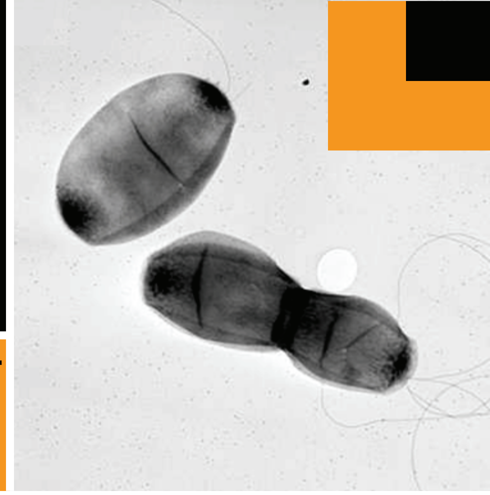
The MicroScope



Department of Microbial Sciences Alumni Newsletter

2007-2008

New Culturing Method Speeds Up Research

Two University of Tennessee scientists discover a way to make quick work of culturing a troublesome cyanobacteria.

Jeff Morris and Erik Zinser

Prochlorococcus (*Pro*) is the smallest marine cyanobacterium on record, measuring only 0.6 micrometers in diameter. Yet what they lack in size, they make up for in numbers: They are the most abundant photosynthetic organisms on Earth. A single drop of sea water can hold up to 10 thousand cells, and they are ubiquitous at the ocean surface between 40 degrees North and South latitude. *Pro* accounts for approximately 20 percent of the oxygen we breathe, and plays a major role in the global carbon cycle. *Pro* thus has a strong influence on the Earth's climate, which makes it an attractive system for research.

Unfortunately, *Pro* isn't very cooperative in laboratory cultures. It grows very slowly, doubling about once every day, and growing pure plate cultures of *Pro* has proved to be more frustrating than successful. If the *Pro* in the culture number fewer than 10 thousand cells per milliliter they die off. That is, unless there are heterotrophic bacteria around.

Assistant Professor Erik Zinser first noticed that Pro would grow on seawater-based agar Petri plates only where there was a contamination of heterotrophic bacteria, suggesting that the heterotrophs were helping *Pro* in some way. Heterotrophic microbial organisms are by definition consumers of organic carbon that originates from primary producers, which fix carbon dioxide into organic

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Message from the Department Head

Dr. Jeffery M. Becker

This represents the first edition of the department's newsletter cleverly called "The MicroScope." Thanks go to Steven Wilhelm, Professor of Microbiology who got the project started and Joel Smithson, an intern from UT's School of Journalism and Electronic Media, who did the majority of writing and all of the formatting. We trust future editions will come out on a regular basis.

Microbiology has a long-standing, strong identity as a distinct scientific discipline supported by extremely robust national and international organizations. Microbiologists have historically contributed to major advances in the biological sciences contributing to humanity's health and welfare. Current scientific developments, such as the rise of multidrug-resistance microbes, the growing awareness of the contributions of microbes to the environment, and the use of microbes in the biofuel industry, indicate that Microbiology is still a leading force and will continue as a major scientific discipline throughout the 21st century.

The Microbiology Department at UT is one of a handful of departments in the U.S. that

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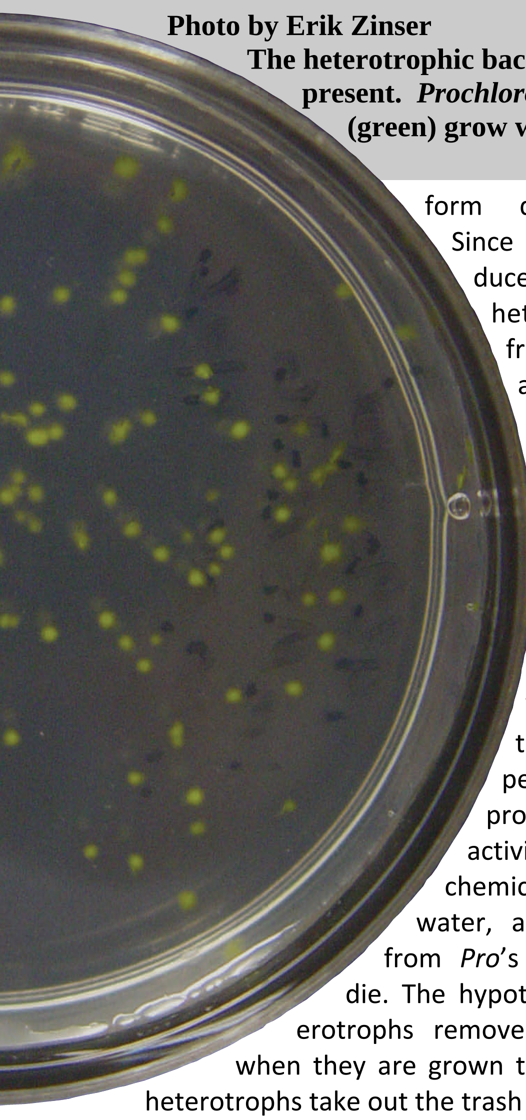


Photo by Erik Zinser

The heterotrophic bacteria are invisible, but present. *Prochlorococcus* colonies (green) grow well in the presence of

form during photosynthesis. Since *Pro* is a primary producer it was likely that the heterotrophs benefited from the presence of *Pro* as a source of food, but how does *Pro* benefit from the presence of the heterotrophic "helper"?

Dr. Zinser theorized that the heterotrophs were protecting *Pro* from oxidative stress. This oxidative stress, in the form of hydrogen peroxide, is a natural by-product of photosynthetic activity and light-driven chemical reactions in the seawater, and if it isn't removed from *Pro*'s environment they will die. The hypothesis was that the heterotrophs remove the peroxide for *Pro* when they are grown together. Essentially, the heterotrophs take out the trash for *Pro.*

This hypothesis makes sense from an ecological and evolutionary point of view. Since the evolutionary origin of *Pro* it has lived in the presence of abundant heterotrophic bacteria. They evolved to live in low-nutrient environments by ridding themselves of as many unnecessary genes as they could in order to conserve resources. Since the heterotrophs were providing ample protection against oxidative stress, *Pro* took advantage and evolved a less adequate ability to protect itself. Each *Pro* cell maintained some ability to remove peroxide, but this ability is effective only when cells are in artificially created high concentrations.

Working with this theory Dr. Zinser and graduate student Jeff Morris discovered a way to generate pure *Pro* cultures by using heterotrophs to sustain them in the early growth stages. This procedure allows scientist to readily obtain pure cultures of this important bacterium, a problem that has impeded studies until now.

In the first stage, heterotrophs are used to grow *Pro* into high concentrations. In the second stage antibiotics are added that specifically target the heterotrophs. Since *Pro* is able to handle oxidative stress on its own in high cell concentrations, all that is left is a culture of healthy, pure *Pro.*

Morris and Dr. Zinser have published their findings in the July issue of the peer-reviewed journal *Applied and Environmental Microbiology*. After such a successful discovery one would imagine a break in the action, but the scientists are determined to take their knowledge onto the seas to take a close look at the real thing.

