THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

Record of the Year

2019-2020

CAES

The Connecticut Agricultural Experiment Station

Putting Science to Work for Society since 1875

The Connecticut Agricultural Experiment Station, founded in 1875, was the first state agricultural experiment station in the United States. The Station has laboratories, offices, and greenhouses at 123 Huntington Street, New Haven 06511, Lockwood Farm for experiments on Evergreen Avenue in Hamden 06518, the Valley Laboratory and farm on Cook Hill Road, Windsor 06095, and a research center in Griswold and Voluntown. Station Research is conducted by members of the following departments: Analytical Chemistry, Entomology, Environmental Sciences, Forestry and Horticulture, Plant Pathology and Ecology, and the Valley Laboratory. The Station is chartered by the Connecticut General Statutes to experiment with plants and their pests, insects, soil and water and to perform analyses.

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BOARD OF CONTROL

The management of The Station is vested in a Board of Control as specified in section 22-79 of the General Statutes of Connecticut.

The members of the Board of Control as of June 30, 2020 were:

Governor Ned Lamont, President
Terry Jones, Vice President
Paul C. Larson, Secretary
Dr. Jason C. White, Director
Commissioner Bryan Hurlburt
Dr. Erol Fikrig
Ms. Joan Nichols
Dr. Dana Royer
Ms. Patti J. Maroney

Dr. Jason C. White was appointed the Director of The Station, effective April 1, 2020, after the retirement of Dr. Theodore G. Andreadis on April 1, 2020.

The Board of Control met on August 7, 2019, October 16, 2019, January 15, 2020, February 4, 2020 (special meeting to appoint a new Director), March 3, 2020 (special meeting to appoint a new Director), and April 15, 2020.

STATION STAFF

The Experiment Station exists to advance scientific knowledge, and that advance depends completely upon the quality and dedication of its staff. The following was the staff of The Connecticut Agricultural Experiment Station as of June 30, 2020.

ADMINISTRATION

Dr. Jason C. White, Director
Dr. Wade H. Elmer, Vice Director
Michael P. Last, Chief Financial Officer
Dianne F. Albertini
Vickie M. Bomba-Lewandoski
Sandra E. Carney
Michael J. Cavadini
Lisa L. Kaczenski
Jennifer L. Stevens

ANALYTICAL CHEMISTRY

Dr. Brian D. Eitzer, Interim Department Head
Dr. Ishaq O. Adisa
Michael A. Ammirata
Terri Arsenault
Dr. Roberto De La Torre-Roche
Dr. Walter J. Krol
Dr. Chuanxin Ma
Dr. MaryJane Incorvia Mattina, Emeritus
Craig Musante
Kitty Prapayotin-Riveros
John F. Ranciato
Dr. Christina S. Robb
Dr. Carlos Tamez
Dr. Nubia Zuverza-Mena

ENTOMOLOGY

Dr. Kirby C. Stafford III, Department Head
Dr. John F. Anderson, Emeritus
Tia M. Blevins
Jamie L. Cantoni
Mark H. Creighton
Katherine Dugas
Jeffrey M. Fengler
Dr. Megan A. Linske
Dr. Eliza A.H. Little
Morgan Lowry
Gerda Magana
Dr. Chris T. Maier, Emeritus
Dr. Gale E. Ridge
Dr. Claire E. Rutledge
Dr. Victoria L. Smith
Dr. Kimberly A. Stoner
Heidi R. Stuber

Tracy A. Zarrillo

ENVIRONMENTAL SCIENCES
Dr. Joseph J. Pignatello, Department Head
Dr. Theodore G. Andreadis, Director Emeritus
Dr. Philip M. Armstrong
Dr. Xiangyu Bi
Dr. Douglas E. Brackney
Angela B. Bransfield
Gregory J. Bugbee
Duncan W. Cozens
Dr. Andrea Gloria-Soria
Noelle Khalil
Dr. Joseph R. McMillan
Michael J. Misencik
Dr. Goudarz Molaei
Dr. Sara L. Nason
Tanya A. Petruff
Dr. Brij L. Sawhney, Emeritus
Dr. Rohit Sharma
John J. Shepard
Summer Stebbins
Dr. Blaire T. Steven
Dr. Charles R. Vossbrinck
Dr. Zhengyang Wang
Dr. Yi Yang

FORESTRY AND HORTICULTURE
Dr. Jeffrey S. Ward, Department Head
Joseph P. Barsky
Dr. Martin P.N. Gent, Emeritus
Dr. Susanna Keriö
Dr. Abigail A. Maynard
Michael R. Short
Dr. Paul E. Waggoner, Emeritus
Dr. Scott C. Williams

