



# THE BUZZ



UC RIVERSIDE - DEPARTMENT OF ENTOMOLOGY  
NEWSLETTER

Spring 2001

## WATER RECLAMATION, WETLANDS AND MOSQUITOES

By Bill Walton

The population of the Southwest is projected to rise 40% over the next 25 years and conservation measures will play an important role in meeting the water needs of the burgeoning human population while minimizing human impact on the environment. An issue related to conservation of water is the development of cost-effective methods for cleaning reclaimed water. Constructed treatment wetland technology offers water reclamation agencies and both large- and small-scale agricultural operations a cost-effective means to reduce nutrient concentrations and other pollutants in municipal and agricultural effluent. The number of water reclamation facilities has been predicted to double over the next decade as communities and agro-businesses strive to meet more stringent discharge requirements by 2016.

In addition to water reclamation, man-made wetlands can be designed for multiple uses. Multipurpose constructed treatment wetlands can provide wildlife habitat, recreation such as birding and hiking, and a venue for public education on issues related to water and wildlife conservation. Because California has lost more than 90% of its wetlands during the last 200 years, man-made wetlands provide one approach to mitigate the losses caused by human land use. Yet, despite the potential benefits of multipurpose constructed treatment wetlands, they can have a serious drawback: the production of pathogen-vectoring and pestiferous mosquitoes.

One of the areas of focus for my research group includes the ecology and control of mosquitoes inhabiting multipurpose constructed wetlands and created wetlands. To date, much of our research has focused on the dispersal and bionomics of adult mosquitoes associated with treatment wetlands, quantification of the interannual and spatial patterns of occurrence of mosquitoes, ovipositional studies, quantification of larval mosquito behavior, assessment of biological control agents for mosquitoes in wetlands, and the relationship between mosquito abundance and both design features and operational procedures of constructed treatment wetlands.

The high levels of mosquito production from man-made wetlands using emergent vegetation as part of the water treatment process and receiving effluent containing high levels of ammonium nitrogen was illustrated by our studies during the first three years of operation (1995-1997) of a 10 hectare wetland in San Jacinto, CA. As vegetation rapidly colonized shallow regions of the wetland (~80% of the water surface) and nitrogen loading was > 6 kg per hectare per day, the abundance of mosquitoes actively seeking blood during the summer increased about 10-fold per year to nearly 40,000 mosquitoes per trap per night in summer 1997.

What do 40,000 mosquitoes in the collection bag of a carbon dioxide-baited suction trap look like? Imagine a mass of mosquitoes the size of a softball weighing approximately 25 grams. Talk about *the buzz!*

The wetland underwent renovations during 1998 to improve water quality performance and reduce mosquito production. We are currently three years after the renovation and data to date indicate that the changes in wetland design and operations have successfully achieved an increase in nitrogen removal efficiency and a reduction in mosquito abundance. In addition to all of the hard work by folks associated with my laboratory, I have been fortunate to collaborate on this project with scientists from the United States Geological Survey and the University of Colorado, and to receive the continued cooperation and support from personnel of the Eastern Municipal Water District.

Several students have carried out projects on topics related to our work at this wetland. **George Peck** (Ph.D. candidate) is investigating the relative importance of top-down vs. bottom-up effects on the food web of this hypereutrophic ecosystem. George is also interested in the ecological stoichiometry of carbon and nutrients in the mosquitoes associated with this wetland and other environments in southern California. **Karrie Chan** (B.S. candidate in

Biochemistry) studied the effects of the gradient in water quality in the San Jacinto wetland on the life history parameters of the western encephalitis mosquito, *Culex tarsalis*. **Yvonne Offill** (M.S. 1998) compared the efficacy of mosquito control provided a native larvivorous fish to the mosquitofish. **Parker Workman**



*Color infrared aerial photographs illustrating the proliferation of emergent vegetation (California and hardstem bulrush) at the San Jacinto wetland between May 1995 (left panel) and May 1996 (right panel). Open water is light or dark blue. Emergent vegetation is red. The teardrop shaped objects are nesting islands for birds. Photos are courtesy of the USGS.*

(M.S. 1998) examined the larval behavior and the spatial/temporal variation of adult production of four conspecific *Culex* inhabiting the San Jacinto wetland.

The Prado Wetland near Corona, CA is about 10 times larger than the San Jacinto site and receives water differing appreciably in chemical composition from that entering the San Jacinto wetland. Nitrate is the predominant form of nitrogen in Santa Ana River water that flows through the Prado Basin. The wetland is operated by the Orange County Water District to lower nitrate concentration in the river water. We have been collaborating with the water district and the local vector control district, Northwest Mosquito and Vector Control District.