"We've done it here in the lab and that's what the paper is about," Dr. Zinser said. "Now we're trying to get conducing evidence that heterotrophs are helping *Pro* in the natural environment."

Having readily available plate cultures of such an important family of cyanobacteria will greatly facilitate laboratory studies, allowing scientists to perform more studies quicker on a pure culture. This organism is responsible for 20 percent of the oxygen we breathe, so the sooner we know everything about it the better.

-Joel Smithson-

Head's Message Continued

has strong faculty representing both microbial pathogenesis and microbial ecology. The unique strength of our Microbiology Department has resulted in many strong, funded projects some of which are highlighted in this Newsletter.

It has been an exciting past five years for the Department as we have recruited eight new faculty members with training from institutions such as Harvard, Yale, MIT, UC-San Diego, Washington U., Emory, and St. Jude. These new professors are taking their research and teaching very seriously. We have a primary responsibility for teaching pre-professional students going into medical and environmental fields and many new courses have been developed. We have come a long way in the past five years, and we have a strong vision of our future.

It is a great honor to serve the faculty, students, and alumni as Head of UT's Department of Microbiology. I look forward to working with all of our constituents to make our teaching and research distinguished world-wide.

Mark Sangster and The New York Influenza Center of Excellence

When we are born we receive a cocktail of vaccinations that serve us for life. Yet every year we line up at hospitals and immunization stations to prevent the flu because, year after year, the flu keeps coming back. What quality does the influenza virus have that makes it so successful against vaccination?

Antigenic drift is the process by which the influenza virus is constantly changing and making our immunities obsolete. This series of mutations gradually leads to the evolution of the virus by changing the antigens that the immune system uses to recognize the virus, allowing it to slip past unnoticed.

The desire to create broader vaccinations coupled with the advent of avian influenza, or bird flu, has lead the United States government along with the National Institutes of Health to create six centers of excellence for influenza research. These centers allow the best minds from the fields of immunology, virology, biochemistry, and medicine to collaborate efforts to create a vaccine that can provide protection against the influenza virus regardless of its mutations.

From The University of Tennessee, Immunologist Dr. Mark Sangster is providing the New York Influenza Center of Excellence (NYICE) with expertise on B cell responses to infection.

B cells are white blood cells that fight infections by producing antibodies that bind to and eliminate infectious agents. Some antibodies are produced at mucosal surfaces, such as the lungs, where they provide an important barrier to infection. During infection, B cells are activated when they encounter a viral antigen. They start producing plasma B cells, which secrete antibodies to fight the infection, and memory B cells, which live for a long time. When activated by re-exposure to the specific viral antigen that induced their formation, memory B cells develop into antibody-producing plasma B cells more rapidly than do regular B cells and provide strong resistance to infection.

If the body is infected with the same strain of influenza that stimulated the formation of plasma B cells and memory B cells, then the immune response will be successful in eliminating the virus. However, antigenic drift changes the virus' surface proteins that the memory B cells use for recognition. As a result, the immune system is less effective in fighting the infection. Vaccination with the changed virus is required to provide strong protection.

Dr. Sangster's lab is dedicated to understanding the nature of the B cell response to infection. This information is important in creating a vaccine that would protect against a larger range of influenza viruses rather than just one specific strain. One B cell antibody in particular has Dr. Sangster very interested. Immunoglobulin A (IgA) is the most important antibody that provides protection at mucosal linings. It has a special mechanism that carries it across the mucosal surface and releases it into the open spaces of the lung or nasal passage, where it can combat the influenza virus and other infectious agents.

Recent studies show that IgA provides broader protection against a range of influenza viruses than do other types of antibodies. Its ability to cross mucosal linings and actually enter open airways and its broad protection could be what NYICE is looking for to improve the effectiveness of vaccines. Dr. Sangster feels that a vaccine that produces a large IgA response could provide superior protection against influenza.

Dr. Sangster regularly contributes his findings and advice to NYICE and several times a year makes a trip to the University of Rochester to meet face-to-face with other experts contributing to the cause. He has been researching the influenza virus for over 15 years and remains committed to understanding the immunology of influenza infection and vaccination. After finishing graduate school at the University of Western Australia he held a five year post-doctoral position at St. Jude Children's Research Hospital. Afterwards he stayed at St. Jude and joined the lab of distinguished Immunologist Dr. Peter Doherty, who won the Nobel Prize in Medicine in 1996 for Identifying the mechanism by which immune system T cells recognize other cells as infected and eliminate them. Dr. Sangster said the six years in Dr. Doherty's lab were priceless.

"I really became an immunologist and became interested in B cell responses at St. Jude," he said. "Dr. Doherty is a T cell expert and it was great collaborating with him."

Dr. Sangster joined the University of Tennessee in 2003 and has continued his research on B cell responses to infection in his lab in Walter's Life-Science building. As he continues his work with NYICE his research may one day contribute to a vaccination that makes the flu season a thing of the past.

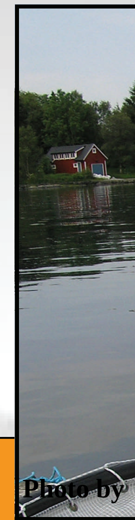
-Joel Smithson-

Spanning the Globe

Photo by Ryan Kimbirauskas

Subin River, Ghana

Curious children watch as Heather Williamson collects a sediment sample. Williamson and the rest of Dr. Pamela Small's lab focus much of their effort on studying *Mycrobacterium ulcerans,* the causative agent of an emerging disease in West Africa, the Buruli Ulcer.