GRISWOLD RESEARCH CENTER
Robert J. Durgy, Research Farm Manager

LOCKWOOD FARM
Richard Cecarelli, Research Farm Manager
Rollin J. Hannan
Michael M. McHill

MAINTENANCE
Eric M. Wagner, Maintenance Supervisor
Isaac K. Bildad
Eric J. Flores
Brian Hart

Ronald A. LaFrazier
Miguel Roman
Michael A. Scott

PLANT PATHOLOGY AND ECOLOGY
Dr. Wade H. Elmer, Vice Director, Department Head
Dr. Sandra L. Anagnostakis, Emeritus
Dr. Donald E. Aylor, Emeritus
Dr. Zhouqi Cui
Dr. Washington L. da Silva
Dr. Sharon M. Douglas, Emeritus
Dr. Francis J. Ferrandino, Emeritus
Regan B. Huntley
Dr. Yonghao Li
Dr. Robert E. Marra
Dr. Neil A. McHale, Emeritus
Dr. Ravikumar R. Patel
Dr. Richard B. Peterson, Emeritus
Dr. Neil P. Schultes
Dr. Teja S. Shidore
Dr. Stephen J. Taerum
Peter W. Thiel
Dr. Lindsay R. Triplett
Dr. Israel Zelitch, Emeritus
Dr. Quan Zeng

VALLEY LABORATORY
Dr. James A. LaMondia, Department Head
Dr. Jatinder S. Aulakh
Jane Canepa-Morrison
Dr. Carole A. Cheah
Dr. Richard S. Cowles
Jeffrey M. Fengler
Rose T. Hiskes
Dr. Srikanth Kodati
Dr. DeWei Li
James J. Preste, Research Farm Manager
Thomas M. Rathier, Emeritus
Diane C. Riddle
Michelle R. Salvas

NEW SCIENTIFIC STAFF

Dr. Susanna Keriö

Dr. Susanna Keriö joined the staff in the Department of Forestry and Horticulture as an Assistant Agricultural Scientist II in April 2020. Dr. Keriö is a forest pathologist and a forest ecologist with expertise in disease resistance of trees to fungal pathogens, and the molecular and genetic factors associated with tree-fungus interaction. Her doctorate research at the University of Helsinki focused on the transcriptional and chemical defense responses of Norway spruce and Scots pine to the *Heterobasidion* root rot pathogens. In her postdoctorate at the Oregon State University, Dr. Keriö's research aimed at identifying genetic variation in *Populus trichocarpa* associated with resistance to the Septoria leaf spot and stem canker pathogen *Sphaerulina musiva*. Her current research at CAES aims at applying this knowledge to develop innovative management strategies to reduce tree stress and to support tree health in urban environments. Dr. Keriö's current projects include impact of metallic nanoparticles on tree stress levels and plant-fungal interactions, cell death and gene expression responses and molecular markers associated with beech leaf disease, and tissue culture and somatic embryogenesis techniques in American chestnut and other hardwood tree species.

Dr. Theodore G. Andreadis

Dr. Theodore Andreadis retired on April 1, 2020, after 42 years of dedicated service and leadership to the Connecticut Agricultural Experiment Station; he now holds the position of Director Emeritus. After completing his Ph.D. in Entomology at the University of Florida in 1978, Ted joined the CAES Department of Entomology. Once at CAES, Ted quickly moved up the ranks, being promoted to Associate Scientist in 1982, Full Scientist in 1986, and then to Chief Scientist of the Department of Soil and Water (now known as the Department of Environmental Sciences) in 1992. With the passing of former Director Dr. Louis A. Magnarelli in 2013, Ted was appointed as CAES Director by the Board of Control and ably led the Station until his retirement in April. Ted's research portfolio and expertise is quite broad, with early work focusing on topics such as the use of *Bacillus thuringiensis* for control of the gypsy moth populations; the biology and ecology of parasitic entomopathogens and parasitoids of the European corn borer, the Japanese beetle, and the Colorado potato beetle; the mosquito defense mechanisms against nematode parasites; and the ecology of microsporidian pathogens of mosquitoes. In more recent years, his work turned to the epidemiology of mosquito-borne arboviruses such as West Nile virus and Eastern equine encephalitis. In spite of Ted's senior leadership roles at CAES, he achieved international recognition as a highly prolific and impactful scientist, publishing over 200 papers that have been cited 10,060 times, giving him an H-index of 56. Ted is a true scholar and a gentleman; his leadership as Director included intensely dedicated efforts to grow the scientific staff and to update CAES facilities and infrastructure. His efforts were always focused on improving the ability of the Station to serve the citizenry of the state and to put science to work for society. We all are grateful for Ted's dedication and achievements over his 42-year career and wish him a happy and healthy retirement.

