Station News

The Connecticut Agricultural Experiment Station
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The mission of The Connecticut Agricultural Experiment Station is to develop, advance, and disseminate scientific knowledge, improve agricultural productivity and environmental quality, protect plants, and enhance human health and well-being through research for the benefit of Connecticut residents and the nation. Seeking solutions across a variety of disciplines for the benefit of urban, suburban, and rural communities, Station scientists remain committed to "Putting Science to Work for Society", a

CAES

The Connecticut Agricultural Experiment Station

Putting Science to Work for Society since 1875

This Issue

GRANTS RECEIVED MARCH 2021

Dynamic Interactions between Sorption and Biodegradation: Implications for Long-Term Performance of Activated Carbon-Based Technology for In Situ Groundwater Remediation of Chlorinated Solvents. Department of Defense Strategic Environmental Research and Development Program ER21-1224. Dimin Fan, Geosyntec Consultants; **Joseph J. Pignatello**, Birthe Veno Kjellerup, University of Maryland, College Park; $1,390,969 total ($414,490 CAES); 33 months starting approximately October 2021.

Objective. This project will investigate the fundamental mechanisms and processes involved in activated carbon (AC)-based treatment technology, an emerging in situ groundwater remediation approach for chlorinated solvents. The primary focus will be on characterizing and quantifying the dynamic interactions between adsorption and biodegradation, which are the core processes inherent to the technology, but have not been rigorously examined for assessing its long-term effectiveness for in situ groundwater remediation.

Technical Approach: This research will be conducted at laboratory scale, using experimental systems that have been previously applied to study contaminant sorption and sorbent-based biofilms separately. Colloidal activated carbon, a representative type of AC that is commercially available and has been applied for in situ remediation of chlorinated solvents, will be tested, together with other well-characterized ACs to qualitatively and quantitatively interrogate the fundamental processes involved in the treatment facilitated by the AC amendments. This research will first establish baseline understanding of biofilm colonization and contaminant sorption/desorption behavior in active and abiotic batch systems, respectively, containing AC-impacted aquifer solids. The two systems will then be combined to quantitatively characterize the link and potential synergy between sorption and biodegradation. Finally, column tests will be conducted to evaluate how the dynamic sorption and biodegradation processes characterized in batch systems can impact long-term treatment effectiveness under flow-through conditions. A suite of solution chemistry, modeling, microscopy, and molecular biological tools will be applied in this project to obtain robust data.

Benefits: AC-based treatment technology has attracted increasing interest due to its claimed long-term effectiveness, but independent evaluation is lacking. This work presents a quantitative and rigorous study focusing on the fundamental processes—combined sorption and biodegradation— involved in AC-based remediation technology to address the need for improved understanding of processes influencing the effectiveness of AC-based remedial technology. This research, although performed at laboratory scale, is designed to simulate the temporal and spatial variations of conditions during *in situ* treatment, providing scientific information of direct practical value. Additionally, this research will significantly advance the state of science and practice on biofilm-based remediation for in situ groundwater remediation. Overall, the outcome of the work is expected to greatly benefit researchers, practitioners, and Department of Defense site managers by: addressing critical concerns of the quantitative differentiation between sorption and degradation; identifying key environmental factors that influence the applicability of AC-based technology, and improving the ability to predict the long-term performance of AC-based technology in field applications.

REEU: Summer Undergraduate Fellows in Plant Health and Protection. Awarded to **Dr. Lindsay Triplett** of CAES (Co-PI), and Drs. Elizabeth Roberts (PI) and Rebecca Silady (Co-PI) of Southern Connecticut State University. 4/2021 through 3/2026. $499,976.00.

The Summer Undergraduate Fellows in Plant Health and Protection program is a collaboration between CAES and Southern Connecticut State University, first initiated in 2017 and recently renewed with the aim to provide agricultural research opportunities to students with no prior experience. The program impacts the skills, understanding, and career goals of the participants and addresses the NIFA-ELI goal of promoting research experiential learning for undergraduates, and its stated focus of including underrepresented groups.