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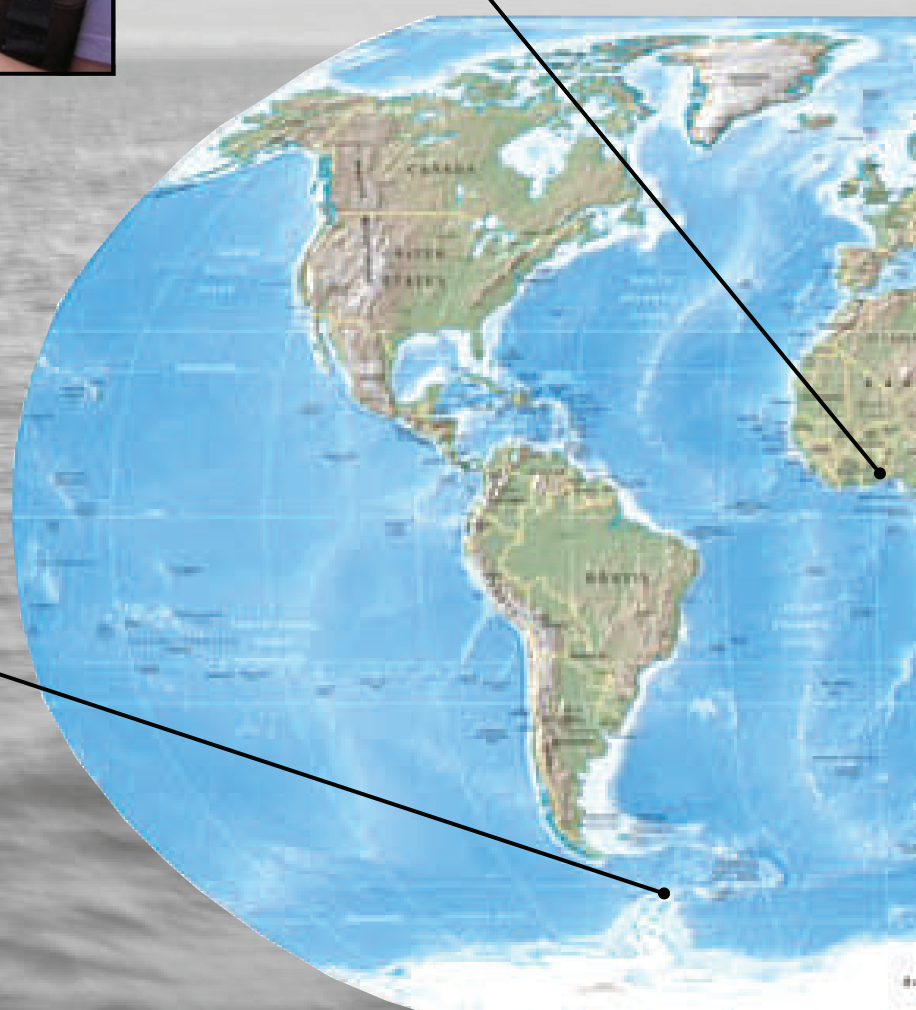


Antartica

Before his post doctoral work at UT, Dr. Gary LeCleir spent six weeks aboard the Antarctic Research and Supply Vessel the Laurence M. Gould. LeCleir was studying the ability of bacteria in Antarctic waters to oxidize ammonia. Ammonia oxidation is the first step in nitrification, which is an important part of the nitrogen cycle in aquatic systems.

Charles Budinoff

way

from Dr. Allison Buchan's lab joined scien-
around the globe to run a series of experi-
trolled algal blooms in these "bags." The
analysis of the impact of viruses on the
Budinoff was focusing his attention on
heterotrophic bacteria that form commen-
with algae. He studied the viruses that

Dacca, Bangladesh

Graduate student Matt Scholz (center, standing) joined researchers from the University of North Carolina and Columbia University to study the geological and microbiological aspects of sub surface aquifers. Along with researchers from the University of Dhaka, the group focused on the effects of arsenic contamination and the transport of pathogens through the aquifers.

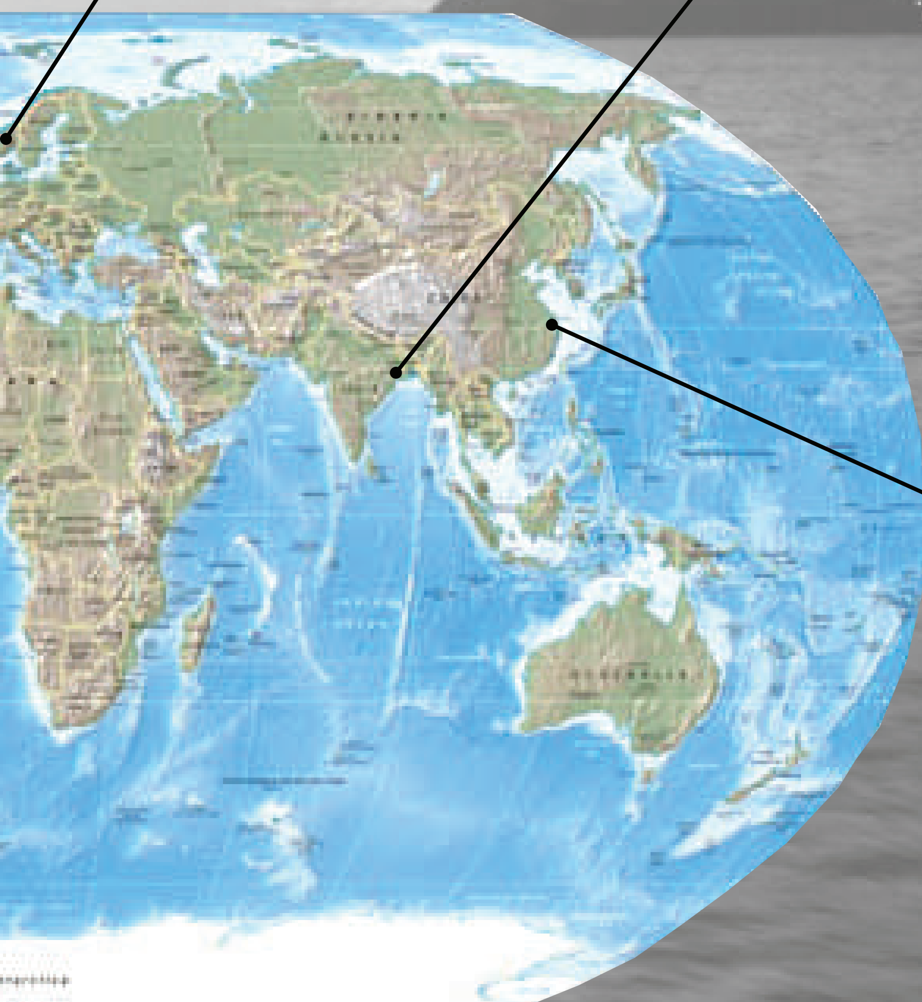


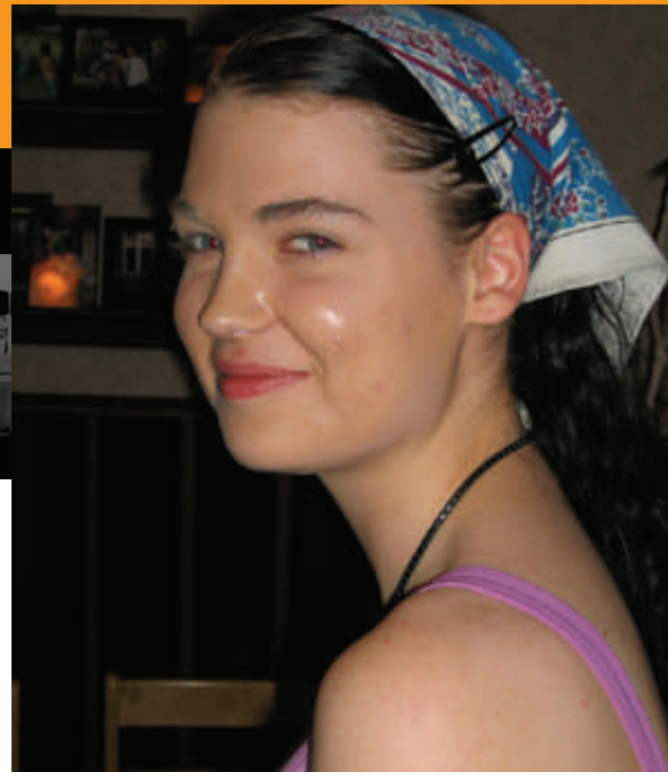
Photo by Dr Qin Boiqiang

Lake Taihu, China

40 million people relied on Lake Taihu for water, fishing or other purposes, but decades of pollution made the water undrinkable, and now there is a destructive algal bloom making things worse. Scientists from UT's Aquatic Microbial Ecology Research Group will head to China to work on the development of controls for toxic *Microcystis* plaguing the lake.