Our studies at the Prado Wetland have focused on describing the trends for mosquito populations inhabiting a wetland receiving comparatively high quality wastewater, experiments comparing the effects of water quality on mosquito production, and evaluating the effects of vegetation management practices on mosquito production in replicated wetland mesocosms. **Dr. Joe Keiper** (a post-doctoral scientist who is now a curator at the Cleveland Museum of Natural History) carried out studies of the spatial and temporal variation in mosquito production from the large wetland and the effects of wastewater nitrogen composition on mosquito abundance. While at UCR, Joe also continued his studies of the biology and taxonomy of higher Diptera and hydroptilid caddisflies.

**Josh Jiannino** (M.S. candidate) began working in my laboratory while pursuing his B.S. degree at UCR and, for his thesis research, studied the effects of three vegetation planting designs on water quality and mosquitoes inhabiting the Prado constructed wetland. **Michelle Sanford** (M.S. candidate) also joined the laboratory while pursuing her B.S. Michelle is currently examining the effect of ammonium nitrogen loading on mosquito production and aquatic insect communities.

In addition to wetlands built primarily for water quality improvement, we have studied the impact of wetland restoration on mosquito and pathogen activity. **Dave Heft** (M.S. candidate) studied the seasonal and interannual dynamics of the mosquito communities and arboviruses during a wetlands restoration and development project in western Los Angeles County that will place high density human residential areas adjacent to several hundred acres of wetlands. A significant human health concern is posed by the potential transmission of arboviruses by

mosquitoes from wetland birds, which serve as reservoirs of encephalitis viruses, to peridomestic species (e.g., house finches and house sparrows), which are among the best hosts for virus amplification, and then ultimately to humans.

Another major research emphasis in my laboratory is the evolution of resistance to bacterial larvicides, the ecological consequences of evolved resistance, and resistance management. Bacterial larvicides are perhaps the most promising method of mosquito control currently available, particularly in treatment wetlands. *Bacillus* toxins are mosquito-specific, do not persist in environmentally significant quantities, and are cost-effective to produce. Much of the work in my laboratory stems from the interests of **Dr. Margaret Wirth** in the evolution of resistance in mosquitoes to bacterial toxins. These studies provide a fruitful collaboration between us and Brian Federici's laboratory.

Our work on mosquito-specific bacteria is directly relevant to control of wetland mosquitoes because *Bacillus thuringiensis* subsp. *israelensis* (*Bti*) is ineffective against mosquitoes inhabiting the organically enriched waters of treatment wetlands; therefore, *Bacillus sphaericus* currently offers the only viable alternative for microbial control of mosquitoes in treatment wetlands. Unlike *Bti* which contains multiple toxins that limit the potential for the rapid evolution of resistance in mosquitoes, the two toxin precursors in *B. sphaericus* act as a single toxin following ingestion and partial digestion by mosquito larvae and mosquitoes can evolve resistance to *B. sphaericus* very rapidly.

Constructed wetland technology will play an increasing role in water reclamation efforts in California and throughout the world. The comparatively lower capital investment for construction and lower annual operating costs of constructed treatment wetlands make them a favorable alternative to conventional wastewater treatment. The added benefits of wildlife and wetland habitat conservation increases the attractiveness of the approach. We need to understand the design features and operational procedures that contribute to mosquito production so that we can design mosquitoes out of constructed wetlands to the greatest extent possible. We also need to develop resistance management strategies to preserve the effectiveness of environmentally friendly approaches to mosquito control. UCR Entomology will continue to fulfill an important role in these efforts.

## HONORS AND AWARDS

**Teun Dekker** received a \$2,000 scholarship from Phi Beta Kappa. The Phi Beta Kappa competition is among southern California universities. **Venessa Higbee** received a \$2,000 scholarship from Pi Chi Omega, fraternity for the structural pest control industry, to conduct research on native and invasive ant species in Urban environments. **Nichole Fernandes** received a President's Undergraduate Fellowship for 2001-2002

to study "Biotic factors influencing feeding and foraging behavior of Argentine ants." **Tim Paine** received the 2001 American Nursery and Landscape Association's Norman Jay Colman Award for research. This award is granted annually to the person judged to have made noteworthy nursery research contributions. **Robert T. Staten**, former graduate student at UCR Entomology won the Secretary's Honor Award, the highest

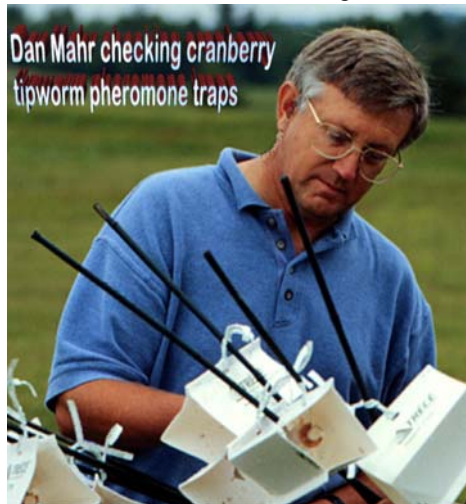
award conferred by USDA. Dr. Staten is Center Director of the Methods Development laboratory at USDA-APHIS in Phoenix, AZ. The award was presented by Secretary Venneman in Washington, D.C. the first week in June 2001. Staten was cited for his contributions to plant protection and quarantine for 30 years. Congratulations to **Jocelyn Millar** and **Dorothy Hartley** who honored each other in marriage on May 12, 2001.