Ms. Joan L. Bravo

Ms. Joan L. Bravo graduated with a B.S. degree in environmental horticulture from the University of Connecticut in 1976. She worked in the Department of Plant Pathology and Ecology from October 1979 through December 1980 before leaving to raise her family. She returned to CAES on June 20, 1994, as a Research Assistant in the Department of Forestry and Horticulture. She was promoted to Technician in 2003. When Joan returned to CAES in 1994, she assisted in studies on raspberries and apple cultivars along with rhododendron tissue culture. In 1995, she assisted with the establishment of the first wine grape cultivar trials for the nascent Connecticut wine industry – a line of research she would assist with for much of her career. Her advanced expertise enabled her to assume the responsibility of training of new staff in a wide variety of pruning techniques, and of being the sole author of "Vineyard Establishment for the Connecticut Homeowner" and "Wine Making Basics – The Next Step for the Home Grower." Joan's adaptability during her 25 years at CAES allowed her to fill critical needs in the Department of Plant Pathology and Ecology, Department of Analytical Chemistry, and Administration. For more than a decade, Joan was the friendly and helpful face that greeted the thousands of visitors to Plant Science Day. Her flexibility and advanced training in database management was key to her invaluable contributions to research examining methods of reducing invasive species to reduce the risk of Lyme disease, urban forest health, and landowner outreach in northwest Connecticut. We honor Ms. Bravo and her contributions on the occasion of her retirement.

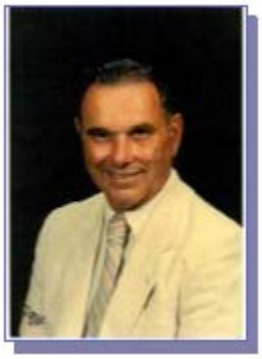
Dr. Francis J. Ferrandino

Dr. Francis J. Ferrandino retired after more than 37 years of dedicated service to the Connecticut Agricultural Experiment Station. Frank arrived at the Station in June 1982 with a green thumb and a Ph.D. in Astrophysics from Rensselaer Polytechnic Institute. He worked in the Department of Climatology and Ecology until 1984 and then in the Department of Plant Pathology and Ecology until his retirement in December 2019. Frank was appointed to Associate Scientist in 1995 and Scientist in 2014. Frank was steadfast in his love of mathematical modeling of diverse physical and biological systems. He applied diffusion-reaction equations to decipher movement of pesticides in soils, aerial transport of plant pathogenic spores, hydraulics of Connecticut lakes, improved sampling methods for bed bugs and mosquitoes, and spatial dynamics of forest growth. A recognized authority on mathematical modelling, he developed epidemiological models of Late blight on

potato, Septoria leaf spot on tomato, and Nectria canker of black birch. Frank applied his unerring application of logic to practical problems including cultural strategies for management of eggplant, potato, and tomato plants affected by Verticillium wilt. Throughout his long tenure, Frank served as the Station's statistician and earned the respect of all his colleagues. In Frank's later years, he worked closely with Connecticut wine grape growers and served on the Connecticut Farm Wine Development Council. Frank was always cheerful and inspirational. We applaud his lengthy and notable career and wish him the very best for a happy and healthy retirement.

DR. DAVID E. HILL TRIBUTE (by Dr. Abigail Maynard)

APRIL 26, 1929 – AUGUST 8, 2019



When Dr. David E. Hill started at the Station fifty years ago, June 28, 1957, to be exact, he only planned to stay for a year. Dave had just finished his PhD at Rutgers and had intended to return there to teach. When the invitation to return came as expected, he turned it down because he had fallen in love with Connecticut. Over fifty years later, though officially retired, you could still find him every day at Lockwood Farm tending his crops.

Dave did not start his career at the Station growing crops at Lockwood Farm. He spent his early years at the Valley Lab in Windsor working on the State Soil Survey and was coauthor of the first three county surveys. His specialty was interpreting soil survey information, especially concerning sanitary facilities. He was transferred to New Haven in 1966 after his work with the Soil Survey ended.

Dave's work with soils did not end with his move to New Haven. He completed an extensive study of Connecticut and Rhode Island's tidal marshes and the resulting Station bulletin is still requested. His research also included the movement of water and nutrients through the soil (fingers) that continues to be cited.

Dave's career changed when he was asked to assist in the Day-Waverly community garden in New Haven's inner city. Because the soil was poor, Dave established a demonstration plot in the community garden where he tried different methods to improve the soil with various soil amendments. This led to research at Lockwood Farm investigating various mulches and their effect on vegetable yields. In 1982, Dave was asked to head the Station's New Crops Program. For the next 25 years, he studied over 35 fruits and vegetables, many of which had never before been grown in Connecticut. Many growers learned how to grow specialty crops like globe artichokes, Belgium endive, and jilo from his research.