Janet Rowe

From Undergraduate Student to Dr. at UT



In 1999 Janet Rowe walked onto The University of Tennessee's Knoxville campus with a keen interest in microbiology. Just nine years later, Janet is months away from leaving UT with a Ph.D.

During her undergraduate studies Janet's interest grew with every microbiology course she took. She started graduate school in Dr. Steven Wilhelm's lab in 2004 and quickly became well versed in the study of marine viruses and their effect on microbial communities. Over the years she has published several peer reviewed articles and looks forward to defending her thesis this fall. Despite the heavy work load that came with the study of marine viruses, Janet couldn't see herself taking any other path in life. Her fascination with microbial life that began in a high school cell biology class hasn't waned ever since.

"Working in the lab, I realized that this was what I wanted to do," she said. "It's so incredible to me that everything that happens for life to occur can happen in this tiny little space you can't even see with your naked eye."

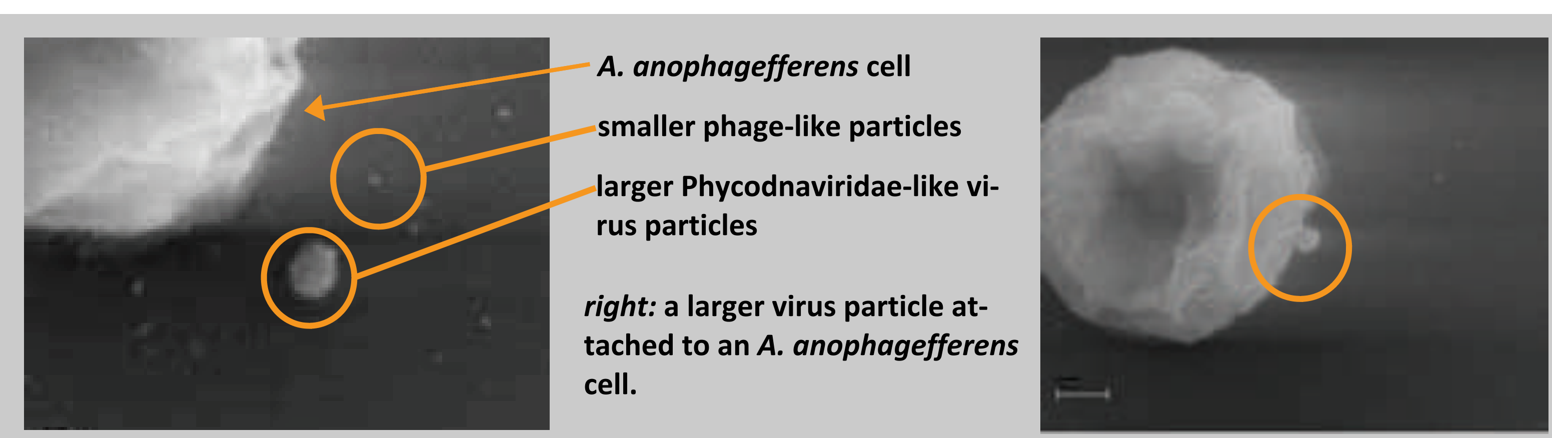
Janet's first big discovery focused her interests on microbial viruses. It started as a lab rotation that is now part of her dissertation and thesis. The alga *Aureococcus anophagefferens* is known for causing 'brown tide' blooms along the Eastern United States coast. These massive blooms wreak havoc on algal grazer populations, such as clams and mussels. In fact, the first 'brown tides' in 1985 damaged the microbial population so severely that a multi-million dollar scallop industry in Long Island collapsed because the scallops' food source was eradicated.

A. anophagefferens was believed to be commonly infected by phage-like virus resembling those that infect bacteria. These phage were identified as being small in size, approximately 50 nanometers in diameter, and having a protruding tail. Janet was confused by this unusual infection because *A. anophagefferens* is a eukaryotic organism, not bacterium. Similar algae are infected by Phycodnaviridae. Phycodnaviridae is a family of viruses that infect marine and freshwater eukaryotic algae. They are much larger than phage viruses, about 100-200 nanometers, and always without a tail.

Janet found this discrepancy unacceptable because *A. anophagefferens* has such a profound impact on its ecosystem that there is no room for ambiguity. Since these viruses have such an influential effect on *A. anophagefferens*, it is important to understand as much about them as possible. She decided to run a series of tests.

After collecting field samples of

"It's so incredible to me that everything that happens for life to occur can happen in this tiny little space you can't even see with your naked eye."



right: a larger virus particle attached to an *A. anophagefferens* cell.

photos taken by Janet Rowe with a scanning electron microscope

A. anophagefferens Janet's colleagues noted that the phage-like viruses were not the only viruses present. There were larger particles that were similar to Phycodnaviridae. Janet observed cultures of *A. anophagefferens* after 30 minutes of exposure to the isolated viruses using a scanning electron microscope (SEM). The SEM works by scanning the culture surface with a beam of electrons that interact with the atoms on the culture, then return information about the physical properties it detected. Janet discovered that 63 percent of the larger viruses appeared attached to *A. anophagefferens* cells while none of the phage-like particles were, contrary to previous reports of phage-like infections.

Janet continued to work with the marine viruses, and in 2005 and 2008 she took her knowledge out of the lab and into the oceans to study virus-host parameters in the Sargasso Sea, the North Atlantic and the Western Pacific. The two expeditions carried her across almost 10,000 miles of water to collect samples of microbial life. The results of her experiments revealed that marine viruses interact with their hosts differently across a multitude of regimes, supporting the argument that the open ocean is full of many microbial ecosystems with unique characteristics. Janet is now working to document these studies, with information from the Sargasso Sea and the North Atlantic as foci for a recently accepted paper.

Due to her professionalism and exceptional research, Janet was award the 2008 Alexander Hollaender Graduate Fellowship in 2007. Dr. Hollaender established the Biology Division of Oak Ridge National Laboratories in 1944. He loved East Tennessee and had a strong desire to support the scholarly achievements of up-and-coming scientists from this region. Janet's research on the open ocean and in the labs expanded the picture of virus effects on photosynthetic organisms and made her a perfect candidate.

Janet has two plans when she earns her Ph.D. The first thing she wants to do is "sleep for about a month." After that, she hopes to earn a faculty position after a post-doctoral research position. The fast-paced academic field has served her well thus far in her career and she wants to return the favor by helping future microbiologists.