ADMINISTRATION

DR. JASON C. WHITE participated in the monthly Laboratory Preparedness Advisory Committee teleconference call with the CT Department of Public Health (March 1); gave an NSF Center for Sustainable Nanotechnology (CSN) Professional Development workshop on the peer review process for manuscripts and journals (March 1); gave a presentation by ZOOM entitled "Nanoscale Nutrients for the Suppression of Crop Disease" at the 14th Annual Agriculture and Food Conference of Southeastern Massachusetts (SEMAP) (March 1); participated in a Teams meeting with staff from OPM and OFA to discuss the development of a recreational marijuana testing program (March 1); participated in the remote assessment of the CT Department of Agriculture's AFRPS program by FDA staff (March 2); participated in the weekly CSN All-Hands call (March 3, 10, 17, 24); participated in a ZOOM call with Ms. Meghan Cahill of the University of Minnesota to discuss research at CAES (March 4); participated in the monthly FDA LFFM WebEx calls for the Human & Animal Food and Food Defense cooperative agreement programs (March 8); participated in a Research Triangle Nanotechnology Network workshop entitled "Nanotech for Food Nutrition Security Workshop" and led a breakout discussion room on "Pests and Pathogens" (March 9); participated in a ZOOM call with collaborators at Harvard University and Nanyang Technological University (Singapore) to discuss ongoing collaborative research (March 10); participated in a ZOOM call with representatives of Elsevier regarding the journal *NanoImpact* (March 11); was invited to become an Associate Editor of *NanoImpact* (March 12); testified by ZOOM in front of the Legislature's Conservation and Development Subcommittee (March 12); participated in an FDA Stakeholder FSI Budget Update WebEx seminar (March 12); held a ZOOM call with colleagues at Johns Hopkins University to discuss collaborative research (March 12); participated in the annual FDA Animal Feed Regulatory Program Standards (AFRPS) conference (March 16-18); participated in the International Conference on Recent Advances in Agricultural Sciences (ICRAAS-2021) "Innovations and Translational Research in Agriculture" conference and gave a presentation entitled "Nanotechnology and Agriculture-Feeding the World for 2050" and participated in the Inaugural and Closing Plenary sessions as an invited guest (March 16-17); participated in the annual Editorial Advisory Board Members of *Environmental Science & Technology* and *Environmental Science & Technology Letters* (March 16); participated in a Teams meeting with UM6P, OCP, and Johns Hopkins University to discuss collaborative research (March 18); participated in a ZOOM call with colleagues at Louisiana State University and the University of Auckland regarding a collaborative research project (March 18); hosted the CAES Safety Committee Quarterly Meeting (March 22); participated in the CT Department of Agriculture launch of the CT Grown 2021 campaign at Geremia Greenhouses in Wallingford (March 22); gave an interview along with CSN graduate students to Shi En Kim of Science News (March 22); participated in the annual CSN All Hands meeting and gave a presentation entitled "Nanochemistry-Plant Interactions Work at CAES" (March 22-23); was appointed as a Clinical Professor of Epidemiology in the Department of Environmental Health Sciences of the Yale School of Public Health (March 23); participated in a ZOOM call with colleagues at Yale University to discuss collaborative field work at Lockwood Farm (March 24); participated in an FDA LFFM CAP All-Hands Meeting (March 26); held a call with state Senator Cathy Osten to discuss CAES programs related to animal epidemics (March 29); held a call with Professor Yangchao Luo of UConn to discuss potential collaborative research (March 30); received the 2020 Outstanding Reviewer Award from the journal *Environmental Science: Nano* (March 30); and testified in front of the Legislature's Bonding Subcommittee (March 31).

ANALYTICAL CHEMISTRY

DR. CHRISTINA ROBB presented a talk entitled "The Analysis of L-Abrine by a Teicoplanin Stationary Phase," virtual Pittcon 2021, Christina S. Robb and Kirk W. Gaston (Forensic Chemistry Center FDA) (March 8); attended an FDA LFFM Human and Animal Food call (March 8); participated in EAS Executive Committee meetings (March 8, 15, 22, 29); met with Bruker representatives about FTIR microscopy (March 9); attended a Bruker Webinar on microplastic analysis by FTIR (March 11); and attended a progress meeting with an FDA Forensic Chemistry Center (FCC) scientist about an abrin analysis project (March 19).

DR. CHRISTIAN DIMKPA gave a presentation entitled "Nanotechnology in Agriculture: Focus on Fertilizers. This presentation was under the auspices of the ''Nano Energy, Nano Agriculture, Nano Education'' Webinar Series of the Nanotechnology Summer School organized by the cooperation between the African Materials Research Society and the United Nations Economic Commission for Africa instituted to promote Nanotechnology on the continent (March 8).

DR. BRIAN EITZER was a participant in an EPA-AAPCO environmental lab ZOOM meeting (March 8-9); was a participant on Food Emergency Response Network conference calls (March 8); was a judge for the Connecticut Science and Engineering Fair (March 8-16); was a participant in the Agricultural Foods Regulatory Program Standards annual conference (March 16-18); and was on a Connecticut Rapid Response Team conference call (March 26).

ENTOMOLOGY

DR. KIRBY C. STAFFORD III presented a 3-hour virtual class entitled "Management of Ticks and Risks of Tick-Borne Disease" in cooperation with the Connecticut Environmental Council (23 attendees) (March 3); presented a tick update at the Forest Health Monitoring Workshop via ZOOM (77 participants) (March 4); participated in the annual meeting of the Northeast Forest Pest Council and presented a state report (60 participants) (March 10-11); participated in the Mid-Atlantic Tick Summit and presented a talk on the control of blacklegged and lone star ticks (72 attendees) (March 23); spoke on ticks and tick management for the Southington Library (15 attendees) (March 23); attended the 14th International Symposium on Ticks and Tick-borne Diseases and co-chaired a poster session (March 24-26); and was interviewed about ticks by Greg Little, WTIC 1080 (March 30).

MS. TIA M. BLEVINS participated in the 95th Annual Eastern Plant Board Meeting held virtually via ZOOM. This meeting focused on plant protection during a pandemic, deregulation of emerald ash borer, and emerging pests and safety concerns of forests and the plant industry (approx. 135 participants) (March 30–April 1).

DR. GALE E. RIDGE was interviewed about the emergence of the 17-year Cicada Brood X and its life history by Greg Little, WTIC 1080 (March 29); and was published in the Bethany Bulletin about restoring chestnut trees to the eastern forests (March 30).

DR. CLAIRE E. RUTLEDGE taught the classes "Insects That Attack Trees and Shrubs" and "Tree Conditions Laboratory" for Arbor 101 for the Connecticut Tree Protective Association (March 3, 17); presented a talk entitled "2021, The Year of the Southern Pine Beetle?" to the Forest Health Monitoring Workshop via ZOOM (March 4); and presented a talk entitled "Tracking the Elusive Wasp: Comparison of 3 Detection Techniques for Larval Parasitoids of Emerald Ash Borer" with co-authors Roy Van Driesch and Jian Duan in the symposium "The Effects of Invasive Insects on Temperate Tree Species: How Do We Measure Injury, Decline, and Control?" at the Annual Meeting of the Eastern Branch of the Entomological Society of America (March 23).