Why did Dave still come out to Lockwood Farm day after day even after retirement? He simply loved to grow things and everyone who met him could not help but be affected by his enthusiasm. He was considered the vegetable expert at the Station. Growers respected him not only for his knowledge but because they knew that he, like them, had been out there living with the crops day after day. He always had time for visitors at the farm and loved to explain about the particular plot he was working on. Quite simply, Dave represented the best of the Station: loyal, dedicated, well-informed, hard-working, all with a friendly demeanor. Indeed, Connecticut is fortunate that Dave made that decision to stay all those years ago.

The Connecticut Agricultural Experiment Station
109th Plant Science Day

Lockwood Farm, Hamden, CT
Wednesday, August 7, 2019

PLANT SCIENCE DAY
2019

The weather on Plant Science Day 2019 was in the 90s. A total of 973 guests visited Lockwood Farm, making it one of the more heavily attended Open Houses at the Farm in recent years.

Director Theodore G. Andreadis welcomed attendees in the Pavilion and gave opening remarks. Ms. Vickie Bomba-Lewandoski moderated the Short Talks and introduced the speakers.

All the short talks were very well attended:

SHORT TALKS:

Dr. James A. LaMondia	**History of Broadleaf Tobacco Production in Connecticut**
Dr. Scott C. Williams	**The Links Between Forest and Public Health**
Dr. Lindsay R. Triplett	**The Carolina Gold Rush: Learning New Secrets from Heirloom Rice**

The Demonstration Tent was full for all the demonstrations of the day:

DEMONSTRATION TENT:

Dr. Abigail A. Maynard	**How to Grow the Best Tomatoes!**
Dr. DeWei Li	**Indoor Molds and Their Management**

Attendees took advantage of several tours around the farm:

BUS TOURS – Mr. Michael Cavadini, Dr. Abigail Maynard, and Dr. Neil Schultes, Guides
Visitors wanting to cool off and take a narrated tour of Lockwood Farm rode an air-conditioned bus for a 30-minute ride. They were able to get off the bus at any plots that interested them and then rejoin the tour when the next bus came around. It was a very popular feature.

BARN EXHIBITS:
A steady flow of visitors went through the barn throughout the day to view the exhibits and listen to scientists explain their research.

- **Emerging Contaminants in the Environment and the Food Supply.** Investigators: Dr. Sara L. Nason and Dr. Nubia Zuverza-Mena.
- **Managing Mature Oak Forests in Connecticut.** Investigator: Dr. Jeffrey S. Ward. Assisted by Mr. Joseph P. Barsky and Ms. Jessica Wikle.
- **Phytophthora Root Rot Management in Christmas Trees.** Investigator: Dr. Richard S. Cowles.
- **Passive Tick Surveillance for Assessing Human Health Risk.** Investigators: Dr. Goudarz Molaei and Dr. Eliza A. H. Little. Assisted by Mr. Alex Diaz, Ms. Mallery Breban, and Mr. Douglas Vuong.

- **Hope for Ash Trees? Biological Control of the Emerald Ash Borer.** Investigator: Dr. Claire E. Rutledge.

- **Ecology and Management of Grapevine Viruses in Connecticut.** Investigator: Dr. Washington L. da Silva.

QUESTION AND ANSWER TENT:
Throughout the day, hundreds of questions were answered by the staff under the Question and Answer Tent. The tent was manned by Ms. Rose Hiskes, Dr. Yonghao Li, Ms. Diane Riddle, and Dr. Gale Ridge.

FIELD PLOTS:
The plots at Lockwood Farm are planted and maintained by The Connecticut Agricultural Experiment Station's scientists and technical staff, along with the help of Farm Manager Mr. Richard Cecarelli and his Research Technicians Mr. Rollin Hannan and Mr. Michael McHill as well as seasonal resource assistants Mr. Harry Tokarz and Mr. Mike Piercey. Visitors were able to visit the following 93 field plots:

CHINESE CHESTNUT TREES	Dr. Sandra Anagnostakis
SHEET COMPOSTING WITH MAPLE AND OAK LEAVES	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
ANNUAL PRODUCTION OF GLOBE ARTICHOKES	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
NUT ORCHARD	Dr. Sandra Anagnostakis
FIG TRIALS IN SELF-WATERING PLANTERS	Dr. Charles R. Vossbrinck, assisted by Mr. Mario DiNatale
USE OF NANOPARTICLES ON FUSARIUM CROWN ROT OF ASPARAGUS	Dr. Wade Elmer, assisted by Mr. Peter Thiel
COMMERCIAL CHESTNUT CULTIVARS	Dr. Sandra Anagnostakis
COMMERCIAL CHESTNUT SEEDLINGS	Dr. Sandra Anagnostakis
REMOTE ACCESS WEATHER STATION	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
TECHNICAL DEMONSTRATION TENT	
CONTROL OF BLIGHT ON AMERICAN CHESTNUTS	Dr. Sandra Anagnostakis
NEW HYBRID CHESTNUT ORCHARD	Dr. Sandra Anagnostakis
USE OF NANOPARTICLES OF METAL OXIDES TO SUPPRESS DISEASES OF PLANTS	Dr. Wade Elmer, Dr. Roberto De La Torre-Roche, Dr. Nubia Zuverza-Mena, Dr. Chuanxin Ma, and Dr. Jason White, assisted by Mr. Peter Thiel

