plant Pathologist, Cereal Disease Laboratory, St. Paul, passed away at home, surrounded by family on December 16, 2010. He was 88 years old.

Don retired from the Agricultural Research Service on September 3, 2001, after more than 40 years of service. Don's research played a pivotal role in the protection of cereal crops from leaf and stem rust, especially in spring and winter wheat cultivars in the Central and Northern Great Plains. Don began his career with ARS in 1960 working in Puerto Rico testing wheat accessions for resistance to race 15B of stem rust, which had caused serious losses in wheat in 1953 and 1954. In 1965 Don was transferred to the Cooperative Rust Laboratory.

Don was best known for his work in testing wheat breeding lines for resistance to stem and leaf rust diseases. Don excelled in evaluating rust resistance in field nurseries, using carefully selected rust races and methods that enabled selection for resistant genotypes to be made each season. Don was a leader in postulating the identity of leaf and stem rust resistance genes that were present in advanced breeding lines from wheat programs throughout the country. Working with Dr. Robert E. Heiner, Don was involved with the release of 'Era' wheat in 1970. 'Era' was the first semi-dwarf spring wheat cultivar in the Upper Midwest that was released by a public institution. 'Era' offered a significant yield advantage over previous spring wheat cultivars and was resistant to stem and leaf rust. 'Era' has been used as a parent in wheat breeding programs and is in the pedigree of many of the present day spring wheat cultivars. Don also contributed greatly to the development of the cultivar 'Marshall' which was released by Minnesota in 1982. 'Marshall' had high yield potential and was the yield standard for the hard red spring wheat. Another notable cultivar that Don helped to develop was the winter wheat 'Siouxland' released by Nebraska. This cultivar was the first wheat to have two leaf and stem rust resistance genes derived from wild relatives of wheat. 'Siouxland' was widely adapted to the Great Plains region and was grown from Texas to South Dakota.

In his latter years at the Cereal Disease Laboratory, Don worked particularly closely with the wheat breeding programs at the University of Minnesota, South Dakota State University and the University of Nebraska. Don was listed as an author on many wheat cultivars released by these institutions. A recent cultivar from Minnesota that Don helped to develop is 'McVey' which was one of the first modern spring wheat cultivars with some resistance to Fusarium head blight. The fact that stem rust was virtually eliminated as a pathogen of wheat in the U.S. can be attributed to the thorough screening for stem rust resistance that Don performed for wheat breeding programs throughout the U.S. In his last years at the Cereal Disease Laboratory, Don also assumed responsibility for conducting the annual race survey of wheat stem rust in the U.S. that has been very important in the development of breeding lines for stem rust resistance. Through his publications and participation in workshops and conferences, Don's contributions were widely recognized and appreciated by both cereal rust pathologists and wheat breeders.

PLANT PATHOLOGY LIBRARY NEWS

The Plant Pathology Library debuted two new exhibits since 2010. One simply titled "Norman Borlaug" featured the life of alumnus Norman Borlaug, and another titled "With Distinction: A Look at University of Minnesota Department of Plant Pathology Distinguished Alumni" featured the work of Borlaug, E.C. Stakman, Helen Hart, J. George Harrar and Bent Skovmand.

Recent notable visitors to the library included author, playwright and lecturer Susan Dworkin, CABI's Market Development Director Phil Abrahams, Associate Plant Pathologist at the University of Hawai'i at Manoa (and son of University of Minnesota Department of Plant Pathology alumnus Dick Nelson) Scot Nelson, and several tour groups led by Richard Zeyen and Brian Steffenson on June 13, 2011, for the St. Paul Field Day.

The library is also in the hands of a new reference librarian. In May 2011, Beth Petsan superseded Leslie Delserone in the role of Library Liaison for the Department of Plant Pathology.

STAKMAN-BORLAUG CEREAL RUST CENTER

by Richard Zeyen, Professor Emeritus

In 2010 our College of Food, Agricultural and Natural Resource Sciences (CFANS) approved the formation of a Stakman-Borlaug Cereal Rust Center (SBCRC). It was funded for one year by CFANS endowment funds. In an era of funding shortages no departmental funds were used, nor will they be. New sources of outside funding are being pursued. The who, what, when, where and why of the SBCRC is as follows.

It is true, rusts never sleep, they just keep evolving. Thus, our department's Nobel Peace Laureate Norman Boralug (M.S. 1941, Ph.D. 1942) was alarmed when he saw that wheat stem rust resistance, built into his Green Revolution "miracle wheats," had succumbed to a new stem rust race (Ug99). With help from Minnesota's USDA/ARS Cereal Disease Laboratory it was determined that nearly 80% of all wheats grown worldwide are susceptible, and 100% of Minnesota grown wheats are susceptible. In addition, the global incidence and severity of leaf rust and yellow (stripe) rust was increasing.