DR. VICTORIA L. SMITH met via ZOOM with representatives of Prides Corner Farms, Leba-

non, to discuss internet commerce of nursery stock (March 3); hosted via ZOOM the annual Forest Health Monitoring Workshop (March 4); participated via ZOOM in the quarterly call with the Eastern Plant Board (March 5); participated via ZOOM in a meeting of the Yale Biosafety Committee (March 18); and participated via ZOOM in the 95th annual Meeting of the Eastern Plant Board (March 29-April 1).

Link for Forest Health Monitoring Workshop: https://us02web.zoom.us/rec/share/l9KD2phT8H6U31uGXswEIZJqsCMNjiRC8sC6yo22EmtXQm2eNf8NgEepv9uB-wX4c.plwOBnTjeJFOtdML)

MS. TRACY ZARRILLO visited the UConn entomology collections to examine bee specimens for the CT bee checklist project, and she also updated the taxonomy for their bee collection (March 8, 15, 22, 29); and was interviewed about mason bee diversity in CT and the use of bee hotels by James Sirch of the Yale Peabody Museum for his blog "In Your Backyard" (March 23).

ENVIRONMENTAL SCIENCES

DR. JOSEPH PIGNATELLO judged middle school and high school presentations at the virtual Connecticut Science and Engineering Fair (March 16-17); and met virtually with collaborators from Villanova University, Pacific Northwest National Laboratory, and Oregon Health and Science University on a SERDP grant project (March 29).

MS. ANGELA BRANSFIELD participated in a CAES Health and Safety Committee meeting via ZOOM (March 22); and participated in a BioRAFT's EHS Community Connection webinar "Designing Safety Training That Sticks" (March 25).

MR. GREGORY BUGBEE gave two virtual talks entitled "Improving Soil in the Home Garden: A Soil Scientist's Perspective " in consecutive breakout sessions as part of the Connecticut Master Gardeners Symposium (approx. 200 attendees) (March 20); gave a virtual talk entitled "Lawn Care" as part of the Avon Free Public Library educational outreach program (approx. 30 attendees) (March 23); and with **MS. SUMMER STEBBINS**, gave a virtual workshop "Connecticut's Invasive Aquatic Plants" as part of the Three Rivers Community College environmental seminar series (approx. 50 attendees) (March 24).

DR. JOSEPH R. McMILLAN presented a virtual seminar entitled "Mosquito & Disease Ecology in CT" to the UConn New Haven Master Gardener's 2021 Spring cohort (approx. 10 attendees) (March 16).

DR. GOUDARZ MOLAEI was interviewed about ticks by Eyewitness News 3 (https://www.wfsb.com/news/state-sees-a-spike-in-tick-bites-due-to-warmer-weather/article_a39c96f6-8ce0-11eb-91a1-b7674de6f72c.html) (March 24).

DR. SARA NASON gave a virtual talk entitled "PFAS Analytical Methods" at the Association of American Pesticide Control Official's annual laboratory directors' meeting (35 attendees) (March 9); met with Dr. Carsten Prasse from Johns Hopkins to discuss a research collaboration (March 18); met with Lee Blaney from the University of Maryland – Baltimore County and **DR. NUBIA ZUVERZA-MENA** regarding beginning a newly funded collaborative project (March 23); participated in a call for the Benchmarking and Publications for Non-targeted Analysis working group and was officially appointed as a webmaster for a one-year term (March 24); met with Satish Myneni from Princeton University regarding a research collaboration (March 26); and attended a webinar with the NEWMOA State/EPA PFAS Working Group on PFAS in Maine (March 31).

FORESTRY AND HORTICULTURE

DR. JEFFREY S. WARD participated in NESAF 2021 planning committee conference calls (March 2, 9, 16, 30); spoke on the relationship of forest management on aboveground carbon storage and sequestration at the Forest Health Monitoring Workshop via ZOOM (76 attendees) (March 4); participated in a Yankee SAF forest carbon outreach conference call (March 12); attended the virtual annual meeting of the Yankee Division, New England Society of American Foresters (March 12); with **MR. JOSEPH P. BARSKY**, spoke on "Changes in Forest Carbon During 38 Years of Active Management" at the 16th Annual Connecticut Conference on Natural Resources (91 attendees) (March 15); participated in a Forest Ecosystem Monitoring Cooperative State Coordinators meeting (March 18); participated in a Forest Ecosystem Monitoring Cooperative Steering Committee meeting (March 18); moderated plenary sessions, moderated a research updates technical session, and spoke on "Black Swans, Grey Rhinos, and Boiling Pots" at the NESAF annual winter meeting (126 attendees) (March 23); and was interviewed about the status of oaks in Connecticut forests by Robert Miller, Danbury News-Times (March 30).

DR. SUSANNA KERIÖ presented a talk entitled "Perspectives on Urban Tree Health" in the Forest Health Monitoring Workshop via ZOOM (76 attendees) (March 4); attended an AFRI -NIFA grant webinar for new investigators (March 4); attended a workshop "Nano for Food and Nutrition Security" (March 9); met with the CT DEEP Urban Forestry Coordinator to plan collaboration (March 17); attended a collaboration ZOOM call organized by the American Chestnut Foundation (March 18); met virtually with Dr. Fahey at UConn to discuss collaboration (March 18); met virtually with Drs. LeBoldus and Showalter at Oregon State University to discuss ongoing collaboration (March 18); attended the virtual conference of New England Society of American Foresters (March 22-24); met virtually with collaborators at the Yale Urban Resources Initiative to discuss collaboration (March 25); and attended a webinar "New England Integrated Pest Management Conference, Spring Research Update" (March 31).

DR. ABIGAIL A. MAYNARD reported on Station activities to a quarterly meeting via ZOOM of the Council on Soil and Water Conservation (March 18); and discussed the New Crops Program at the Hindinger Farm in Hamden (March 25).