Nine years ago Janet Rowe became a student at the University of Tennessee. Soon, she will be leaving as Dr. Janet Rowe. The keen interest in microbiology that she brought here has expanded into a formidable expertise that will serve her, the scientific community, and UT for the rest of her career.

-Joel Smithson-

Awards

From **Dr. Pamela Small's** lab, **Lydia Mosi** has been awarded the 2008 Association for Women in Science Educational Foundation predoctoral award in the amount of $1,000 for her projects: Investigations into the role of the proposed aquatic reservoirs; Naucoridae and Belostomatidae, in the transmission of the Buruli ulcer (Mycobacteriium ulcerans disease). Mosi also received a $250 Wind River travel grant.

From **Dr. Steven Wilhelm's** Lab, **Janet Rowe** has been Awarded the 2008 Alexander Hoellaender Graduate Fellowship Award in the amount of $6,000 for her work on the influences of marine viruses on their microbial hosts and communities

From **Dr. Pamela Small's** lab, **Samantha Wirth**, and from **Dr. Thandi Onami's** lab, **Jenish Patel**, have been awarded the Emerging Infectious Diseases Laboratory Fellowship sponsored by the Association of Public Health Laboratories and Centers for Disease Control.

From **Dr. Todd Reynolds** lab, **Ying-Lien Chen**, and from **Dr. Pamela Small's** Lab, **Heather Williamson**, have been awarded the Science Alliance Award for Outstanding Scholarly Achievement by a Graduate Student.

From **Dr. Chunlei Su**'s lab, **Debashree Majumdar** has been awarded the Graduate Teaching Award for excellence in undergraduate teaching.

Emily Bethea, Jeremy Chandler, Joseph Chen, Li-Yin Huang, Heejung Kim, Jeff Morris, Lydia Mosi, Jenish Patel, Matt Scholz, George Umanah, and **Samantha Wirth** all received the David White Travel Award in the amount of $1,000 for their research.

From **Dr. Thandi Onami's** lab, **Junwei Zeng** received a $1000 travel award from the Society for Glycobiology to travel to the annual meeting in Boston, Mass.

From **Dr. Todd Reynold's** lab, **Joseph Chen** was chosen to present his abstract as a platform talk at the 9th ASM Conference on *Candida candidiasis*. He received an received an award for outstanding presentation in a platform talk which included a free subscription to Eukaryotic Cell and a $500 travel award.

From **Dr. Todd Reynold's** lab, **Emily Bethea** received an award for outstanding oral presentation at the 15th annual Southeast Regional Yeast Meeting in Gatlinburg, Tenn.

From **Dr. Jeffery Becker's** lab, **George Umanah** received a $1,000 travel award from the Keystone Foundation to attend a meeting in Ireland in May on GPCRs.

From **Dr. Mark Sangster's** lab, **Aarthi Sundararajan** and **Lifang Huan** received scholarships to attend the "Immunobiology and Pathogenesis of Influenza Infection" meeting in Atlanta, Ga. in June 2008.

From **Dr. Pamela Small's** lab, **Heather Williamson** received a Burroughs Welcome Travel Award to attend the NIH Ecology of Infectious Disease Meeting in Albuquerque, N.M. in December 2007.

From **Dr. Erik Zinser's** lab, **Jeff Morris** received the award fpr best presentation at the annual Southeastern Phycological Colloquy in October 2007 at Dauphin Island Sea Labs near Mobile, Ala.

Department of Microbiology Publications

2007-2008

The ultimate judge of an academic department's research production is both the quality of the students that are produced and the academic products (scientific publications) from that group. The Department of Microbiology has a rich history of the highest level of academic productivity. Since the beginning of 2007 the faculty and their students have maintained this productivity as is illustrated by their publications in peer-reviewed literature.

Abd-El-Haleem D, Ripp S, Zaki S, **Sayler GS** (2007) Detection of nitrate/nitrite bioavailability in wastewater using a luxCDABE-based *Klebsiella oxytoca* bioluminescent bioreporter. Journal of Microbiology and Biotechnology, 17(8):1254-126

Alexander RP, **Zhulin IB** (2007) Evolutionary genomics reveals conserved structural determinants of signalling and adaptation in microbial chemoreceptors. Proceedings of the National Academy of Sciences of the USA, 104:2885-2890

Alexandre G (2008) A sense of self-worth: energy taxis provides insight into how *Helicobacter pylori* navigates through its environment. Journal of Bacteriolology, 190:3095-3097

Anderson I, Rodriguez J, Susanti D, Porat I, Reich C, Ulrich LE, Elkins J, Mavromatis K, Lykidis A, Kim E, Thompson LS, Nolan M, Land M, A Copeland, Lapidus A, Lucas S, Detter C, Richardson P, **Zhulin IB**, Whitman W, Mukhopadhyav B, Woese C, Kyrpides N (2008) Genome sequence of the Crenarchaeal hyperthermophile *Thermofilum pendens* reveals an unprecedented loss of biosynthetic pathways in a free-living organism. Journal of Bacteriology, 190:2957-2965

Balambika R, Inui T, Sargsyan H, Arshava B, Cohen LS, Ding FX, **Becker JM**, Naider F (2007) Synthesis of a double transmembrane domain fragment of Ste2p by native chemical ligation. International Journal of Peptide Research and Therapeutics, 13:251-263

Belas R, **Zhulin IB**, Yang Z (2008) Bacterial sensing and motility: sure bets. Journal of Bacteriology, 190:1849-1856

Benbow ME, Williamson HR, Kimbirauskus RK, McIntosh MD, Kolar R, Quaye C, Boakye D, **Small PLC**, Merritt RW (2008) A large-scale field study on aquatic invertebrates associated with Buruli ulcer disease: are biting water bugs likely vectors? Emerg Infect Dis 2008, in press

Borziak K, **Zhulin IB** (2007) FIST: a sensory domain for diverse signal transduction pathways in prokaryotes and ubiquitin signalling in eukaryotes. Bioinformatics, 23:2518-2521

Brigati JR, Ripp SA, Johnson CM, Iakova PA, Jegier P, **Sayler GS** (2007) Bacteriophage-based bioluminescent bioreporter for the detection of *Escherichia coli* O157:H7. Journal of Food Protection, 70(6):1386-1392

Brussaard CPD, **Wilhelm SW**, Thingstad F, Weinbauer MG, Bratbak G, Heldal M, Kimmance SE, Middelboe M, Nagasaki K, Paul JH, Schroeder DC, Suttle CA, Vaqué D, Womack KE (2008) Global scale processes with a nanoscale drive: The role of marine viruses. The ISME Journal, 2:575-578

Cai HJ, Hauser M, Naider F, **Becker JM** (2007) Differential regulation and substrate preferences in two peptide transporters of *Saccharomyces cerevisiae*. Eukaryotic Cell, 6:1805-1813

Chen YL, Kauffman S, **Reynolds TB** (2008) *Candida albicans* uses multiple mechanisms to acquire the essential metabolite inositol during infection. Infect Immun, 76:2793-801

