UNDERGRADUATE RESEARCH Highlights

Recent Peer-Reviewed Publications by CUR Members with Undergraduate Coauthors

Bultman TL, Leuchtmann A, Sullivan TJ, Dreyer A. Do Botanophila flies provide reproductive isolation between two species of Epichloë fungi? A field test. New Phytologist 2011;190:206-212. (Hope College and ETH-Zurich)

Botanophila flies visit fruiting structures of Epichloë fungi for egg laying. Flies transfer fungal gametes among stromata and thereby serve to cross fertilize fungi. We investigated if the flies play a role in the reproductive isolation of two Epichloë species at a field site in southwestern Switzerland. Most ascospores collected from both fungal species indicated intraspecific mating, yet 9.3% of fungal fruiting bodies contained spores of hybrid origin, suggesting post-zygotic isolating mechanisms are an important means of reproductive isolation. We also found preferences by Botanophila flies for particular fungal species that should influence reproductive isolation between the fungi. Tom Bultman, professor of biology and T.J. Sullivan, postdoctoral associate are members of the Biology Department at Hope College; Adrian Leuchtmann is a faculty member of the Institute of Integrative Biology at ETH in Zurich, Switzerland. Austin Dreyer conducted the work in Switzerland as a senior biology major. He is currently in a Ph.D. program in biology at Michigan State University. The research was supported by NSF-CRUI (DBI-03300840) award to Tom Bultman.

Weinman JJ, Lidaka A, Aggarwal S. "Large-scale machine learning". In, GPU Computing Gems Emerald Edition, edited by Wen-mei W. Hwu, 277-291. Burlington, MA: Morgan Kauffman, 2011. (Grinnell College)

The chapter presents a parallel implementation of an algorithm that learns to do pattern recognition. By porting the algorithm to graphics processing units, we accelerated runtime for the learning process over two-hundred fold. While the authors used the work to improve character recognition, this publication and free distribution of the software will enable other scientists and practitioners to apply the work to their own pattern recognition problems. Jerod Weinman is an assistant professor of computer science. Augustus Lidaka is a 2010 graduate of Grinnell College and is currently employed by Microsoft. Shitanshu Aggarwal will graduate from Grinnell College in 2011 and begin work at Amazon. They undertook this work as a summer project in 2009. Augustus Lidaka and Shitanshu Aggarwal were supported by Grinnell College and the Howard Hughes Medical Institute. Experimental results were also made possible in part by a hardware grant from the NVIDIA Corporation.

Furniss S, Grover N. Thermodynamic examination of the pyrophosphate sensor helix in the thiamine pyrophosphate riboswitch. RNA. 2011;17:4:710-717. (Colorado College)

This study examined the effect of RNA sequence and structure on its stability. We were specifically examining the pyrophosphate binding domain of the TPP riboswitch. The sequence in the bulge region was varied to examine the changes in RNA stability in 1 M KCl and in the presence of magnesium ions. Neena Grover is an associate professor and the chair of the Colorado College Department of Chemistry and Biochemistry. Stephanie Furniss worked in the laboratory starting in her second year and did research during the school year, summers, and after she graduated. This work was supported by a National Science Foundation grant to Neena Grover. Venture grants and divisional funding were also provided to Stephanie Furniss and Neena Grover by Colorado College.

Anderson PJ, Beckwith M. Form-focused teaching and the intermediate Latin student. Teaching Classical Languages 2010;2:1. (Grand Valley State University)

The present study examined and offered practical applications for classroom use based on form-focused Second Language Acquisition theories connected with visual highlighting (and other enhanced input) and indirect corrective feedback with recasting. The application of these theories offer a set of intriguing possibilities for the intermediate Latin classroom, where the conflict between the demands of reading and interpreting complex texts and the constraints of students' cognitive resources becomes most apparent. Peter Anderson is an associate professor of Classics. Mark Beckwith is a graduating senior, with a double major in English and Latin, with degree emphases in secondary education. The article arose out of his Honors Senior Thesis. Mr. Beckwith is finishing his field placements this year, and will be taking up his first teaching position in Latin in the Fall of 2011. The research was a 3 credit hour Honors senior project conducted as an unremunerated course overload.