DR. SCOTT C. WILLIAMS participated in the CDC's Emerging Infectious Diseases virtual mid-year meeting with CT Dept. of Public Health staff (March 2); as a sitting advisory member, participated in the kickoff meeting of the new National Wildlife Tick-Borne Disease Program (March 2); participated in the annual meeting of the Executive Committee of the Northeast Section of The Wildlife Society (March 3); gave a talk entitled "Impacts of Deer Exclusion on Oak Regeneration in Three Different Timber Harvesting Regimes: A Collaborative Effort" at the Forest Health Monitoring Workshop via ZOOM (March 4); and attended a ZOOM meeting of the National Wildlife Tick-Borne Disease Program (March 18).

MR. JOSEPH P. BARSKY participated in a New England Society of American Foresters executive committee conference call (March 21); and served as a session facilitator/ moderator during the New England Society of American Foresters Annual Meeting and Conference (March 22-23).

PLANT PATHOLOGY AND ECOLOGY

DR. WADE H. ELMER attended a WebEx meeting as a member of the UConn Search Committee for a Department Head of Plant Science and Landscape Architecture (PSLA) (9 members) (March 9, 24, 25); attended the Forest Health Monitoring Workshop via ZOOM (March 4); participated via Teams in the CAES Nano updates (March 8); participated in a web conference entitled "How Can Open-Access University Facilities Best Support Food and Nutrition Security" and in the breakout session "Pests and Pathogens" with **DR. JASON WHITE** (March 9); attended the annual meeting of Northeastern Division of the American Phytopathological Society (NEDAPS) (March 10-11) and participated in the Extension and Industry Update (March 10), served as a judge for Graduate Student competition (March 11), participated in the NEDAPS business meeting (March 11); and gave a presentation entitled "Influence of Single and Combined Mixtures of Metal Oxide Nanoparticles on Eggplant Growth, Yield, and Verticillium Wilt Severity" (130 participants) (March 11); attended via Teams the CT Management Advisory Council - Regular Membership Monthly Meeting (March 17); participated via ZOOM in the American Phytopathological Society Foundation meeting (March 17); with **DRS. JASON WHITE** and **ISHAQ ADISA**, met via ZOOM with Dr. Amrijit Basra and colleagues from OCP to discuss nanoscale P research; participated with **DRS. JASON WHITE** and **YI WANG** via Teams in the CAES-UMASS Nano S update (March 19); attended via ZOOM the Center for Sustainable Nanotechnology All Hands meeting (March 23-25); and participated as a member of the UConn Search Committee for the PSLA Department Head via WebEx in the interviews of Dr. Sydney Everhart (March 24-25) and Dr. Stacey Bonos (March 29-30).

DR. YONGHAO LI presented "Weather and Foliar Diseases" at the Forest Health Monitoring Workshop via ZOOM (77 adults) (March 4); presented "Organic Disease Control" at the Connecticut and Rhode Island NOFA Winter Conference via ZOOM (22 adults) (March 6); presented "Turfgrass Pest Identification and Management" at the SiteOne, CAES, Bayer, and Corteva Lunch and Learn via ZOOM (14 adults) (March 10); attended the 2021 APS Potomac Division and Northeastern Division Joint Virtual Meeting and presented "Disease Updates in Connecticut" at the meeting (47 adults) (March 10); participated in the National Plant Diagnostic Network Online Communication and Web portal Committee Meeting via ZOOM (7 adults) (March 16); and presented "Pruning 101" for the Kensington Garden Club via WebEx (76 adults) (March 18).

DR. ROBERT E. MARRA presented a talk, via ZOOM, entitled "Beech Leaf Disease: Updates for Connecticut" for the Forest Health Monitoring Workshop (80 participants) (March 4); presented a talk, via ZOOM, on beech leaf disease for a webinar series held jointly by the Bartlett Arboretum and Harvard's Arnold Arboretum (168 participants) (March 9); met via Teams, with beech leaf disease collaborators at the USDA-ARS and Ontario Ministry of Natural Resources to discuss current and planned research (5 participants) (March 9); participated in and co-hosted the annual Connecticut Conference on Natural Resources, via ZOOM (356 participants) (March 15); participated in, via MS Teams, the Forest Ecosystem Monitoring Cooperative State Coordinators meeting (25 participants) (March 18); participated in, via MS Teams, the Forest Ecosystem Monitoring Cooperative Steering Committee meeting (12 participants) (March 18); and participated, via ZOOM, in the annual meeting of the American Phytopathological Society, Northeastern Division, where he presented an invited symposium talk on "Beech Leaf Disease" (130 participants) (March 10-12).

DR. NEIL SCHULTES participated in the annual meeting of the Northeastern Division of the American Phytopathological Society (March 10-12); and participated in the semi-annual CAES IUPAC meeting (6 attendees) (March 31).

DR. STEPHEN J. TAERUM presented a talk entitled "Ecology and Evolution of Symbiotic Single Cell Eukaryotes" to the Penn State Microbiome Center (70 adults) (March 26).

DR. LINDSAY TRIPLETT served on the graduate advisory committee of UConn Ph.D. student Gabrielle Corso during her dissertation proposal defense (6 attendees) (March 17).

DR. QUAN ZENG had a ZOOM meeting discussion with Dr. Daniel Cooley from the University of Massachusetts (March 29); and hosted Mr. Paul O'Connor from the University of Massachusetts to perform some collaborative research on detection of *Erwinia amylovora* using hyperspectral imaging at CAES (March 31).

VALLEY LABORATORY

DR. CAROLE CHEAH gave a presentation on the HWA biological control program at the Forest Health Monitoring Workshop via ZOOM (80 attendees) (March 4); presented a talk entitled "The Plight of the Hemlock Tree" via Google meet for the Land Trust Hot Topics Series, hosted by The Flanders Nature Center and Land Trust, Town of Woodbury, and participated in the round table discussion (10 attendees) (March 9).