Borlaug called for a massive, coordinated international effort to combat cereal rust diseases with Ug99 as a catalyst. Why? Wheat is responsible for nearly 50% of the energy and protein in human diets. Thus, in a world with 6.9 billion people and record low wheat stocks, losses caused by Ug99 and/or other rust diseases have widespread food security, economic and societal implications. Throughout the history of agriculture and civilization, cereal rust diseases have caused food shortages and famines, disrupted national and regional economies, and led to rioting and civil unrest.

In 2005 the Gates Foundation and the Rockefeller Foundation responded to Borlaug's pleas. They funded a Global Rust Initiative (recently renamed the Borlaug Global Rust Initiative), and chose Cornell University to administer the program. The folks at Cornell immediately contacted the University of Minnesota's Department of Plant Pathology and our USDA/ARS Cereal Disease Laboratory for assistance. Why? Because for more than 100 years Minnesota has been the epicenter of cereal rust research and prevention in North America. We educated and trained many of the 20th century's "rust fighters" including Norman Borlaug. Our history is impressive, and our faculty and alumni were instrumental in seminal discoveries. We are experienced in developing international collaborations and strategies for rust disease prevention and control.

The University of Minnesota is committed to that discovery and is re-doubling our efforts through a new partnership with the United Nations Food and Agriculture

SBCRC MEMBERS

James Anderson *Department of Agronomy & Plant Genetics*
Martin Carson *USDA/ARS Cereal Disease Laboratory*
Ruth Dill-Macky *Department of Plant Pathology*
Nancy Ehlke *Department of Agronomy & Plant Genetics*
David Garvin *USDA/ARS Plant Science Research Unit*
Jane Glazebrook *Department of Plant Biology*
Carol Ishimaru *Department of Plant Pathology*
Yue Jin *USDA/ARS Cereal Disease Laboratory*
Fumi Katagiri *Department of Plant Biology*
James Kolmer *USDA/ARS Cereal Disease Laboratory*
Gary Muehlbauer *Department of Agronomy & Plant Genetics*
Phil Pardey *Department of Applied Economics*
Matthew Rouse *USDA/ARS Cereal Disease Laboratory*
Kevin Smith *Department of Agronomy & Plant Genetics*
Les Szabo *USDA/ARS Cereal Disease Laboratory*
Carroll Vance *USDA/ARS Plant Science Research Unit*
Eric Watkins *Department of Horticulture*

Contributions by former faculty and alumni:

- Physiological races and scientific resistance breeding
  E. Stakman, et al.
- Establishment of USDA Cereal Rust Laboratory at Minnesota
  E. Stakman, et al.
- Barberry Eradication Program in the Northern United States
  E. Stakman, et al.
- Aerobiology of the *Puccinia* Pathway
  E. Freeman, E. Stakman et al.
- Discovery of the sexual cycle of *Puccinia graminis*
  J. Craige, et. al.
- "Slow rusting" phenomena
  H. Hart, et al.
- Gene-for-Gene Theory – Flax Rust Model System
  H. Flor
- Stem Rust resistance in Green Revolution "miracle wheats"
  N. Borlaug et. al.
- Establish North American Cereal Rust Workers Conference
  Fletcher, et al.
- International genetic preservation of resistant plant materials
  B. Skovmand
- Discovery of an alternate host for *Puccinia striiformis*
  Y. Jin, L. Szabo, M. Carson

CONSULTING SBCRC MEMBERS

William Bushnell *USDA/ARS Cereal Disease Laboratory*
Eugene Hayden *Hayden & Associates*
Kurt Leonard *USDA/ARS Cereal Disease Laboratory*
Ron Phillips *Department of Agronomy & Plant Genetics*
Howard Rines *USDA/ARS Plant Science Research Unit*
Alan Roelfs *USDA/ARS Cereal Disease Laboratory*
Richard Zeyen *Department of Plant Pathology*

Organization. We stand ready to follow in the footsteps of our esteemed alumnus Norman Borlaug and to begin the next Green Revolution – this time, a truly 'green' revolution – one that our planet can sustain as well as one that can sustain the doubling of global food demand by the year 2050.

In 2008, at the urging of our alumni, a rust center in the College of Food, Agricultural and Natural Resource Sciences at Minnesota was proposed. It would support the new partnership between the University of Minnesota and the United Nations Food and Agricultural Organization. The SBCRC would be a University of Minnesota contribution to a much-needed second Green Revolution, and to educating and training new generations of "rust fighters." The center would take advantage of the 100+ years of rust prevention experience and of extraordinary facilities and graduate education expertise. Minnesota has the largest collection of scientists with rust disease experience in the world.

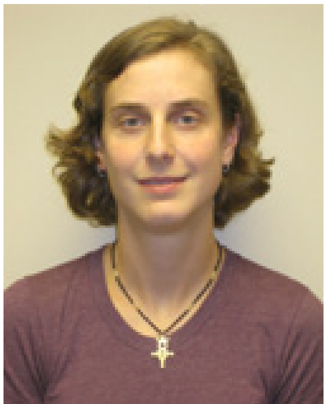
After much debate and input, CFANS approved this center in the spring of 2010. The SBCRC has, of yet, no physical location. It is interdisciplinary and inter-institutional. The SBCRC has ties to the North American Cereal Rust Workers Conference and several other international efforts including the Global Rust Initiative.