TABLE GRAPE DEMONSTRATION PLOT	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
ENVIRONMENTALLY-FRIENDLY CONTROL OF POWDERY MILDEW ON LANDSCAPE PLANTS	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
USE OF EXPERIMENTAL FUNGICIDES FOR SUPPRESSION OF FUSARIUM WILT OF CHRYSANTHEMUM	Dr. Wade Elmer, assisted by Mr. Peter Thiel and Southern CT State University Interns
STUDENT RESEARCH: CHRYSANTHEMUM WILT DISEASE TRIAL	Ms. Kylee Brown, Mr. Carlos Calderon, Ms. Amanda DeLucia, Ms. Esther Kim, Ms. Kate Manning, Ms. Alenka Mora, Ms. Kawainohiaakalani Navares, Mr. Harvey Ng, Ms. Olivia Rianhard, and Mr. Ethan Tippett, assisted by Dr. Lindsay Triplett and Dr. Wade Elmer
POWDERY MILDEW ON CHARDONNAY WINE GRAPES	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
SEEDLINGS OF OLD SURVIVING AMERICAN CHESTNUTS	Dr. Sandra Anagnostakis
WILD CHESTNUTS FROM TURKEY	Dr. Sandra Anagnostakis
IDENTIFICATION AND CONTROL OF WEEDS OF ORNAMENTAL PLANTS	Dr. Jatinder S. Aulakh, assisted by Ms. Anna Childress
QUESTIONS AND ANSWERS TENT	Ms. Rose Hiskes, Dr. Yonghao Li, Ms. Diane Riddle, and Dr. Gale E. Ridge
COMPOSTING LEAVES USING THE STATIC PILE METHOD	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
HAMDEN POLICE DEPARTMENT	
CROWN CASTLE CELLULAR TOWER	
THE BIG DIPPER	Mr. Harry Rowe
KIDS' KORNER	Ms. Terri Arsenault and Dr. Andrea Gloria-Soria
SELF-GUIDED ACTIVITY FOR ALL CHILDREN, INCLUDING GIRL SCOUTS	Ms. Terri Arsenault
FARM EQUIPMENT USED AT LOCKWOOD FARM	

EXPERIMENT STATION ASSOCIATES	Mr. Skip Hobbs
MODIFICATION OF BIOCHARS FOR NUTRIENT BINDING	Dr. Joseph J. Pignatello, assisted by Dr. Philip Wang
HANDS-ON CHEMISTRY	Dr. Christina Robb, Dr. Walter Krol, Mr. John Ranciato, Mr. Michael Ammirata, and Dr. Jason C. White
USE OF ENGINEERED NANOMATERIALS TO SUPPRESS CROP DISEASES	Dr. Chuanxin Ma, Dr. Roberto De La Torre-Roche, Dr. Nubia Zuverza-Mena, Dr. Wade Elmer, Mr. Peter Thiel, and Dr. Jason C. White
THE PUBLIC HEALTH AND ENTOMOLOGY TENT:	
STATEWIDE MONITORING PROGRAM FOR MOSQUITO-BORNE VIRAL DISEASES IN CONNECTICUT	Dr. Philip Armstrong, Mr. John Shepard, Ms. Angela Bransfield, Mr. Michael Misencik, and Ms. Tanya Petruff, assisted by Ms. Kathryn Cleary, Ms. Caroline Cullen, Mr. William Cutrone, Mr. Patrick Daly, Mr. Aiden Floria, Ms. Noelle Khalil, Mr. Jack Miller, Mr. Michael Olson, Mr. Anthony Perugini, Ms. Demi Rodriguez, and Mr. Joshua Stumpf
THE BLACKLEGGED TICK (DEER TICK) *IXODES SCAPULARIS* AND LONE STAR TICK, *AMBLYOMMA AMERICANUM*	Dr. Kirby C. Stafford III, assisted by Ms. Heidi Stuber, Ms. Sarah Hemstock, and Ms. Jamie Cantoni
AN INTEGRATED TICK MANAGEMENT PROJECT FOR THE CONTROL OF THE BLACKLEGGED TICK, *IXODES SCAPULARIS*	Dr. Kirby C. Stafford III, Dr. Scott C. Williams, and Dr. Megan A. Linske, assisted by Mr. Michael Short, Ms. Heidi Stuber, Ms. Baily C. Willett, and Ms. Meagan de Nicolo
A WORLD OF VIRUSES	Dr. Doug Brackney, assisted by Dr. Josephine Hyde and Mr. Duncan Cozens
APPLE FLOWER MICROBIOME AND ITS IMPACT ON FIRE BLIGHT DISEASE DEVELOPMENT	Dr. Quan Zeng, Dr. Zhouqi Cui, and Dr. Blaire Steven
POP-PRODUCE OVERWINTERING PROGRAM	Mr. Robert Durgy
PROTISTS: TINY HUNTERS OF THE SOIL	Dr. Stephen Taerum and Dr. Blaire Steven, assisted by Ms. Kate Manning and Mr. Carlos Calderon
THE PAVILION AT LOCKWOOD FARM	
NATIVE WOODY SHRUBS	Dr. Jeffrey S. Ward, assisted by Mr. Joseph P. Barsky