## ALUMNUS FEATURE

**Dr. Daniel L. Mahr** is Professor and Extension Specialist at the Department of Entomology, University of Wisconsin - Madison.

Dan is a 5<sup>th</sup> generation southern California native, having grown up near San Diego, and spending time on various family farms in northern San Diego County. He received his B.S. in Zoology from San Diego State College in 1970, and his M. Sc. in biology at California State University, San Diego (same institution) in 1973. He started working in the area of insect pathology with Dr. Irv Hall in 1973. However, most of Hall's work at that time was in the area of mosquito pathology, and Dan's interest was definitely in agriculture. Therefore, in 1974, Dan began work in Dr. Jim McMurtry's lab, where his research focused on the taxonomy and biology of a group of phytoseiid mites that are common spider mite predators in a diversity of crops. Dan's funding ended before his research did, so he took a Lecturer position in the Department of Zoology at San Diego State University (yes, the third name for the same campus) in 1977. He completed his Ph.D. in 1978. He continued on the faculty at San Diego State through 1979, where he was a full time instructor, teaching courses in General Entomology, Biological Control, Economic Entomology, Immature Insects, Insect Ecology, Arachnology, and Nematology. He also had three graduate students during this period; a fourth, John Sanderson (now at Cornell) was encouraged to transfer to UCR when Mahr departed San Diego State.

Dan desired to get more deeply involved in agricultural pest management, so he accepted a position as Assistant Professor and Extension Entomologist at the University of Wisconsin in 1980. Dan had heard many stories about Wisconsin from Earl Oatman, Dick Goeden, and Fred Legner, who had all spent time at UW, but he wasn't prepared for the frigid weather when he interviewed during winter. Dan was initially hired to conduct pest management research and extension programs on all horticultural crops except vegetables. Within a few years, the position was split, and Dan's commodity responsibilities have since been exclusively in fruit crops, primarily cranberry and apple. At the same time as the split, Dan also assumed responsibility for teaching Biological Control and also became one of the first extension entomologists in the country with an official responsibility to develop extension programs focusing on biological control. Because of this somewhat unique role, Dan has been successful in attracting significant grants to develop biological control educational materials and programs. A series of North Central Regional in-depth extension pest management bulletins focuses on biological control in commodities such as cole crops and greenhouse crops. In collaboration with colleagues throughout the North Central Region, *Midwest Biological Control News* was established as the first such multi-state extension newsletter, with a primary audience of county



extension agents. Recently, the now-quarterly newsletter is of national scope, and is entirely web based

:<http://www.entomology.wisc.edu/mbcn/mbcn.html>.

Contributions are welcome. Although Dan is Project Director for Biological Control News, the hard work is done by the editor, who is his wife, Dr. Susan Rice Mahr, whose primary responsibility is Coordinator of Wisconsin's statewide Master Gardener Program.

Because of Dan's activities in developing extension biological control programs, he has been asked to serve in various advisory capacities in Washington, D.C. He was one of the initial members of the Advisory Panel for the National Biological Control Institute, he was a member of the National Academy of Sciences committee on ecologically based pest management, and he currently serves as a Land Grant University representative to the Biological Control Coordinating Committee. Dan is also currently in the first year of his term as president of the Nearctic Regional

Section of the International Organization for Biological Control. He follows Larry Charlet, another UCR grad, in this position.

As an applied entomologist dealing with fruit crops, Dan conducts research and extension programs on all aspects of pest management, but concentrates efforts on helping growers successfully reduce reliance on broad spectrum insecticides. In the mid 1980s he coordinated a 4-year pilot IPM program for the Wisconsin cranberry industry. As a result, today over 80% of the acreage is scouted weekly by corporate or private pest consultants and pesticide use has been reduced by 40%. Dan also works closely with the apple industry and for 15 years has conducted, with colleagues, an IPM workshop. Registration is restricted to small groups for closer interaction with the educators. Insecticide use on apple has decreased nearly 50% as growers have switched from preventive spray programs to pest monitoring. In 1999, Dan was presented the Distinguished Service Award by the Wisconsin Apple Growers Association.