SBCRC members are dedicated to:

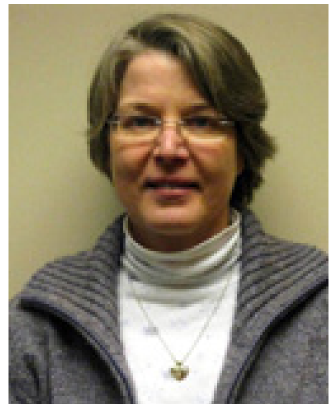
- Educating and training new generations of 21st century rust fighters
- Expanding the genetic base for rust resistances in cereal crops, with genes from wild cereal relatives and from novel resistance sources
- Using genomic information from rusts for rapid pathotyping of dangerous rust race families
- Establishing 21st century epidemiological concepts, including remote sensing technologies, useful in locating and stopping local and regional outbreaks of cereal rust diseases
- Encouraging collaborations with local, regional and international partners and private concerns
- Promoting use of funding resources that ensure sustainability and stability in the battle against evolving rust disease pathogens of cereal crops

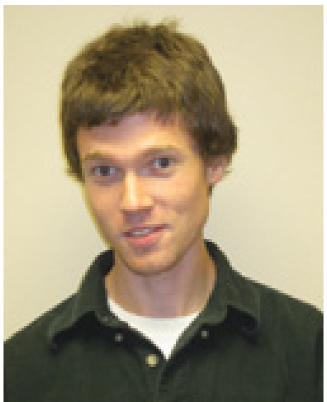
GRADUATE STUDENT OFFICE REMODELING PROJECT, 4th FLOOR STAKMAN HALL

Ten graduate student offices located on the fourth floor of Stakman Hall were remodeled earlier this year. To begin the project, all gas lines were capped and old sinks were removed from the offices, since these offices were previously "lab" space. Once the students moved out, all old furniture was removed, the rooms were completely repainted, and new carpet and vinyl baseboards were installed. Once this was completed, new modular furniture was delivered and installed, including new chairs. We've received very favorable feedback from the students about their new and improved space. The offices now give the impression of being fresh and clean, with furniture that is more modern, efficient and comfortable.


Laura Felice


Zane Grabau


Gretchen Freed


Nicholas LaBlanc


Michelle Grabowski

WELCOME TO OUR NEW STUDENTS!

PLANT PATHOLOGY RESEARCH FAIR 2011

The 3rd Annual Plant Pathology Research Fair took place on Friday, April 22, in the Cargill Building with a combination of faculty research presentations, posters from students, post-doc, faculty and staff, plus plenty of food and beverages. This continues to be a popular event, with more than 50 attendees for the third year running. Dr. James Bradeen opened the event with a presentation about his lab's research focus, comparative genomics in *Solanum* as a tool to study disease resistance in potato. He was followed by a presentation by Dr. Ben Lockhart reviewing the many different and unusual plant viruses studied in his lab. After the presentations, everyone moved to the combined poster session and reception in the Cargill Atrium. Altogether there were 12 posters and they spanned the range of Plant Pathology, Antarctic fungi, biocontrol of nematodes, Fusarium toxins, soybean diseases, next generation sequencing of Phytophthora, diseases of hickory, mapping stem rust resistance genes, population genetics of defensins. Wonderful food came from Byerly's, coupled with interesting wines, beers and soft drinks from The Little Wine Shoppe in St. Anthony Park. Key to the success of the fair was all the help provided by Carol Anderson, Matthew Hass, Ji-Hyun, Joel Jurgens, Sandesh Nicol, Charlie Paule, Tracy Scanlon and Nevin Young. Based on the experience of these first three years, it is likely the Research Fair will continue in the future as a regular Plant Pathology tradition.

DEPARTMENT OF PLANT PATHOLOGY HONORED BY TWIN CITIES PUBLIC TELEVISION DOCUMENTARY: "Saving Wheat: Rusts Never Sleep"

by Richard Zeyen, Professor Emeritus

We live in a time when most people don't know where their food comes from. Few appreciate the importance of rust diseases to global food security. In summer 2011, Minnesota Channel Productions of Twin Cities Public Television (tpt) honored, with a half-hour documentary, the University of Minnesota's Department of Plant Pathology for more than one hundred years of cereal rust prevention research and education. The entire film is available for viewing on tpt's MN Video Vault website found here: http://z.umn.edu/savingwheat.