Jackson M, Milne JA, Zink LR. Measurement of Optically Pumped CH318OH Laser Frequencies Between 3 and 9 THz. IEEE J. Quantum Electron. 2011;47:3:386-389. (Central Washington University)

This investigation examined whether the O-18 isotopic form of methanol could serve as an effective source of laser emissions in the short wavelength portion (below 150 micron) of the far-infrared region. During the course of this study, four laser emissions were discovered and the frequencies of twelve laser lines were measured with fractional uncertainties up to a few parts in ten million. This work includes the discovery and frequency measurement of the first 9 THz laser emission generated by this laser medium, tripling the frequency range previously available from optically pumped O-18 methanol. Michael Jackson

is a professor of physics and department chairperson at Central Washington University while Lyndon Zink is a faculty member in the Physics Department at the University of Wisconsin-La Crosse. Jason Milne is a senior majoring in physics and mathematics. He participated in the summer through a paid research experience and in the academic year for research credit. Jason is in the process of applying to graduate programs. The research was supported by the National Science Foundation (award no. 0910935) and the Washington Space Grant Consortium.

Thompson RC, Herscovitch M, Zhao I, Ford TJ, Gilmore TD. NF-kappaB down-regulates expression of the B-lymphoma marker CD10 through a miR-155/PU.1 pathway. J Biol Chem. 2011;286:1675-1681. (Boston University)

Using molecular and cellular approaches, this paper describes for the first time a molecular pathway by which expression of CD10 is regulated in certain B-lymphoma cells. Namely, it shows that transcription factor NF-kB activates expression of micro-RNA miR-155, which then downregulates expression of transcription factor PU.1 and consequently its target gene CD10. Dr Thomas D Gilmore is a professor of biology and is Director of the Undergraduate Research Opportunities Program (UROP) at Boston University. Tyler Ford took part in this research during his junior and senior years (2009-2010). This research was also part of his work for Distinction in Biochemistry & Molecular Biology. Tyler is currently in a PhD program in biomedicine at Harvard University. This research was supported by an NIH grant (to Thomas Gilmore), and Tyler Ford was supported by the Beckman Scholars Program awarded to Boston University.

Johnson AR, Vitha MF. Chromatography selectivity triangles - a review. J. Chromatogr. A. 2011;1218:4:556-586. (Drake University)

The first chromatographic selectivity triangle was proposed by Brown and applied to GC stationary phases. Snyder then developed the influential solvent selectivity triangle (SST) based on the gas-liquid partition data of Rohrschneider. The SST was combined with simplex experimental designs to optimize RPLC separations. Subsequent criticisms of the work revolved around the inaccurate predictions that resulted from the SST. This article reviews the successes and criticisms of the SST as applied to RPLC and NPLC. We also explore more recent applications of triangle selectivity schemes based on linear solvation energy relationships (LSERs) in micellar electrokinetic capillary chromatography (MEKC) and on the hydrophobic subtraction model (HSM) applied to RPLC columns. Mark F. Vitha is an assistant professor of chemistry. Andrew Johnson is a senior chemistry major. He has been accepted to several graduate programs for the coming year. His work on this project was started in 2009 as part of our summer undergraduate research program. Support for Andrew Johnson was provided by the Drake Undergraduate Science Collaborative Institute (DU-SCI). Support for Mark Vitha was provided in part by the ACS-PRF.

Krentz BD, Mulheron HJ, Semrau JD, DiSpirito AA, Bandow NL, Haft DH, Vuilleumier S, Murrell JC, McEllistrem MT, Hartsel SC, Gallagher WH. A comparison of methanobactins from methylosinus trichosporium ob3b and methylocystis strain sb2 predicts methanobactins are synthesized from diverse peptide precursors modified to create a common core for binding and reducing copper ions. Biochemistry 2010;49:47:10117–10130. (University of Wisconsin-Eau Claire, Iowa State University, University of Michigan, J. Craig Venter Universite Strasbourg Warwick)

Methanobactins (mb) are low-molecular mass, copper-binding molecules secreted by most methanotrophic bacteria. These molecules have been identified for a number of methanotrophs, but only the one produced by Methylosinus trichosporium OB3b (mb-OB3b) has to date been chemically characterized. Here we report the chemical characterization and copper binding properties of a second methanobactin, which is produced by Methylocystis strain SB2 (mb-SB2). Marcus McEllistrem, Scott Hartsel, and Warren Gallagher are professors of chemistry. Benjamin Krentz is a senior biochemistry/molecular biology major and participated in the research as part of an ongoing faculty/student mentoring project. Heidi Mulheron is a student at UW-Manitowoc who participated in the research as part of a National Science Foundation funded Research Experiences for Undergraduates program. The research was supported by NSF (CHE 0850701, CHE-10112271), Research Corp. (7638), Department of Energy (DE-FC26-05NT42431, DE-AC02-05CH11231), NIH (1R01HG004881), and UW-Eau Claire Office of Research and Sponsored Programs.