BIRD & BUTTERFLY GARDEN	Ms. Jane Canepa-Morrison, Mr. Jeffrey Fengler, and Ms. Lisa Kaczenski-Corsaro
POLLINATOR VISITATION TO *ZINNIA* VARIETIES	Dr. Kimberly A. Stoner, assisted by Ms. Tracy Zarrillo, Ms. Morgan Lowry, Mr. James Durrell, Mr. Jeremy Day, Ms. Annie Bolduc, Ms. Heather Huminski, and Mr. Ben Gluck
INVASIVE AQUATIC PLANT PROGRAM	Mr. Gregory Bugbee, assisted by Ms. Summer Stebbins
HEMP DEMONSTRATION PLOT	Dr. Walter Krol, Ms. Terri Arsenault, Mr. Richard Cecarelli, and Dr. Jason C. White
HEIRLOOM TOMATO VARIETY TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
BUTTERNUT SQUASH TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
ORGANIC CONTROL OF FIRE BLIGHT ON APPLES	Dr. Neil Schultes and Dr. Quan Zeng
CHESTNUT SPECIES AND HYBRIDS	Dr. Sandra Anagnostakis
HEALTHY PLANTS-HEALTHY BUSINESS: SUPPORT OF THE GREEN INDUSTRY BY INSPECTION	Dr. Victoria Lynn Smith, assisted by Ms. Tia Blevins, Mr. Mark Creighton, and Mr. Jeff Fengler
THE COOPERATIVE AGRICULTURAL PEST SURVEY (CAPS) PROGRAM AND PLANT PROTECTION ACT SURVEYS	Ms. Katherine Dugas, assisted by Jacob Gross and Victoria Kamilar
BIOLOGICAL CONTROL OF HEMLOCK WOOLLY ADELGID AND MILE-A-MINUTE WEED	Dr. Carole A. Cheah
THE ROCK	
ASIAN CHESTNUT GALL WASP ON CHESTNUT	Dr. Sandra Anagnostakis
BEACH PLUM TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
PAWPAW TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
HYBRID ELM TREES	Dr. Sandra Anagnostakis

ROCKY HILL AMERICAN CHESTNUT TREES	Dr. Sandra Anagnostakis
PINOT GRIS CULTURAL TRIALS	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
HYBRID AND VINIFERA WINEGRAPE CULTIVAR TRIAL	Dr. Francis J. Ferrandino, assisted by Ms. Joan Bravo
STORAGE ONION TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
SWEET POTATO TRIALS	Dr. Abigail Maynard, assisted by Mr. Joseph Liquori
HOPS – VARIETY EVALUATION AND INTEGRATED PEST MANAGEMENT	Dr. James A. LaMondia and Dr. Elisha Allan-Perkins, assisted by Ms. Michelle Salvas
SUPPRESSION OF PUMPKIN DISEASES WITH NANOPARTICLES	Dr. Wade Elmer, Dr. Roberto De La Torre-Roche, Dr. Nubia Zuverza-Mena, Dr. Chuanxin Ma, and Dr. Jason White, assisted by Mr. Peter Thiel
CONNECTICUT BOTANICAL SOCIETY	Truda Steinnagel, David Yih, Frank Kaputa, and Sigrun Nicodemis
UCONN INTEGRATED PEST MANAGEMENT TEAM (IPM)	Mary Concklin
US DEPARTMENT OF LABOR OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)	Leona May
SLEEPING GIANT PARK ASSOCIATION	Julie Hulten
HAMDEN ALLIANCE FOR TREES	Henry Dynia and Dick Hasbany
CONNECTICUT FOREST AND PARK ASSOCIATION	Amelia Graham, Emma Kravet, and Lindsay Suhr
CONNECTICUT INVASIVE PLANT WORKING GROUP	Charlotte Pyle
CONNECTICUT FARM BUREAU ASSOCIATION	
US DEPARTMENT OF LABOR WAGE AND HOUR DIVISION (WHD)	Heather Callahan
WILD ONES – MOUNTAIN LAUREL CHAPTER	Lydia Pan