MS. ROSE HISKES chaired the virtual Connecticut Invasive Plant Working Group Outdoor Educator planning committee ZOOM meetings (March 2, 25).

DR. SRIKANTH KODATI attended and presented a poster entitled "In Vitro Study on the Effect of Temperature, Leaf Wetness Period, and Cultivar Susceptibility on Boxwood Blight Incidence" as a part of the Northeastern Division of the American Phytopathological Society virtual meeting (March 10-12).

DR. JAMES LAMONDIA spoke about research plans for Diaporthe leaf spot and cone blight management at the CT Hop Growers Association meeting held virtually (7 attendees) (March 4); with **DR. ROBERT MARRA**, presented Beech Leaf Disease for a Bartlett Arboretum and Arnold Arboretum Educational Webinar (168 attendees) (March 9); participated as an expert mentor in the NED APS Careers 101 CV Workshop as a part of the virtual regional meeting (25 attendees) (March 10); participated in the Northeast/Potomac Division meeting of the American Phytopathological Society (March 10-12); discussed research on reduced tillage of tobacco with Dr. Emily Cole of the American Farmland Trust (March 18); welcomed attendees and introduced Ag Day at the Capitol as chair of the CT Agricultural Information Council, and participated in the virtual Ag Day Program (40 attendees) (March 23); and mentored a Ph.D. student in a one-on-one follow-up to the NED APS Careers 101 CV Workshop (March 24).

DEPARTMENTAL RESEARCH UPDATES MARCH 2021

Borgatta, J., C. A. Lochbaum, **Wade H. Elmer**, **Jason C. White**, J. A. Pedersen, and R. J. Hamers. 2020. Biomolecular corona formation on CuO nanoparticles in plant xylem fluid. *Environ. Sci.: Nano*. doi.org/10.1039/D1EN00140J.

Abstract- Biomolecular coatings, referred to as coronas, that form on nanomaterials have been widely investigated in animal and bacterial cell culture and in the extracellular and intracellular fluids of animals. Such coronas influence the distribution of nanoparticles within organisms, their uptake by cells, and their storage in intracellular compartments. Plants can be exposed to nanoparticles either inadvertently (e.g., via biosolids amendment of soils) or intentionally in application of nanotechnologies to agriculture. Development of a mechanistic understanding of nanoparticle transport and fate within plants requires consideration of corona acquisition within plants, particularly within the vascular fluids (xylem, phloem) that transport nanoparticles throughout plants. Here, we examine the interactions between copper oxide (CuO) nanoparticles and pumpkin xylem fluid to understand corona formation in plant systems. We used CuO nanoparticles because they have emerged as a promising micronutrient source for the suppression of fungal diseases. The isolated corona is composed primarily of proteins, despite the higher abundance of carbohydrates in xylem fluid. We used X-ray photoelectron spectroscopy to determine the thickness of the protein corona. Polyacrylamide gel electrophoresis revealed that proteins binding to the CuO nanoparticle surface was selective; the most abundant proteins in the corona are not the most abundant ones in the xylem fluid. We used in situ attenuated total reflectance Fourier-transform infrared spectroscopy to show that the protein-CuO interactions are quasi-irreversible, while car-

bohydrate-CuO interactions are reversible. Corona formation is expected to influence the distribution and transformation of nanomaterials in plants.

Burtis, J. C., J. D. Poggi, **Joseph R. McMillan**, S. C. Crans, S. R. Campbell, A. Isenberg, J. Pulver, P. Casey, K. White, C. Zondag, J. R. Badger, R. Berger, J. Betz, S. Giordano, M. Kawalkowski, J. L. Petersen, G. Williams, **Theodore G. Andreadis**, **Philip M. Armstrong**, and L. C. Harrington. NEVBD Pesticide Resistance Monitoring Network: Establishing a Centralized Network to Increase Regional Capacity for Pesticide Resistance Detection and Monitoring. *J. Med. Entomol*. 2021 Mar 12; 58(2):787-797.

Abstract- Pesticide resistance in arthropod vectors of disease agents is a growing issue globally. Despite the importance of resistance monitoring to inform mosquito control programs, no regional monitoring programs exist in the United States. The Northeastern Regional Center for Excellence in Vector-Borne Diseases (NEVBD) is a consortium of researchers and public health practitioners with a primary goal of supporting regional vector control activities. NEVBD initiated a pesticide resistance monitoring program to detect resistant mosquito populations throughout the northeastern United States. A regionwide survey was distributed to vector control agencies to determine needs and refine program development and in response, a specimen submission system was established, allowing agencies to submit *Culex pipiens* (L.) (Diptera:Culicidae) and *Aedes albopictus* (Skuse) (Diptera: Culicidae) for pesticide resistance testing. NEVBD also established larvicide resistance diagnostics for *Bacillus thuringiensis israelensis* (Bti) and methoprene. Additional diagnostics were developed for *Cx. pipiens* resistance to *Lysinibacillus sphaericus*. We received 58 survey responses, representing at least one agency from each of the 13 northeastern U.S. states. Results indicated that larvicides were deployed more frequently than adulticides, but rarely paired with resistance monitoring. Over 18,000 mosquitoes were tested from six states. Widespread low-level (1 × LC-99) methoprene resistance was detected in *Cx. pipiens*, but not in *Ae. albopictus*. No resistance to Bti or *L. sphaericus* was detected. Resistance to pyrethroids was detected in many locations for both species. Our results highlight the need for increased pesticide resistance testing in the United States and we provide guidance for building a centralized pesticide resistance testing program.