Laughlin DC, Leppert JJ, Moore MM, Sieg CH. A multi-trait test of the Leaf-Height-Seed plant strategy scheme with 133 species from a pine forest flora. Funct Ecol. 2010;24:493-501. (Northern Arizona University)

This study examined 10 functional traits on 133 plant species in a ponderosa pine forest in northern Arizona to evaluate how well Westoby's (1998) Leaf-Height-Seed (LHS) plant ecology strategy scheme accounts for the variation in above and belowground traits. The LHS scheme was well supported in this multi-trait analysis. The three most important functional traits (specific leaf area, seed mass, and height) were composed of multiple correlated traits, but these traits loaded on separate axes. The LHS scheme also accounts for belowground plant function since root traits were correlated with aboveground traits. Daniel C. Laughlin is an assistant research professor and Margaret M. Moore is a professor in the School of Forestry. Jessica Leppert was a chemistry major and an undergraduate research assistant with the Ecological Restoration Institute, where she conducted her senior thesis project. She is currently employed. Jessica received a Northern Arizona University Hooper Sustainability Award to support a portion of this research.

North MA, Bhattacharyya S, Truhlar DG. Improved density functional description of the electrochemistry and structure–property descriptors of substituted flavins. J. Phys. Chem. B. 2010;114:46:14907-14915. (University of Wisconsin-Eau Claire)

The energetics of electrochemical changes have been investigated for several substituted flavins with the M06-L density functional. The reduction potentials for one- and two-electron reductions of these molecules have been determined and the results are consistent with experimental findings with a mean unsigned error of only 42 mV. It is especially noteworthy that the M06-L density functional makes a significant difference in the computed free energy of the first reduction of lumiflavin, which produces a neutral semiquinone. We also investigate the effects of flavin ring substituents on the geometries, charge distributions, reduction potentials, pKa's, ionization potentials, electron affinities, hardnesses, softnesses, electrophilic powers, and nucleophilicities. Dr. Sudeep Bhattacharyya is an instructor and researcher in chemistry. Michael North is a chemistry major. This work was partially supported by a TeraGrid Grant (TG-DMR090140), the National Science Foundation (CHE09-56776), and University of Wisconsin-Eau Claire Office of Research and Sponsored Programs.

Morada M, Manzur M, Lam B, Tan C, Tachezy J, Rappelli P, Dessi D, Fiori PL, Yarlett N. Arginine metabolism in Trichomonas vaginalis infected with Mycoplasma hominis. Microbiol. 2010;156:3734-3743. (Pace University New York Campus)

This study examined the effect of the intracellular parasite, Mycoplasma hominis on arginine metabolism by Trichomonas vaginalis. We have previously demonstrated that M. hominis forms a stable intracellular relationship with T. vaginalis. As both organisms are capable of metabolizing arginine to produce energy in the form of ATP we were interested in the potential energy benefit to T. vaginalis from this symbiotic relationship with M. hominis. The results indicate that ornithine which is a product of arginine metabolism by M. hominis accumulates and can provide an additional source of ATP for T. vaginalis. The potential of this model for the study of 'the symbiotic theory' for organelle acquisition is discussed. Mary Morada is a research associate at Haskins Laboratories and Nigel Yarlett is professor and chair of Chemistry and Physical Sciences. Cho Tan, senior forensic science/chemistry joint major (2009) and Brian Lam senior biochemistry major (2010) participated in this work as a summer research project. Cho is currently in the doctoral program at CUNY graduate school, NY. Brian is currently applying to graduate programs and is working at the Haskins Laboratories of Pace University. The research was supported by a grant from the NIH-NIAID to Nigel Yarlett.

De Haan DO, Hawkins LN, Kononenko JA, Turley JJ, Corrigan AL, Tolbert MA, Jimenez JL. Formation of nitrogen-containing oligomers by methylglyoxal and amines in simulated evaporating cloud droplets. Environ. Sci. Technol. 2011;45:3:984-991. (University of San Diego)

The aerosol-forming reactions of methylglyoxal and amines were examined by scanning mobility particle sizing, NMR, electrospray ionization mass spectrometry, and aerosol mass spectrometry. Under slightly acidic cloudwater-like conditions, the formation of imines occurs in seconds in drying aerosol droplets, followed by derivatized imidazoles and brown nitrogen-containing oligomer compounds on a timescale of minutes to hours. These reactions may explain the polymerized, brown material commonly observed in atmospheric aerosol particles. David De Haan is an associate professor of chemistry at USD. Margaret Tolbert and Jose Jimenez are professors in the Departments of Chemistry and CIRES fellows at CU Boulder. Lelia Hawkins is a postdoctoral fellow about to begin a faculty position at Harvey Mudd College. Julia Kononenko and Jake Turley are scheduled to graduate in 2011, and participated in summer research as rising seniors. Ashley Corrigan participated in summer research beginning after her freshman year, and is now studying aerosol chemistry in the graduate program at Scripps Institute of Oceanography. This research was supported by an NSF RUI award.