Cohen LS, Arshava B, Estephan R, Englander J, Kim H, Hauser M, **Becker JM**, Naider F (2007) Expression of double transmembrane domain GPCR fragments for biophysical analysis. Biopolymers, 88:564-564

Cohen LS, Arshava B, Estephan R, Englander J, Kim H, Hauser M, Zerbe O, Ceruso M, **Becker JM**, Naider F (2008) Expression and biophysical analysis of two double-transmembrane domain-containing fragments from a yeast G protein-coupled receptor. Biopolymers, 90:117-130

de la Cruz AA, Rublee P, Hungerford JM, Zimba PV, **Wilhelm SW**, Meriluoto JAO, Echols K, Meyer MT, Stelma G, Mandeville R, Lawton L, Sivonen K, Furey A (2008) Analytical methods work group report. In HK Hudnell (ed). Proceedings of the Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms. Advances in Experimental Medicine and Biology, 475-488

Dean AL, Higgins JL, DeBruyn JM, Rinta-Kanto JM, Bourbonniere RA, **Wilhelm SW** (2008) Viral populations in Lake Erie: abundance, production and predicted impacts, p. 247-270. In M. Munawar and R. T. Heath [eds.], Checking the Pulse of Lake Erie. Aquatic Ecosystem Health Management Society / Ecovision World Monographs

DeBruyn JM, Chewning CS, **Sayler GS** (2007) Comparative Quantitative Prevalence of Mycobacteria and Functionally Abundant nidA, nahAc, and nagAc Dioxygenase Genes in Coal Tar Contaminated Sediments. Environmental Science & Technology, 41(15):5426-5432

Doblin MA, Coyne KJ, Rinta-Kanto JM, **Wilhelm SW**, Dobbs FC (2007) Dynamics and survival of HABs in ballast residuals. Harmful Algae, 64:519-530

Dubey JP, Velmurugan GV, Ulrich V, Gill J, Carstensen M, Sundar N, Kwok OCH, Thulliez P, Majumdar D, **Su C** (2008) Transplacental toxoplasmosis in naturally-infected white-tailed deer: Isolation and genetic characterisation of *Toxoplasma gondii* from foetuses of different gestational ages. International Journal for Parasitology, 38:1057-1063

Dubey JP, Sundar N, Gennari SM, Minervino AH, Farias NA, Ruas JL, Dos Santos TR, Cavalcante GT, Kwok OCH, **Su C** (2007) Biologic and genetic comparison of *Toxoplasma gondii* isolates in free-range chickens from the northern Para state and the southern state Rio Grande do Sul, Brazil revealed highly diverse and distinct parasite populations. Veterinary Parasitology, 143:182-188

Dubey JP, Sundar N, Hill D, Velmurugan GV, Bandini LA, Kwok OHC, Majumdar D, **Su C** (2008) High prevalence and abundant atypical genotypes of *Toxoplasma gondii* isolated from lambs destined for human consumption in the USA. International Journal for Parasitology, 38:999-1006

Eldridge ML, Cadotte MW, Rozmus AE, **Wilhelm SW** (2007) The response of bacterial functional groups to changes in available iron in the Eastern subtropical Pacific Ocean. The Journal of Experimental Marine Biology and Ecology, 348:11-22

Eldridge ML, Sanseverino J, Layton AC, Easter JP, Schultz TW, **Sayler GS** (2007) *Saccharomyces cerevisiae* /BLYAS: a new bioluminescent bioreporter for the detection of androgenic compounds. Applied and Environmental Microbiology, 73(19):6012-6018

En J, Goto M, Nakanaga K, Higashi M, Ishii N, Saito H, Yonezawa S, Hamada H, **Small PLC** (2008) Mycolactone is responsible for the painlessness of *Mycobacterium ulcerans* infection (buruli ulcer) in a murine study. Infect Immun, 76(5):2002-7

Frazier AD, Rowe JM, Rentz CA, Gobler CJ, **Wilhelm SW** (2007) Isolation and characterization of bacterial pathogens of *Aureococcus anophagefferens* CCMP 1784. Journal of Phycology, 43 (3):461-465

Fux B, Nawas J, Khan A, Gill DB, **Su C**, Sibley LD (2007) *Toxoplasma gondii* strains defective in oral transmission are also defective in developmental stage differentiation. Infection and Immunity, 75:2580-2590

Gentry RW, Layton AC, McKay LD, McCarthy JF, Williams DE, Koirala SR, **Sayler GS** (2007) Efficacy of bacteroides measurements for reducing the statistical uncertainty associated with hydrologic flow and fecal loads in a mixed use watershed. Journal of Environmental Quality, 36(5):1324-1330

Gobler CJ , Anderson OR, Gastrich MD, **Wilhelm SW** (2007) The ecology of viruses infecting the harmful brown tide alga, *Aureococcus anophagefferens*. Aquatic Microbial Ecology, 47:25-36

Gobler CJ, Davis TW, Deonarine SN, Saxton MA, Lavrentyev PJ, Jochem FJ, **Wilhelm SW** (2008) Zooplankton and viral induced mortality of microbial populations before and during the onset of hypoxia in Lake Erie. Aquatic Microbial Ecology, 51:117-128

Godfrey D, Williamson H, Silverman J, **Small PLC** (2007) Newly identified Mycobacterium species in a *Xenopus laevis* colony. Comparative Medicine, 57(1):97-104

Hauser M, Kauffman S, Lee BK, Naider F, **Becker JM** (2007) The first extracellular loop of the *Saccharomyces cerevisiae* G protein-coupled receptor Ste2p undergoes a conformational change upon ligand binding. Journal of Biological Chemistry, 282:10387-10397

Hawkins SA, Robinson KG, Layton AC, **Sayler GS** (2008) Response of nitrobacter spp. ribosomal gene and transcript abundance following nitrite starvation and exposure to Mechanistically Distinct Inhibitors. Environmental Science & Technology, p 92

Henry TB, Menn F, Fleming JT, Wilgus J, Compton RN, **Sayler GS** (2007) Attributing effects of aqueous C_{60} nano-aggregates to tetrahydrofuran decomposition products in larval zebrafish by Assessment of Gene Expression. Environmental Health Perspectives, 115(7):1059-1065

Heo J, Petheram S, Demmler G, Murph JR, Adler S, Bale J, **Sparer TE** (2008) Polymorphisms within cytomegalovirus chemokine (UL146/UL147) and cytokine receptor (UL144) genes lack correlation with CMV sequelae in congenitally infected children. Virology, 378: 86-96

Hu W, Sillaots S, Lemieux S, Davison J, Kauffman S, Breton A, Linteau A, Xin C, Bowman J, **Becker JM**, Jiang B, Roemer T (2007) Essential gene identification and drug target prioritization in *Aspergillus fumigatus*. PLoS Pathology 3:e24

Islam SK, Vijayaraghavan R, Zhang M, Ripp S, Caylor SD, Weathers B, Moser S, Terry S, Blalock BJ, **Sayler GS** (2007) Integrated circuit biosensors using living whole-cell bioreporters. IEEE Transactions on Circuits and Systems, 54(1):89-98