US DEPARTMENT OF AGRICULTURE FARM SERVICE AGENCY (FSA)	Teresa Peavey and Kathy Dangelo
US DEPT. OF AGRICULTURE, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, PLANT PROTECTION AND QUARANTINE (APHIS-PPQ)	Charles Baker
FEDERATED GARDEN CLUBS OF CONNECTICUT, INC.	Karin Pyskaty, Arlene Field, Polly Brooks, and Shirley Hall
LYMAN HALL HIGH SCHOOL AGRICULTURAL SCIENCE AND TECHNOLOGY PROGRAM	Emily Picard and students
BARTLETT ARBORETUM	Mike Belletzkie
AGRIVOLUTION	Richard Fu
CONNECTICUT FARMLAND TRUST	Brianna Dunlap, Kathleen Doherty, and Lily Orr
CONNECTICUT CHRISTMAS TREE GROWERS ASSOCIATION	Kathy Kogut, Dick Jaynes, and Joe Vignola
CONNECTICUT ENVIRONMENTAL COUNCIL	Erica Fearn
CONNECTICUT HORTICULTURAL SOCIETY	Cheryl Marino
US DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE (NRCS)	Jacob Isleib
CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION, FORESTRY (CT DEEP FORESTRY)	Chris Donnelly and crew
CONNECTICUT COLLEGE ARBORETUM	Mary Villa, Leigh Knuttel, Bryan Goulet, and Kraig Clark
CONNECTICUT TREE PROTECTIVE ASSOCIATION	
TREE-SAVERS, LLC	Jayme Boniewicz, Justine Lishman, and Kayla Zaleski
CONNECTICUT DEPARTMENT OF AGRICULTURE (DoAg)	Rebecca Murphy
US DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE (NRCS) SoilSHOP	Tarah Somers (ATSDR), Meg Harvey (CT-DPH), and Jacob Isleib (USDA-NRCS)

SOUTH CENTRAL CONNECTICUT REGIONAL WATER AUTHORITY	Kate Powell, Lisa DiFrancesco, Ron Walters, and Josh Tracy
UCONN EXTENSION MASTER GARDENER PROGRAM	Cheryl Cappiali
CONNECTICUT PROFESSIONAL TIMBER PRODUCERS ASSOCIATION	Brennan Sheahan

Lockwood Farm made a beautiful appearance due to the hard work of the farm crew: Richard M. Cecarelli (Farm Manager), Rollin J. Hannan, Jr., and Michael M. McHill, who worked on the plots, grass, trimming, and setup. The barns, buildings, and grounds were cleaned by the Maintenance crew – Eric Wagner (Supervisor), Eric Flores, Brian Hart, Ronald A. LaFrazier, and Miguel Roman. They also delivered all items needed for the day to the farm. Tent setups were done by Eric Flores, Brian Hart, Ronald LaFrazier, and Miguel Roman. The podium, tables, and chairs setup in the pavilion, washing tables and chairs, and the cleaning of the cement floor were all done by Richard Cecarelli, Eric Flores, Brian Hart, Ronald LaFrazier, Michael McHill, and Miguel Roman.

At 10:45 a.m., Director Theodore G. Andreadis presented the Century Farm Award to Hastings Farm, LLC, of Suffield, Connecticut.

CENTURY FARM AWARD

Hastings Farm, LLC
Suffield, CT

The Century Farm Award is given to a farm that has been in family operation for more than 100 years. The recipient is selected by the Connecticut Agricultural Information Council.

Proclamation from Governor Ned Lamont:

Hastings Farm is currently farmed by owners Lawrence and Susan Hastings, and their daughters Megan and Lauren, with help from extended family and several longtime employees that are like extended family. The original 59 acres of the farm was acquired by Lawrence's grandfather Howard Hastings in 1916, a time when farms were quite diversified. There were sheep, pigs, tobacco, milking cows, and a small orchard that comprised the farming activities. Consequently, each generation has purchased adjoining farms through the years with the last purchase of 47 acres in 2014 so that the farm now totals 200 acres, with 138 acres of that being preserved farmland.