One of Dan's recent research projects has been on pheromone-mediated mating disruption of two tortricid pests of cranberry. The work has been done in collaboration with Drs. Sheila Fitzpatrick (Ag and Ag-Food Canada), Tom Baker (Iowa State University, formerly at UCR), and Sridhar Polavarapu (Rutgers University). Recently, mating disruption products have been commercialized and are now being used by the cranberry industry. Another project has been on-going studies of the chemical ecology of cranberry tipworm (*Cecidomyiidae*).

Away from work, one of Dan's interests involves growing and studying desert plants, particularly succulents. He is on the Board of Directors of the Cactus and Succulent Society of America and chairs its Research Committee. He and Susan enjoy traveling, particularly to see the world's deserts. Their favorite trip so far was to northern Namibia, where they saw the famed Namib Desert elephant in its native habitat, as well as the primitive desert conifer *Welwitschia*. Dan tries to stay in shape

by playing racquetball and softball, but admits that it is a losing battle. Dan and Susan have two Maine coon cats, Toby and

Tyler. They live on their 2-acre "botanic garden" in semi-rural Dane County. Dan can be contacted at [dmahr@entomology.wisc.edu](mailto:dmahr@entomology.wisc.edu).

## TIM'S FAN CLUB

On Saturday June 9, his 50<sup>th</sup> birthday weekend, Department Chair Tim Paine was completely overwhelmed by the huge turnout of his adoring fans, during a morning run along the Gage Canal and Victoria Ave.

Although the existence of a devoted following- if not an actual Fan Club – has long been known, modesty prevented Tim from acknowledging it. Originally started by a select group of runners, walkers and enthusiastic admirers, the Fan Club seems to have spawned an undercurrent of support that grows weekly – as witness the events of June 9.

Those of us lucky enough to be present with Tim on these Fan Club encounters can't help but be heartened and inspired. We have come to the conclusion that it's good to be king.



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## ENTOMOLOGY UNDERGRADUATE STUDENT NEWS

By Tom Perring, Advisor

The Department of Entomology has experienced a growth in the number of students in the undergraduate program over the past several years; in the academic year 2000-2001, there



were 13 students in the program. These students were **Steve Barbosa, Nicole Fernandes, Rosalyn Goh, Vanessa Higbee, Lila Higgins, Deane Huffman, Ryan McCoy, Justin Nay, Candice Stafford, Jeanne Stoddard, Alex Van Dam, Matthew Van Dam, and Heather Yaffee**. The students recently participated, along with Drs. Paine and Perring, in the 2<sup>nd</sup> Annual Undergraduate Social, where there was plenty of food and drink to go along with various swimming pool games.

At the June Commencement, 3 students graduated with the Bachelor of Science Degree in Entomology. Vanessa Higbee, a Dean's Honor Roll Student, has been accepted into the Entomology graduate program here at UCR. She intends to take a quarter or two off to become a mom (dad George Peck, one of our graduate students, also may need some time off!).

Lila Higgins, also a Dean's Honor Roll student, will be heading to Pennsylvania with her significant other, where the two would like to work as ceramic artists. It will be interesting to see how she "sculpts" her entomological background into her pottery work. Heather Yaffee, our third graduate, is on her way to the University of Arizona, where she has been accepted into the College of Education. She will earn her teaching credential in science education. This will fulfill Heather's dream of teaching high school biology.

One aspect on which the Department prides itself is the ability of our undergraduate students to work in various labs in the department. All of our students participate in this activity. Steve Barbosa, Lila Higgins, and Heather Yaffee worked with Dr. Paine, Nicole Fernandes worked with Drs. Miller and Rust, Vanessa Higbee worked with Dr. Rust, Rosalyn Goh, Ryan McCoy, and Jeanne Stoddard worked with Dr. Redak, Deane Huffman worked with Dr. Millar, Justin Nay worked with Dr. Perring, and Alex and Matthew Van Dam worked in the Entomology Museum. Our newest undergraduate, Candice Stafford intends to begin working in the Department in early August. These positions provide an invaluable opportunity for the students to have a "hands-on" research experience.

Recently the Department learned that senior student, Nicole Fernandes, was selected as a scholarship recipient of two significant college awards. She will receive \$1,000 from the Myron Winslow Scholarship, which is awarded to students who have careers planned in veterinary medicine an agricultural profession. She also will receive \$2,000 from the Dana King Scholarship, which is awarded to students for undergraduate research related to the agricultural sciences. Nicole submitted a proposal to conduct research



Nicole Fernandes

under the direction of Drs. Mike Rust and Greg Walker on the foraging and feeding behavior of Argentine ant workers. The goal is to use the results of her studies to develop more effective baits for ant control.