This documentary was conceived during a book tour by author Susan Dworkin who wrote "The Viking in the Wheat Field." Ms. Dworkin's 2009 book is about the life and times of one of the Department of Plant Pathology's famous alums, Sir Bent Skovmand. The College of Food, Agricultural and Natural Resource Sciences (CFANS) live streamed Ms. Dworkin's talk about her book on March 4, 2010, at the Cargill Building on the Saint Paul Campus and tpt Executive Producer Tom Trow happened to watch. Mr. Trow telephoned the Cargill Building and requested that Ms. Dworkin, Richard Zeyen, Carol Ishimaru and CFANS's Alumni Director Mary Buschette along with Communications Director Becky Beyers meet immediately. Then plans were made for the documentary, funds were raised, and a contract between the University of Minnesota and tpt was signed.

This documentary tells the very special story about the international impact of the University of Minnesota's Department of Plant Pathology wheat researchers and the battle against their rust diseases throughout the 20th century. Minnesota faculty and alumni were instrumental in scientific rust resistance breeding (Stakman et al.) and made wheat growing an immensely profitable venture on the North American Great Plains. Then after containing the infamous race 15b stem rust epidemic of the 1950's, they helped alum Norman Borlaug build-in strong and relatively durable rust resistances into Green Revolution "miracle wheats."

After these mid-20th century successes, it appeared to politicians and non-scientific policy makers that the rust diseases were beaten. They were of no importance. Therefore support for maintenance rust prevention research and for educating future rust fighters, at Minnesota and worldwide, drastically declined as did most publically funded agricultural research. However, true to their biological nature the rust fungi kept hybridizing, mutating and evolving. Apparently rust fungi are oblivious to the whims and wishful thoughts of politicians and policy makers.

In particular, the fungus causing the most devastating disease of cereals, stem rust of wheat and barley, was co-evolving with the wide spread use of the Green Revolution's miracle wheats. Then, after 40 years of relative stem rust resistance durability, a novel and highly virulent wheat stem rust race arose in Africa. It was discovered in the wheat growing regions of Uganda and Kenya in 1999. It and its siblings were given the common name Ug99. Stem rust fungi then began their airborne spread out of Africa, across the Arabian Peninsula and into Iran and Pakistan and India. Research at the USDA Cereal Disease Laboratory and in Kenya revealed that 70% of the world's wheat varieties were susceptible to Ug99 family of stem rust races.

Concurrently, other rust diseases like leaf rust of wheat and barley, yellow or stripe rust of wheat, and crown rust of oat continued evolving, and once again threaten genetic resistances used in the 20th century. New and emerging rust diseases and their effects on yields of cereal crops are exacerbated by climate changes. In addition, the world's population increased from 3.5 billion in 1970 (the first Green Revolution) to 7 billion in 2011. Meanwhile wheat production has dropped 5% from its Green Revolution highs. Evolving rust fungus diseases threaten to lower production and quality even more. Now with food security a very large issue, society is becoming aware of the effects of 40 years of global political indifference to agricultural research and education.

Worldwide, the rust disease situation has been worsened by the lack of educated and trained "rust fighters." Most highly skilled and Minnesota trained plant pathologists and disease resistance breeders of the mid-20th century have retired or passed away. New generations of rust fighting scientists, plant pathologists and resistance breeders must now be educated and trained. The times require them, as does a much-needed second and sustainable Green Revolution, which will need to feed a population of 10 billion by 2050.

PLANT PATHOLOGISTS ADOPT NEXT GENERATION DNA SEQUENCING TECHNOLOGIES

by Deborah Samac

A revolution has quietly occurred in plant pathology research. There has been a re-evolution in DNA sequencing technology that is changing how we conduct research and train graduate students, and eventually how we understand plant-microbe interactions and manage plant diseases.

Not too terribly long ago, sequencing a single gene was a major undertaking in terms of time and resources. A lab had to have special equipment for making and running large polyacrylamide gels. It was no simple matter to learn how to create the radiolabeled DNA fragments and separate them on a gel. Once the X-ray film was developed, the tedious and time-consuming task of deciphering the bands and piecing together the gene sequence began. If one person was skilled and lucky, it was possible to sequence about 1,000 bases in a week.

A major stimulus for inventing new ways to sequence DNA was the drive to sequence the human genome as well as to sequence the genomes of model plants and animals such as *Arabidopsis* and *Drosophila*. Clearly, to sequence the approximately 3.4 billion base pairs in the human genome, faster and cheaper means of DNA sequencing were needed. Rapidly, new methods were developed for handling DNA, obtaining the sequence, and knitting the sequences together in the proper order. Importantly, the magnitude of the Human Genome Sequencing Project also led to the development of large DNA sequencing centers with the capacity for high throughput DNA sequencing and collaborations at a global scale. Once the human genome and the genomes of the first model organisms were completed, these centers were in a position to sequence genomes of agriculturally important microbes and plants. However, such projects were still based on the original chain termination method invented by Frederick Sanger in the 1970s and were major undertakings.