Ding, Xiaolei, Qingtong Wang, Yunfei Guo, Yulong Li, Sixi Lin, Qingwei Zeng, Feijian Sun, **De-Wei Li**, Jianren Ye. 2021. Copy number variations of glycoside hydrolase 45 genes in *Bursaphelenchus xylophilus* and their impact on the pathogenesis of pine wilt disease. Forests 12: 275. http://doi.org/10.3390/ f12030275

Abstract- The pine wood nematode *Bursaphelenchus xylophilus* parasitizes millions of pine trees worldwide each year, causing severe wilt and the death of host trees. Glycoside hydrolase 45 genes of *B. xylophilus* are reported to have been acquired by horizontal gene transfer from fungi and are responsible for cell wall degradation during nematode infection. Previous studies ignored the possibility of copy number variations of such genes. In this study, we determined that two of the glycoside hydrolase 45 genes evolved to maintain multiple copies with distinct expression levels, enabling the nematode to infect a variety of pine hosts. Additionally, tandem repeat variations within coding regions were also detected between different copies of glycoside hydrolase 45 genes that could result in changes in protein sequences and serve as an effective biological marker to detect copy number variations among different *B. xylophilus* populations. Consequently, we were able to further identify the copy number variations of glycoside hydrolase 45 genes among *B. xylophilus* strains with different virulence. Our results provide new insights into the pathogenicity of *B. xylophilus*, provide a practical marker to genotype copy number variations and may aid in population classification.

Farooq, T., M. Adeel, Z. He, M. Umar, N. Shakoor, **Washington da Silva**, **Wade Elmer**, **Jason C. White,** and Y. Rui. 2021. Nanotechnology and plant viruses: A novel disease management approach for resistant pathogens. *ACS Nano* doi.org/10.1021/acsnano.0c10910.

Abstract- Phytoviruses are highly destructive plant pathogens, causing significant agricultural losses due to their genomic diversity, rapid and dynamic evolution, and the general inadequacy of management options. Although an increasing number of studies are being published demonstrating the efficacy of engineered nanomaterials to treat a range of plant pathogens, very little work has been done with phytoviruses. Herein, we describe the emerging field of "Nanophytovirology" as a potential management approach to combat plant viral diseases. Owing to their special physiochemical properties, nanoparticles (NPs) can interact with viruses, their vectors, and the host plants in a variety of specific and useful ways. We specifically describe the potential mechanisms underlying NPs-plant-virus interactions and explore the antiviral role of NPs. We discuss the limited literature,

as well as the challenges and research gaps that are instrumental to the successful development of a nanotechnology-based, multidisciplinary approach for timely detection, treatment, and prevention of viral diseases.

Hagstrom, A. L., P. Anastas, A. Boissevain, A. Borrel, N. C. Deziel, S. E. Fenton, C. Fields, J. D. Fortner, N. Franceschi-Hofmann, R. Frigon, L. Jin, J. Kim, N. C. Kleinstreuer, J. Koelmel, Y. Lei, Z. Liew, X. Ma, L. Mathieu, **Sara L. Nason**, K. Organtini, Y. Oulhote, S. Pociu, K. J. G. Pollitt, J. Saiers, D. C. Thompson, B. Toal, E. J. Weiner, S. Whirledge, Y. Zhang, and V. Vasiliou. Yale School of Public Health Symposium: An Overview of the Challenges and Opportunities Associated with Per- and Polyfluoroalkyl Substances (PFAS). *Science of the Total Environment,* **2021**, 146192, https://doi.org/10.1016/j.scitotenv.2021.146192

Abstract- On December 13, 2019, the Yale School of Public Health hosted a symposium titled "Per- and Polyfluoroalkyl Substances (PFAS): Challenges and Opportunities" in New Haven, Connecticut. The meeting focused on the current state of the science on these chemicals, highlighted the challenges unique to PFAS, and explored promising opportunities for addressing them. It brought together participants from Yale University, the National Institute of Environmental Health Sciences, the University of Massachusetts Amherst, the University of Connecticut, the Connecticut Agricultural Experiment Station, the Connecticut Departments of Public Health and Energy and Environmental Protection, and the public and private sectors. Presentations during the symposium centered around several primary themes. The first reviewed the current state of the science on the health effects associated with PFAS exposure and noted key areas that warranted future research. As research in this field relies on specialized laboratory analyses, the second theme considered commercially available methods for PFAS analysis as well as several emerging analytical approaches that support health studies and facilitate the investigation of a broader range of PFAS. Since mitigation of PFAS exposure requires prevention and cleanup of contamination, the third theme highlighted new nanotechnology-enabled PFAS remediation technologies and explored the potential of green chemistry to develop safer alternatives to PFAS. The fourth theme covered collaborative efforts to assess the vulnerability of in-state private wells and small public water supplies to PFAS contamination by adjacent landfills, and the fifth focused on strategies that promote successful community engagement. This symposium supported a unique interdisciplinary coalition established during the development of Connecticut's PFAS Action Plan, and discussions occurring throughout the symposium revealed opportunities for collaborations among Connecticut scientists, state and local officials, and community advocates. In doing so, it bolstered the State of Connecticut's efforts to implement the ambitious initiatives that its PFAS Action Plan recommends.

Li, C., C. Ma, H. Shang, **Jason C. White**, D. J. McClements, and B. Xing. 2020. Food-grade titanium dioxide particles decrease the bioaccessibility of iron released from spinach leaves in simulated human gastrointestinal tract. *Environ. Sci: Nano* In press.