Ivanikova NV, Matteson AR, Gobler CJ, Popels LC, McKay RML, **Wilhelm SW**, Bullerjahn GS (2008) Picoplanktonic cyanobacteria in Lakes Superior and Erie: phylogenies of endemic populations and cultured isolates. Verhandlungen Internationale Vereinigung für theoretische und angewandte Limnologie, 30:459-465

Jiang B, Xu D, Allocco J, Parish C, Davison J, Veillette K, Sillaots S, Hu W, Rodriguez-Suarez R, Trosok S, Zhang L, Li Y, Rahkhoodaee F, Ransom T, Martel N, Wang H, Gauvin D, Wiltsie J, Wisniewski D, Salowe S, Kahn JN, Hsu MJ, Giacobbe R, Abruzzo G, Flattery A, Gill C, Youngman P, Wilson K, Bills G, Platas G, Pelaez F, Diez MT, Kauffman S, **Becker JM**, Harris G, Liberator P, Roemer T (2008) PAP inhibitor with in vivo efficacy identified by *Candida albicans* genetic profiling of natural products. Chemical Biology, 15:363-374

Joo HM, He Y, **Sangster MY** (2008) Broad dispersion and lung localization of virus-specific memory B cells induced by influenza pneumonia. Proceedings of the National Academy of Sciences USA, 105: 3485-3490

Khan A, Fux B, **Su C**, Dubey JP, Darde ML, Ajioka JW, Rosenthal BM, Sibley LD (2007) Recent transcontinental sweep of *Toxoplasma gondii* driven by a single monomorphic chromosome. Proceedings of the National Academy of Sciences USA, 104:14872-14877

Kenst A, Perfect E, **Wilhelm SW**, Zhuang J, McCathy J, McKay L (2008) Virus transport during infiltration of a wetting front into initially unsaturated sand columns. Environmental Science and Technology, 42:1102-1108

LeCleir GR, **Buchan A**, Maurer J, Moran MA, Hollibaugh JT (2007) Comparison of chitinolytic enzymes from an alkaline, hypersaline lake and an estuary. Environmental Microbiology, 9:197-205

Lee BK, Jung KS, Son C, Kini H, VerBerknioes NC, Arshava B, Naider F, **Becker JM** (2007) Affinity purification and characterization of a G-protein coupled receptor, *Saccharomyces cerevisiae* Ste2p. Protein Expression and Purification, 56:62-71

Li R, **Wilhelm SW**, Carmichael WW, Watanabe MM (2008) Polyphasic characterization of water bloom forming *Raphidiopsis* species (cyanobacteria) from central China. Harmful Algae, 146-153

Mann DGJ, McKnight TE, Melechko AV, Simpson ML, **Sayler GS** (2007) Quantitative analysis of EDC-condensed DNA on vertically aligned carbon nanofiber gene delivery arrays. Biotechnology and Bioengineering, 97(4):680-688

Mann DGJ, McKnight TE, McPherson JT, Hoyt PR, Melechko AV, Simpson ML, **Sayler GS** (2008) Inducible RNA interference-mediated gene silencing using nanostructured gene delivery arrays. American Chemical Society Nano, 2(1):69–76

Moran MA, Belas R, Schell MA, Gonzaléz JM, Sun F, Sun S, Binder BJ, Edmonds J, Ye W, Orcutt B, Howard EC, Meile C, Palefsky W, Goesmann A, Ren Q, Paulsen I, Ulrich LE, Thompson LS, Saunders E, **Buchan A** (2007) Ecological genomics of marine Roseobacters. Applied and Environmental Microbiology, 73:4559-4569

Miller-Kittrell, Jiqing MS, Penfold M, Richmond A, **Sparer TE** (2007) Functional characterization of chimpanzee cytomegalovirus chemokine, vCXCL-1CCMV. Virology, 1:364(2):454-65

Miller LD, Yost CK, Hynes F, **Alexandre G** (2007) The major chemotaxis gene cluster of *Rhizobium leguminosarum* bv. viciae is essential for competitive nodulation. Molecular Microbiology, 63:348-36

Mioni CE, Pakulski JD, Poorvin L, Baldwin A, Twiss MR, Jeffrey WH, **Wilhelm SW** (2007) Assessment of bacterial and community Fe status in the eastern subtropical Pacific Ocean. Aquatic Microbial Ecology, 46:239-251

Naider F, **Becker JM**, Lee YH, Horovitz A (2007) Double-mutant cycle scanning of the interaction of a peptide ligand and its G protein-coupled receptor. Biochemistry, 46:3476-3481

Naider F, Neumoin A, Arshava B, Cohen L, **Becker JM**, Zerbe O (2007) Structural studies on large fragments of G protein coupled receptors. Biopolymers, 88:581-581

Oguz MT, Robinson KG, Layton AC, **Sayler GS** (2007) Concurrent nitrite oxidation and aerobic denitrification in activated sludge exposed to volatile fatty acids. Biotechnology and Bioengineering, 97(6): 1562-1572

Ornston, Nicholas L, Schlimpert S, **Buchan A**, Parke D (2008) *Acinetobacter baylyigenetics*. In: Acinetobacter: Molecular Biology. Gerischer U (ed). Norfolk, UK: Caister Academic Press, pp 141-

162

Pakulski JD, Baldwin A, Dean AL, Durkin S, Karentz D, Kelley CA, Scott K, Spero HJ, **Wilhelm SW**, Amin R, Jeffrey WH (2007) Responses of heterotrophic bacteria to solar irradiance in the eastern Pacific Ocean. Aquatic Microbial Ecology, 47:153-162

Pena HFJ, Gennari SM, Dubey JP, **Su C** (2008) Population structure and mouse-virulence of *Toxoplasma gondii* in Brazil. International Journal for Parasitology, 38:561-569

Portaels F, Meyers WM, Ablordey A, Castro AG, Chemlal K, de Rijk P, Elsen P, Fissette K, Fraga AG, Lee R, Mahrous E, **Small PLC**, Stragier P, Torrado E, Van Aerde A, Silva MT, Pedrosa J (2008) First cultivation and characterization of *Mycobacterium ulcerans* from the environment. PLoS Negl Tropical Disease, 2:e178

Poretsky RS, Bano N, **Buchan A**, Hollibaugh JT, Moran MA (2008) Environmental Transcriptomics: A method to access expressed genes in complex microbial communities. In: Molecular Microbial Ecology Manual, 2nd edition. Kowalchuk GA, de Bruijn FJ, Head IM, Akkermans ADL, van Elsas JD (eds). Kluwer Academic Publishers, pp 1892-1904

Reynolds TB, Jansen A, Peng X, Fink GR. 2008. Mat formation in *Saccharomyces cerevisiae* requires nutrient and pH gradients. Eukaryot Cell, 7(1):122-30

Ripp S, Jegier P, Johnson C, Moser S, Islam S, **Sayler GS** (2008) Bioluminescent bioreporter assays for targeted detection of chemical and biological agents. In: Optics and Photonics in Global Homeland Security IV. Halvorson CS, Lehrfeld D, Saito TT (ed.). vol. 6945, Proceedings of SPIE