Over the past several years, radically different methods and machines for sequencing DNA have been invented that massively increase the ability to sequence DNA and reduce the costs for DNA sequencing. Collectively, these methods are called Next-Generation (NextGen) or second generation sequencing methods. The affordability of high throughput DNA sequencing is making large scale sequencing projects possible to address incredibly diverse research questions. In the next few years, the third generation of DNA sequencing machines will come on line, which will increase sequencing capacity and speed while reducing costs to the extent that a genome may be sequenced for about $1,000 in 15 minutes!

> The advent of these new technologies promises to have a tremendous impact on all of the biological sciences. They are already changing what we know about how pathogens cause disease and how plants defend themselves against pathogens. These new methodologies are opening up new areas of research and shedding new light on the incredible diversity of microbes and the diversity of microbial activities that influence plant growth and plant health.

At the Biomedical Genetic Center (BMGC) at the University of Minnesota, NextGen sequencing is done using the Illumina GA IIx sequencing instrument. This instrument is capable of producing up to 50 gigabases (50 billion bases) of sequence per day. The sequences are relatively short, on the order of 100 bp, creating new challenges for sequence assembly and limiting some applications such as identification of environmental microbes. The BMGC also makes available Roche-454, or pyrosequencing, which enables longer DNA fragments to be sequenced at a high throughput level. This is useful for sequencing genomes with highly repetitive sequences and for microbial identification projects. The Center retains the capacity to carry out first generation sequencing, which is still needed for obtaining sequence of individual DNA molecules in research labs.

To date, the biological applications of NextGen sequencing have focused primarily on de novo sequencing of genomes, re-sequencing genomes, metagenomics, and sequencing the transcripts of an organism (RNA-seq). De novo sequencing is the sequencing of genomes from organisms that have previously not been sequenced while re-sequencing is the sequencing of new strains of pathogens or new accessions or varieties of plants. Metagenomics is the sequencing of total DNA samples extracted from the environment such as the rhizosphere of plants, which enables identification of organisms that are not culturable on artificial media. RNA-seq is a particularly powerful means of determining which genes are being expressed in an organism without having to develop special tools such as microarrays. The technique also enables researchers to identify all of the transcripts, not all of which may be detected by a microarray, and also detects novel gene expression regulatory mechanisms such as alternative splicing of introns.

The faculty in Plant Pathology have projects that span all of these areas. Several projects are currently involved in sequencing the genomes of plant pathogens:

- Sequencing of strains of *Puccinia graminis* f. sp. *tritici* (wheat stem rust pathogen), including Ug99 and related isolates, is being done in Les Szabo's lab to look at sequence variation within and between strains. They are also using RNA-seq to identify differences in gene expression when the pathogen is interacting with different wheat lines and to identify candidate effector (pathogenicity and avirulence) genes.
- Corby Kistler's lab is re-sequencing of multiple strains of *Fusarium graminearum* (Fusarium head blight; scab) from different populations and with different toxin profiles. They are also creating genome sequence assemblies for strains of *Fusarium oxysporum* with different host specificities and a "non-pathogenic" strain.
- The genomes of *Clavibacter michiganensis* subsp. *insidiosus* (alfalfa bacterial wilt) and *Bipolaris oryzae* (fungal brown spot of wildrice) are being assembled by Debby Samac's lab.

A number of faculty are using NextGen techniques for plant genome sequencing:

- In Nevin Young's lab the population genomics and genome diversity in *Medicago truncatula* (barrel medic) is being investigated in order to create an association mapping platform that can be used to discover candidate loci involved in plant-microbe symbiosis.
- The genomes of wild barley and wild potato accessions are being sequenced by the Steffenson and Bradeen labs, respectively, to identify genes for disease resistance.

Metagenomic studies are on-going to investigate bacterial and fungal populations:

- Kabir Peay is assessing the diversity and dispersal distances of fungal spores.
- Linda Kinkel's lab members are characterizing rhizosphere microbial communities associated with different native prairie plant hosts and how the plant and initial microbial community determines rhizosphere community composition. They are also evaluating rhizosphere community characteristics when host plants are grown in communities that vary in species diversity and characterizing endophyte communities.
- Corby Kistler's lab is carrying out metagenomics of fungi associated with the wheat rhizosphere and corn endophytes.

2010 GRADUATE STUDENT AWARDS

Fred I. Frosheiser Scholarship

Benjamin Held
advisor Bob Blanchette

M.F. Kernkamp Scholarship

Ryan Syverson
advisor Carol Ishimaru

Ward. C. Stienstra and Richard A. Meronuck Graduate Travel Award

None presented

Elwin Stewart Graduate Student Travel Award

Brett Arenz and Benjamin Held
advisor for both is Bob Blanchette

Ben and Brett both used the award to attend the 9th International Mycology Conference in Edinburgh, Scotland where they presented data from their Ph.D. research. Brett presented a poster titled "Soil properties affecting fungi in Antarctic ecosystems" and Ben presented a poster titled "Fungi, fire and ice: extraordinary fungal diversity at Deception Island, Antarctica."