Abstract- Food grade titanium dioxide particles (E171) are added to various foods as whitening agents, including chewing gums, candies, sauces, powdered milks, and salad dressings. Salad dressings are often consumed with leafy green vegetables, such as spinach, which are rich in minerals. We hypothesized that the presence of titanium dioxide particles in foods would interfere with the bioaccessibility of essential minerals. For this reason, we investigated the impact of E171 on the bioaccessibility of minerals (Ca, K, Mg, Fe, Mn, Zn, P and S) released from spinach leaves using a simulated human digestion tract (GIT) that involves mouth, stomach, and small intestinal phases. The digestive enzymes used in the GIT model, including α-amylase, pepsin, and pancreatin, prompted mineral release from the spinach leaves under simulated GIT conditions (with the exception of Ca). The presence of titanium dioxide did not impact the bioaccessibility of most of the minerals, with the exception of iron. For instance, the final bioaccessibility of Fe decreased from 59% in the absence of E171 to 53% in the presence of 0.2 wt% E171. Interestingly, the decrease in iron bioaccessibility mainly occurred within the mouth phase, rather than the stomach or intestinal phases. Mechanistic studies indicated that the reduction in iron bioaccessibility was due to a number of effects: (i) adsorption of iron onto E171 particles; (2) inhibition of α-amylase activity by E171, thereby interfering with Fe release from the spinach leaves. The results of this study are useful for assessing the potential impact of E171 on the human digestive process and the nutritional value of foods.

Ma, C., Y. Hao, J. Zhao, **Nubia Zuverza-Mena**, A. G. Meselhy, O. Parkash Dhankher, Y. Rui, **Jason C. White,** and B. Xing. 2021. Graphitic carbon nitride (C_3N_4) reduces cadmium and arsenic phytotoxicity and accumulation in rice (*Oryza sativa* L.). *Nanomaterials* 11(4), 839.

Abstract- The present study investigated the role of graphitic carbon nitride (C_3N_4) in alleviating cadmium (Cd) or arsenic (As)-induced phytotoxicity to rice (*Oryza sativa* L.). A high-temperature pyrolysis was used to synthesize the C_3N_4, which were characterized by transmission electron microscopy (TEM), Fourier transform infrared (FTIR) and Dynamic

Light Scattering (DLS). Rice seedlings were exposed to C_3N_4 at 50 and 250 mg/L in half strengthen Hoagland's solution amended with or without 10 mg/L Cd or As for 14 days. Exposure to 250 mg/L C_3N_4 alone increased the root and shoot fresh biomass by 17.5 and 25.9%, respectively. Upon co-exposure to Cd or As, C_3N_4 alleviated the heavy metal-induced phytotoxicity and increased the fresh weight by 26-38% and 49-56%, respectively. The addition of C_3N_4 decreased Cd and As accumulation in the roots by 32 and 25%, respectively; metal content in the roots exceeded 30% with C_3N_4. The macro- (K, P, Ca, S, Mg) and micro- (Cu, Fe, Zn, Mn) alterations induced by heavy metal exposure were also partly alleviated by C_3N_4 treatment. Random amplified polymorphic DNA (RAPD) analysis suggests that Cd significantly altered the genomic DNA of rice roots, although no difference was found in shoot tissues. The presence of heavy metals and C_3N_4 both controlled Cd and As uptake by rice by regulating transport related genes. For example, the relative expression of Cd transporter (OsIRT1) in roots was upregulated by approximately 3-fold with metal exposure but C_3N_4 co-amendment reduced expression by 25%. Similar results were evident in the expression of As transporter (OsNIP1;1) in roots. Overall, these findings facilitate understanding of the underlying mechanisms by which carbon-based nanomaterials alleviate contaminant-induced phyto- and genotoxicity and may provide a new strategy for carbon-based nanomaterial-alleviation of heavy metal contamination in agriculture.

Preising, Stephanie, Darlan Ferreira Borges, Márcia Michelle de Queiroz Ambrósio, and **Washington Luís da Silva**. A Fig Deal: A Global Look at Fig Mosaic Disease and its Putative Associates. Plant Disease Feature Article. https://doi.org/10.1094/PDIS-06-20-1352-FE

Abstract- Fig mosaic disease (FMD) is a complex viral disease with which 12 viruses, including a confirmed causal agent, fig mosaic emaravirus (FMV), and three viroids are associated worldwide. FMD was first described in California in the early 1930s. Symptoms include foliar chlorosis, deformation, and mosaic patterns. FMD is disseminated by vegetative propagation, seed transmission, and vectors, including a mite, *Aceria ficus*. Management of the disease in fig orchards relies on scouting and elimination of infected trees. In this review, we focus on the distribution of the FMD-associated viruses and viroids by summarizing worldwide surveys and their genome structure. We also determined the full-length sequence of FMV and fig badnavirus 1 (FBV-1) isolates from Connecticut and compared the virus and viroid sequences from fig isolates. We suggest important areas of research including determining the potential synergistic effect of multiple viruses, elucidating the full-length genome sequence of each associated virus, and relating virus titer to phenotypic changes in *Ficus carica*.

Wilson S. N., K. López, S. Coutermash-Ott, D. I. Auguste, D. L. Porier, **Philip M. Armstrong**, **Theodore G. Andreadis**, G. Eastwood, and A. J. Auguste. La Crosse Virus Shows Strain-Specific Differences in Pathogenesis. *Pathogens*. 2021 Mar 29; 10(4):400. doi: 10.3390/pathogens10040400.