Ripp S, Jegier P, Johnson CM, Brigati J, Sayler GS (2008) Bacteriophage-amplified bioluminescent sensing of Escherichia coli O157:H7. Analytical and Bioanalytical Chemistry, 391:507-514

Rodriguez-Suarez R, Xu D, Veillette K, Davison J, Sillaots S, Kauffman S, Hu W, Bowman J, Martel N, Trosok S, Wang H, Zhang L, Huang LY, Li Y, Rahkhoodaee F, Ransom T, Gauvin D, Douglas C, Youngman P, **Becker JM**, Jiang B, Roemer T (2007) Mechanism-of-action determination of GMP synthase inhibitors and target validation in *Candida albicans* and *Aspergillus fumigatus*. Chemical Biology, 14:1163-1175

Rowe JM, Dunlap JR, Gobler CJ, Anderson OR, Gastrich MD, **Wilhelm SW** (2008) Isolation of a non-phage-like lytic virus infecting *Aureococcus anophagefferens*. Journal of Phycology, 44:71-76

Rowe JM, Saxton MA, Cottrell MT, DeBruyn JM, Berg GM, Kirchman DL, Hutchins DA, **Wilhelm SW** (2008) Constraints on virus production in the Sargasso Sea and North Atlantic. Aquatic Microbial Ecology,

Small PLC, Stinear T (2007) The mycolactones: biologically active macrolides produced by *Mycobacterium ulcerans* and related aquatic mycobacteria. In: The Mycobacterial Cell Envelope: An Overview. Daffé M, Reyrat JM (eds) ASM

Small PLC, van der Goot G (2007) Editorial Overview: Current Opinions in Microbioloy, Regulation of virulence. 10:1-3

Stinear TP, Seemann T, Harrison PF, Jenkin GA, Davies JK, Johnson PD, Abdellah Z, Arrowsmith C, Chillingworth T, Churcher C, Clarke K, Cronin A, Davis P, Goodhead I, Holroyd N, Jagels K, Lord A, Moule S, Mungall K, Norbertczak H, Quail MA, Rabbinowitsch E, Walker D, White B, Whitehead S, **Small PLC**, Brosch R, Ramakrishnan L, Fischbach MA, Parkhill J, Cole ST (2008) Insights from the complete genome sequence of *Mycobacterium marinum* on the evolution of *Mycobacterium tuberculosis*. Genome Res, May 18(5):729-41

Suvas PK, Dech HM, Sambira F, Zeng J, **Onami TM** (2007) Systemic and mucosal infection program protective memory CD8 T cells in the vaginal mucosa. Journal of Immunology 179: 8122-8127

Stinear TP, Seemann T, Pidot S, Frigui W, Reysset G, Garnier T, Meurice G, Simon D, Bouchier C, Ma L, Tichit M, Porter JL, Ryan J, Johnson PD, Davies JK, Jenkin GA, **Small PLC**, Jones LM, Tekaia F, Laval F, Daffé M, Parkhill J, Cole ST (2007) Reductive evolution and niche adaptation inferred from the genome of *Mycobacterium ulcerans*, the causative agent of Buruli ulcer. Genome Research, 17:192-200

Torrado E, Adusumilli S, Fraga AG, **Small PLC**, Castro AG, Pedrosa J (2007) Mycolactone-mediated inhibition of tumor necrosis factor production by macrophages infected with *Mycobacterium ulcerans* has implications for the control of infection. Infection and Immunity, 75:3979-88

Trogl J, Kuncova G, Kubicova L, Parik P, Halova J, Demnerova K, Ripp S, **Sayler GS** (2007) Response of the bioluminescent bioreporter *Pseudomonas fluorescens* HK44 to analogs of naphthalene and salicylic acid. Folia Microbiologica (Prague, Czech Republic), 52(1):3-14

Ulrich LE, **Zhulin IB** (2007) MiST: a Microbial Signal Transduction database. Nucleic Acids Research, 35:D386-D390

Umanah G, Huang LY, Schultz PG, Naider F, **Becker JM** (2007) Incorporation of the unnatural amino acid p-benzoyl-L-phenylalanine (Bpa) into a G protein-coupled receptor in its native context. Biopolymers, 88:522-522

Vanitha DJ, Joo HM, Rouse BT, **Sangster MY** (2007) Quantitative analysis of herpes simplex virus type 1-specific memory B cells generated by different routes of infection. Virology, 360:136-142.

Vijayaraghavan R, Islam SK, Zhang M, Ripp S, Caylor S, Bull ND, Moser S, Terry SC, Blalock BJ, **Sayler GS** (2007) A bioreporter bioluminescent integrated circuit for very low-level chemical sensing in both gas and liquid environments. Sensors and Actuators B,123:922–928

Vulava VM, McKay LD, Driese SG, Menn F, **Sayler GS** (2007) Distribution and transport of coal tar-derived PAHs in fine-grained residuum. Chemosphere Environmental Chemistry, Volume 68, Issue 3, pp 554–563

Wagner T, Benbow M, Burns M, Johnson R, Merritt R, Qi J, **Small PLC** (2008) A Landscape-based model for predicting *Mycobacterium ulcerans* infection (Buruli Ulcer Disease) presence in Benin, West Africa. EcoHealth, Volume 5, Number 1, pp. 69-79

Weiner RM, Taylor II LE, Henrissat B, Hauser L, Land M, Coutinho PM, Rancurel C, Saunders EH, Longmire AG, Zhang H, Bayer EA, Gilbert HJ, Larimer F, **Zhulin IB**, Lamed R, Richardson PM, Borovok I, Hutcheson S (2008) Complete genome sequence of the complex carbohydrate-degrading marine bacterium *Saccharophagus degradans* strain 2-40. PLoS Genet 4(5): e1000087. doi:10.1371/journal.pgen.1000087

Wilhelm SW (2008) Field methods in the study of toxic cyanobacterial blooms: results and insights from Lake Erie research. In: Proceedings of the Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms. Hudnell HK (ed). Advances in Experimental Medicine and Biology, pp 507-519

Wilhelm SW and Matteson AR (2008) Freshwater and marine virioplankton: a brief overview of commonalities and differences. Freshwater Biology, 53:1076 - 1089

Williamson HR, Benbow ME, Nguyen KD, Beachboard DC, Kimbirauskas RK, McIntosh MD, Quaye C, Ampadu EO, Boakye D, Merritt RW, **Small PLC** (2008) Distribution of *Mycobacterium ulcerans* in Buruli Ulcer endemic and non-endemic aquatic sites in Ghana. PLoS Negl Tropical Disease 2:e20

Wuichet K, Alexander RP, **Zhulin IB** (2007) Comparative genomic and protein sequence analyses of a complex system controlling bacterial chemotaxis. Methods in Enzymology, 422: 3-31

THE UNIVERSITY of TENNESSEE UT

Department of Microbiology
M409 Walters Life Sciences
Knoxville, Tennessee
37996-0845