FACULTY UPDATES

Robert Blanchette

Investigations on wood decay fungi have been continuing on a variety of new projects with the assistance of Ben Held and Joel Jurgens. The detrimental effects of these decomposer fungi continue to take a toll and this past year we have worked on wood from several unusual places. Samples from ship timbers of the "Manhattan Ship" found during excavations at Ground Zero in New York were sent for identification and evaluation of the decay present. The decay was caused by bacterial attack and the timbers were all North American tree species with a keel made from hickory providing information on the origin of the vessel. Other projects involved a decay assessment and wood identification of the prehistoric wood in a large multi-room cliff dwelling at Montezuma National Monument in Arizona and work at the Forbidden City in China with the World Monument Fund and the Palace Museum. This project is restoring 27 buildings in the Forbidden City built by the Quinlong Emperor. On the opposite extreme, investigations on the mechanisms of decomposition aimed at accelerating decay are providing new information on how white and brown rot fungi can be used in bioconversion processes to pretreat perennial plant biomass for biofuel production. The release of cellulose from lignified cell walls provides a feedstock for ethanol production. Cooperative projects with Professor Jonathan Schilling have been awarded DOE funding and grants from the University of Minnesota Institute of the Environment also provide funds to carry out these new studies.

Jennifer Juzwik, Northern Research Station, U.S. Forest Service

My research on the etiology of crown decline and mortality of hickory in the North Central and Northeastern states is in its final year. Based on field surveys in six states and follow-up processing of log samples, we have concluded that at least three different diseases have contributed to the widespread problem recently documented by the U.S. Forest Service Forest Health Monitoring Program. Ji-Hyun Park, Ph.D. candidate, investigated the pathogenicity of three putative pathogens commonly isolated from dying bitternut hickory. Furthermore, she determined that Ceratocystis smalleyi is playing an important role in the most common disease observed (characterized by rapid crown decline and tree death). Besides being associated with hundreds of bark cankers on stems of affected trees, the fungus is associated with limited vascular plugging and significantly reduced sap flow rates in affected trees compared to controls. My research has focused on the interaction between the hickory bark beetle and C. smalleyi in this same disease scenario.

During summer 2010, Mr. Paul Castillo, Forester in my lab, and I initiated visual surveys and early detection efforts for Thousand Cankers Disease in several Midwestern States. The work continues in 2011. I am also investigating bark and ambrosia beetles (along with their associated fungi) colonizing stressed black walnut in Indiana, Missouri and Tennessee. New cooperative work with Forest Service colleague Dr. Dan Lindner (Madison, WI) has opened opportunities for development and/or use of molecular detection tools in my classical studies of major hardwood and conifer diseases in the region.

A highlight of the past year was the opportunity to present an oak wilt synthesis paper at the International Union of Forest Research Organizations World Congress in Seoul, South Korea, in August 2010. The trip also allowed for a delightful visit with Prof. Yin Won Lee (Ph.D., Chet Mirocha) at Seoul National University.

Deborah Samac, USDA/ARS

It often comes as a surprise to people to learn that alfalfa is the fourth most widely grown crop in the United States, behind corn, soybean, and wheat, and is grown in all 50 states. It has a direct annual value of over $8 billion and is essential for U.S. milk production, as it is a basic component in feeding programs for dairy cattle. Cultivation of alfalfa has a vital role in promoting soil conservation and enhancing water quality. Alfalfa also has attributes that make it well suited as a bioenergy/bioproduct crop. Decades of recurrent selection has resulted in cultivars with multiple disease resistance that has proven very durable. The durability is due in part to the out-crossing nature of alfalfa that results in natural multi-lines with a proportion of susceptible individuals, so that there is little selection pressure for new virulent races of pathogens. Nonetheless, in the past few years we have identified alfalfa diseases causing major stand and yield losses. Working with Charla Hollingsworth (now with USDA-APHIS), we found that brown root rot was a major contributor to winter kill of alfalfa in Minnesota and Wisconsin. Due to this work, extension educators and crop consultants frequently send alfalfa plants to me for diagnosis. Some interesting trends are emerging. In several locations we found crown rot organisms that had previously been found only sporadically and had been thought to be of minor importance to be widespread and causing major damage. Interestingly, these pathogens have a fairly broad host range, including soybean. Possibly, changing farming methods such as low or minimum tillage and increased cultivation of soybean is increasing the prevalence of these pathogens. Additionally, climate shifts and changes in alfalfa germplasm may also be playing a role. Recently, I diagnosed witches'-broom phytoplasma in alfalfa plants from Lancaster County, Pennsylvania. The disease is possibly affecting hundreds of fields in Pennsylvania, and caused severe plant stunting and debilitation. Such a high incidence of this disease has never been seen previously in the U.S. The alfalfa witches'-broom phytoplasma is the same organism, or very closely related to the aster yellows phytoplasma. It is only found in the phloem of plants and is only transmitted by leafhoppers. The aster leafhopper is rarely found on alfalfa, so the source of the pathogen in the Pennsylvania plants is not clear. We will be further characterizing the pathogen and will be looking into its transmission to try to solve this mystery and provide management options to producers.