Abstract- La Crosse virus (LACV) is the leading cause of pediatric viral encephalitis in North America, and is an important public health pathogen. Historically, studies involving LACV pathogenesis have focused on lineage I strains, but no former work has explored the pathogenesis between or within lineages. Given the absence of LACV disease in endemic regions where a robust entomological risk exists, we hypothesize that some LACV strains are attenuated and demonstrate reduced neuroinvasiveness. Herein, we compared four viral strains representing all three lineages to determine differences in neurovirulence or neuroinvasiveness using three murine models. A representative strain from lineage I was shown to be the most lethal, causing >50% mortality in each of the three mouse studies. However, other strains only presented excessive mortality (>50%) within the suckling mouse neurovirulence model. Neurovirulence was comparable among strains, but viruses differed in their neuroinvasive capacities. Our studies also showed that viruses within lineage III vary in pathogenesis with contemporaneous strains, showing reduced neuroinvasiveness compared to an ancestral strain from the same U.S. state (i.e., Connecticut). These findings demonstrate that LACV strains differ markedly in pathogenesis, and that strain selection is important for assessing vaccine and therapeutic efficacies.

JOURNAL ARTICLES APPROVED MARCH 2021

Cao, X., X. Pan, S. Couvillion, T. Zhang, **Carlos Tamez**, L. M. Bramer, **Jason C. White**, W.-J. Qian, B. D. Thrall, K. W. Ng, X. Hu, and P. Demokritou. Fate, cytotoxicity and cellular metabolomic impact of ingested carbon dots using simulated digestion and a triculture small intestinal epithelial model. *Journal of Agricultural and Food Chemistry*

Cao, X., C. Wang, X. Luo, L. Yu, **Jason C. White**, **Wade Elmer**, O. Parkash Dhankher, Z. Wang, and B. Xing. Elemental sulfur nanoparticles enhance disease resistance in tomato. *ACS Nano*

Gloria-Soria, Andrea, **Doug E. Brackney**, and **Philip M. Armstrong**. Forced saliva collection via capillary method underestimates arboviral transmission by mosquitoes. *The American Journal of Tropical Medicine and Hygiene*

Hou, J., C. Hu, **Jason C. White**, K. Yang, L. Zhu, and D. Lin. A novel nano-bioremediation technology using nanoscale zero-valent iron and nematodes for organochlorines-contaminated soil. *Nature Nanotechnology*

LaMondia, James A., E. Allan-Perkins, and **Srikanth Kodati**. Factors affecting boxwood blight spread under landscape conditions. *Journal of Environmental Horticulture*

Li, Q., C. Ma, **Jason C. White**, and B. Xing. Effects of phosphorus ensembled nanomaterials on nutrient uptake and distribution in *Glycine max* L. *Agronomy*

Maier, Chris T. Seasonal flight activity of *Atylotus duplex* (Walker), *Atylotus thoracicus* (Hine), and *Stonemyia rasa* (Loew) (Diptera: Tabanidae) in Connecticut, with floral hosts of *Stonemyia* species in New England. *Proceedings of the Entomological Society of Washington*

Pagano, L., M. Marmiroli, M. Villani, J. Magnani, R. Rossi, A. Zappettini, **Jason C. White**, and N. Marmiroli. Engineered nanomaterial exposure controls organelle genetic material replication in *Arabidopsis thaliana*. *ACS Nano*

Steven, Blaire, **Jacquelyn C. LaReau**, **Stephen J. Taerum**, **Nubia Zuverza-Mena**, and **Richard S. Cowles**. What's under the Christmas tree? Soil acidification alters fir tree rhizosphere bacterial and eukaryotic communities, their interactions, and functional traits. *Applied and Environmental Microbiology*

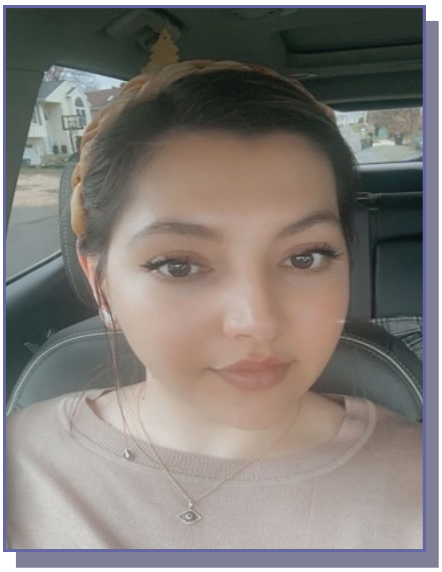
Wang, Yi, S. Chen, C. Deng, X. Shi, K. Cota-Ruiz, **Jason C. White**, L. Zhao, and J. L. Gardea-Torresdey. Metabolomic analysis reveals dose-dependent alteration of maize (*Zea mays* L.) metabolites and mineral nutrient profiles upon exposure to zerovalent iron nanoparticles. *NanoImpact*

Yang, Y., J. Wang, **Zhengyang Wang**, Y. Gao, and **Joseph J. Pignatello**. Abatement of polycyclic aromatic hydrocarbon residues in biochars by thermal oxidation. *Environmental Science & Technology Letters*

NEW STAFF, STUDENTS, AND VOLUNTEERS MARCH 2021

Aida Feng, a Ph.D. student in Germanic Languages and Literatures at Yale University, joined the **da Silva Laboratory** as an intern. Under the guidance of **Dr. Washington da Silva**, she will work on validating reference genes for gene expression quantification in potato plants infected with potato virus Y (PVY).

Emanuela Elezi, a senior student at Southern Connecticut State University (SCSU), joined the **da Silva Laboratory** as an intern. Under the guidance of **Dr. Washington da Silva**, she will work on sequencing the whole genome of grapevine red-blotch virus, a DNA virus that was first detected in New England vineyards by Dr. da Silva's team. She will also work on obtaining transmission electron microscopy (TEM) images of the virus from infected grapevine samples.



Isabella Gega is a high school sophomore at Greenwich High School in Greenwich, CT, who interned with **Dr. Wade Elmer** on using mesoporous silica nanoparticles for suppression of Alternaria leaf spot of coffee.

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