Byron C, Kunz H, Matuszek H, Lewis S, VanValkinburgh D. Rudimentary pedal grasping in mice and implications for terminal branch arboreal quadrupedalism. J Morph. 2011;272:230-240. (Mercer University)

The present study examined skeletal morphology of mice trained for living and climbing among thin branches that simulate a terminal branch arboreal niche. Climb-trained mice exhibited significant morphological differences compared to controls specifically within hindlimb regions of the proximal thigh, ankle, and tail. Notably, climbing mice learned to be agile among branches by coordinating tail use with pedal grasping. The morphological changes from these anatomical regions suggest that phenotypic plasticity within the mouse body is sufficient for a non-specialist climber to acclimate to this novel ecological niche. These findings suggest that the pedal grasp traditionally associated with early events in primate evolution are not necessarily restricted to this clade and could have been a component of the Euarchontogliran bauplan. This work was carried out in the Department of Biology, College of Liberal Arts, Mercer University. Hawley Kunz was a senior and participated as a summer researcher in the Mercer MUBS program. Hawley is currently in a biomedical science PhD program in Houston, TX. Heather Matuszek was a senior when this work was carried out. Heather is currently applying to health science professional schools.Stephanie Lewis was a senior when this work was carried out. Stephanie is currently in her second year at Mercer University School of Medicine.Daniel VanValkinburgh was a

sophomore when this work was carried out. He is currently preparing for his senior year where he will explore medical school and/or PhD training opportunities. Funding for this work was attained from the Mercer University Biomedical Scholars Research Program and from the Department of Biology.

Glazier DS, Deptola TJ. The amphipod Gammarus minus has larger eyes in freshwater springs with numerous fish predators. Invert Biol. 2011;130:1:60-67. (Juniata College)

For the first time we report that intraspecific variation in eye size may be associated with the presence of visual predators, with individuals having larger eyes occurring in habitats with more predators. Our observations are based on allometric comparisons of eye size among five populations of the amphipod crustacean Gammarus minus that inhabit freshwater springs with and without fish predators. Douglas Glazier is a professor of biology. Travis Deptola, a biology/geology major, undertook this work during 2007 as a von Liebig Summer Research Fellow. Travis is currently a graduate student in the Geosciences Department at the Pennsylvania State University. This research was supported by von Liebig (Juniata College) summer fellowships awarded to both authors.

Herrington DG, Yezierski EJ, Luxford KM, Luxford CJ. Target inquiry:changing chemistry high school teachers' classroom practices and knowledge and beliefs about inquiry instruction. Chem. Educ. Res. & Pract. 2011;12. http://pubs.rsc.org/en/journals/journalissues/rp#!issueid=rp012001&type=current&issnprint=1756-1108. (Grand Valley State University)

This study examined changes in high school chemistry teachers' teaching practices and knowledge and beliefs about inquiry instruction as they progressed through a 2 ½ year, inquiry-focused professional development program called Target Inquiry (TI). Classroom observational data collected using the Reformed Teaching Observation Protocol indicated that as teachers progressed through the TI program, their practices became more aligned with inquiry-based strategies. Teacher interviews using the Inquiry Teaching Beliefs instrument supported these findings and indicated that at the beginning of the TI program most teachers had a theoretical view of what an inquiry-based class should look like but by the end of the program, teachers' descriptions of what an inquiry-based class should look like was largely based on their personal classroom. Deborah Herrington and Ellen Yezierski are the TI co-directors and associate professors of chemistry (Yezierski is now at Miami University). Karen and Cynthia Luxford were both science education majors who began working as research assistants on the TI project as a sophomore and junior respectively, and continued to work on the project through their senior years. Karen is currently employed as a high school biology teacher in Michigan and Cynthia is in a doctoral program in chemical education at Miami University. This project was funded by the National Science Foundation ESI-0553215.