2010 AWARD WINNERS

Distinguished Alumnus Award
Robert Noyd

E.C. Stakman Award
Dr. Ravi Prakash Singh

Nevin Young

This past year has been a busy one, full of teaching, traveling, advising, and writing. Interest in PlPa 5301 (Plant Genomics, cross-listed with PBio) remains high, with nearly 20 graduate and undergraduate students for the tenth year in a row. In the class, we use several disease resistance "stories" as models for teaching the rapidly changing field of genomics. There are several computer lab exercises and toward the end of the semester, students work in groups to carry out a data-mining project into gene families of interest. Even with all the teaching, there was time for trips to NSF headquarters in D.C., legume conferences in Asilomar, CA and St. Maxime, France, and workshops at the National Center for Genome Resources in Santa Fe, NM and the Noble Foundation in Ardmore, OK. Graduate students Peng Zhou and Lian Lian (advised by Senyu Chen while working in my lab) are excelling in their projects. Peng is studying the genome architecture of two large defense-related gene families: the NBS-LRRs resistance genes and the defensin-like peptides. Lian is mapping novel forms of soybean cyst nematode resistance using a new and faster type of DNA marker technology known as SNPs (single nucleotide polymorphisms). Finally, the main projects in the lab, sequencing and genome diversity in the model legume, *Medicago truncatula*, are finally leading to important publications. Given that there are approximately 126 co-authors on the *Medicago* genome paper, just keeping track of everyone is a project all by itself.

WELCOME TO OUR NEW HIRES!

Jonathan C. Anderson

Brett Evan Arenz

Yuan Chai

John R. Christensen

Rebecca Danica Curland

Amar Mohamed Elakkad

Laura J. Felice

Gretchen M. Freed

Zane J. Grabau

Matthew William Haas

Wilfried Jonkers

A J Bennett Lange

Nicholas R. LaBlanc

Philip James Manlick

Charles R. Paule

Matthew N. Rouse

THE UNDERGROUND WORLD OF POTATO LATE BLIGHT

by Jim Bradeen, Associate Professor

Anyone who has taken an introductory course in plant pathology learns about the devastating effects of potato late blight disease. And for more than a century, plant pathologists and other scientists have studied interactions between potato and *Phytophthora infestans* (the causal agent of late blight) with the goal of building a better, disease resistant potato. Surprisingly, however, there is still much we don't know about how potato plants mount effective defense responses against *P. infestans*.

Do potato plants use the same disease resistance genes to protect both foliage and tubers? Does P. infestans *use the same strategy to attack potato leaves and tubers? Once a potato plant recognizes that* P. infestans *is present, are the resulting disease response pathways modulated based on where they occur in the plant?*

It turns out, the potato-*P. infestans* pathosystem is a perfect experimental subject to study basic plant-pathogen interactions. *P. infestans* attacks two distinct potato tissues: the foliage and the tuber. A large set of late blight resistant transgenic potato lines are available for study, and the genomes of both potato and *P. infestans* have been sequenced. While it's undeniable that model plant systems such as *Arabidopsis* have taught us a lot about how plants function, research in the potato-*P. infestans* pathosystem can be directly translated into agricultural practice.

Former Plant Pathology Ph.D. student Ben Millett demonstrated that under specific conditions the *RB* gene, which functions to impart late blight resistance in the potato foliage, also functions to impart tuber blight resistance (Figure 1). Transgenic potato lines with very high *RB* transcript levels (meaning the gene is turned "on" to a high degree) in the tuber show improved resistance against *P. infestans* relative to non-transgenic controls. But *RB* transcript levels and susceptibility to tuber blight vary between transgenic lines and with the length of time a tuber is held in cold storage. Tubers that are resistant at harvest show reduced *RB* transcript levels—and increased tuber blight susceptibility after 19 weeks in storage.

Now, using these same transgenic potato lines, Plant Pathology Ph.D. student Liangliang Gao is determining what genes *P. infestans* uses to attack the potato tuber and what genes the potato tuber uses to defend against *P. infestans* attack. Liang's research takes advantage of recent technological advances in RNA sequencing that are revolutionizing molecular plant pathology. Liang challenged a series of transgenic and non-transgenic potato tubers with *P. infestans* and collected tissue samples over a 72-hour period after inoculation. During this time period, we speculated, *P. infestans* genes involved in attacking the tuber and potato genes involved in defending the tuber should be transcribed. RNA was isolated from the infected tissues and sequenced. From 42 samples, Liang has generated nearly 900 million sequence reads. By comparing his sequencing data to potato and *P. infestans* genome sequences, Liang can determine which genes are active at multiple time points, and by comparing data between time points, whether genes are up- or down-regulated. Preliminary analyses suggest that *P. infestans* uses the same set of genes, and thus the same genetic strategy, to attack both potato foliage and tuber. On the plant side, it appears that resistant tubers recognize *P. infestans* faster than do susceptible tubers, resulting in stronger and faster up-regulation of defense responses. Comparisons of defense responses between potato foliage and tubers are pending.

Research findings from our research group are informing scientists in India, Bangladesh, and Indonesia on how best to use *RB* for the control of potato late blight disease. Potato is an important food crop in these countries (India is the world's third largest producer of potato) and conditions are annually conducive for late blight epidemics. Sadly, food insecurity remains an issue for millions in the region. Providing reliable genetic control of potato late blight disease will reduce grower and environmental costs while enhancing the ability of farmers to produce nutritious food at a local level. Through a US-AID funded effort, *RB* is being integrated into a reduced- or no-fungicide disease management system in the region and our research is being translated into field managment practices. We still have a lot to learn about potato-*P. infestans* interactions. But recent scientific breakthroughs are yielding new insights with global impacts.

figure 1

Foliar blight resistance gene RB functions in some lines to enhance tuber blight resistance. Tubers from five transgenic lines of 'Russet Burbank' [untransformed control and four foliar resistant transgenic (+*RB*) lines, designated "SP"] were tested for resistance to tuber blight. Tubers were challenged with water (top row; negative control) or with *P. infestans* US8 (bottom three rows) and incubated under conditions that favor disease development. Untransformed tubers inoculated with *P. infestans* developed tuber blight symptoms (brown, collapsed tissue) regardless of tuber age (1-19 weeks post harvest, as indicated). Transgenic lines SP2105 and SP2182 responded similarly, despite being resistant to foliar late blight. Transgenic lines SP2211 and SP2213, in contrast, are both foliar and tuber blight resistant. However, tuber resistance decreases as tubers age (compare week 19 to week 6). Tuber resistance correlates closely with *RB* transcript levels (not shown).

GRADUATE UPDATES

Brett Arenz

Brett Arenz, under the guidance of advisor Robert Blanchette, completed his Ph.D. degree in July 2010. The title of his thesis was "Fungi in Antarctica: A circumpolar study of biodiversity in soils and historic structures." Arenz is currently a post- doc in the department on a 50% teaching, 50% research appointment. He has taught parts of Principles of Plant Pathology and Microbiology, and is doing research with Linda Kinkel and Jim Bradeen.

John Bienapfl

John Bienapfl, under the guidance of coadvisors Dean Malvick and James Percich, completed his Ph.D. degree in plant pathology at the University of Minnesota in December 2010. The title of his thesis was "Fusarium and Phytophthora species associated with root rot of soybean (Glycine max)." John is now working as a research associate with Yilmaz Balci in the Department of Plant Science and Landscape Architecture, University of Maryland.

Pravin Gautam

Pravin Gautam, under the guidance of advisor Ruth Dill-Macky, completed his Ph.D. degree in June, 2010. His thesis was entitled "Factors affecting Fusarium head blight development and trichothecene accumulation in *Fusarium*-infected wheat heads." Gautam now is a post-doc with Jeff Stein and Bill Berzonsky at South Dakota State University where he is working on winter wheat disease resistance and breeding.

Ann Impullitti

Ann Impullitti completed her Ph. D. degree with the thesis "Colonization of soybean by the pathogen *Phialophora gregata* and endophytes." Dean Malvick was her advisor. She now is now an assistant professor of biology at Augsburg College in Minneapolis, MN.

Tammy Kolander

Tammy Kolander completed her M.S. degree with the thesis "The host range of *Fusarium virguliforme* on rotational crops and common plant species and its survival and growth on crop residues." Tammy was coadvised by James Kurle and Dean Malvick. She is employed as a vegetable pathologist at Seminis/ Monsanto in DeForest, WI.

Paul Meyer

Paul Meyer completed his Ph.D. thesis research on "Interaction of temperature, soil moisture, seed treatment, cultivar, and soybean cyst nematode in root rot of soybean" with Dr. James Kurle as his advisor. Paul has returned to California where he is organizing a start-up enterprise that combines his previous engineering experience with his background in plant pathology and soil science to design low-cost, high-performance soil moisture sensors for use in agricultural research and crop water management.

Greg Reynolds

Gregory Reynolds earned his M.S. degree and his thesis was "Remote sensing for detection of Rhizoctona crown and root rot in sugar beet and the effect of the disease on chlorophyll content." He was coadvised by Carol Windels and Ian MacRae. Reynolds is continuing his graduate studies for a Ph. D. degree in the Plant Pathology Department at the University of California - Davis.

Matthew Rouse

Matthew Rouse completed the requirements for his Ph. D. degree in October 2010 under the guidance of advisor Yue Jin. His thesis was entitled "Studies on wheat resistance to Ug99." Rouse is now employed as a research plant pathologist at the USDA/ARS Cereal Disease Laboratory in St. Paul, MN.

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