By the 1930s, the Hastings family had changed the focus of the farm to concentrate on milk and tobacco as the main crops, with the first milking machine and tractor on the farm, a Farmall F12, purchased in 1936. The old sheep barn was converted to a milking barn and an addition added to the barn in 1947 in order to increase the herd of milkers. In 1956, when Howard died and Richard Hastings (father of Lawrence) took over the farm, the focus was changed again to only dairy production, and the old tobacco barns were converted to other uses such as cattle housing, a workshop, and storage. Today, only one of the sheds remains on the farm as a loafing barn for dry cows and heifers. The other 3 sheds on the farm were destroyed in the 1979 tornado that ripped through our area. The tornado was a blessing in disguise since it presented the opportunity to replace the old sheds with more efficient buildings better suited for their purposes. Also

destroyed and rebuilt was a large section of the freestall barn that was built in 1972 when Richard and Lawrence were in business as partners.
In the 1990s, the farm passed from Richard and Lawrence to Lawrence and Susan, and then in 2010, an LLC was formed with the next generation involved in the ownership and operation of the farm to ensure its continuance. In 2011, the focus of our products shifted once again to include processing of our milk on the farm, and a farm store, to take advantage of the benefit of value-added products. Today, our Greek style yogurt and Cream-Line milk can be found in grocery stores and farm markets throughout the state. A small herd of beef cattle can also be found wandering on the farm to provide our farm store with homegrown grass-fed beef.

Hastings Farm has become a blend of the old and new with the original barn dating from circa 1830, and listed on connecticutbarns.org, to the newest barn addition in 2016 to house the Delaval VMS robotic milker, the first of its kind in the state. With innovation, hard work, and a strong family bond, we hope to be here for another 100 years.

At 11:15 a.m., Director Theodore G. Andreadis introduced Mr. Keith B. Bishop, Co-CEO, Treasurer, and Winemaker of Bishop's Orchards in Guilford, as the Samuel W. Johnson Memorial Lecturer. He gave a talk entitled "What Your Grandparents Couldn't Teach You: Seven Generations of Adapting Stewardship."

EVENTS HELD AT THE STATION

Bed Bug Forum XI

Dr. Gale E. Ridge held Bed Bug Forum XI at the Experiment Station's Jones Auditorium on November 7, 2019. There were 74 attendees. Dr. Kirby Stafford provided the welcome. The speakers were:

- Dr. Gale E. Ridge, "Bed Bug Research: Understanding an Enigma"
- Dr. Kirby C. Stafford III, "Review of the "Natural" Product Minefield for Bed Bug Control"
- Attorney Judith R. Dicine, "Bed Bugs – CT Legal Aspects"
- Daniel E. Wollman, "Sensation and Emotion: A Discussion of Human Interaction with the Insect World?"

Advocating for the Biological Value of Your Utility Right-of-Way Conference

Dr. Kimberly Stoner, along with the Right-of-Way Working Group of the Connecticut Botanical Society, organized a conference entitled "Advocating for the Biological Value of Your Utility Right-of-Way" on March 12, 2020, held in Jones Auditorium and also by ZOOM, due to the COVID-19 virus. Twenty-nine people participated.

The speakers were:

- Kimberly Stoner, Introduction: Advocating for Your Local Right of Way
- Donna Merrill, Wilton Land Trust
- Sean Redding and Marissa Flynn of Eversource (via ZOOM)
- Kimberly Stoner, Advocating for Your Local Right of Way – Some Basics
- Bill Moorhead (via ZOOM), Natural Diversity Database and other ways to document value of ROW habitat
- Robert Askins, Birds and ROW habitat
- Lisa Wahle, New England Cottontails and ROW habitat
- Sigrun Gadwa and George Logan – Research on ROW habitat and Recommendations from CT Botanical Society on Best Management Practices for ROW

All the materials from this conference were shared with the listserv for the Connecticut Land Conservation Council and are posted on their website: http://www.ctconservation.org/information-powerline-right-way-vegetation-management.

EVENTS HELD AT LOCKWOOD FARM

2019 Connecticut FFA Association Forestry Career Development Event

On November 22, 2019, the Department of Forestry and Horticulture hosted the Connecticut FFA Association Forestry Career Development Event (CDE) at the Lockwood Farm Pavilion. This year's Forestry CDE evaluated students' knowledge of forest management practices, forest mensuration, topographic map interpretation, forestry-related equipment, chainsaw troubleshooting, and tree identification. Forty-eight students from 12 State FFA Chapters participated in this year's event, with the 4- student team from E. O. Smith High School Agricultural Education Program taking first place. Students from E. O Smith FFA will represent the State of Connecticut in regional and national competitions at the

2020 Eastern States Exposition and the 2020 National FFA Convention in Indianapolis, IN. We would like to thank Eric Hansen of Ferrucci & Walicki, LLC for his assistance. Dr. Scott Williams, Mr. Michael Short, and Mr. Joseph P. Barsky of the Dept. of Forestry and Horticulture and Dr. Megan Linske of the Dept. of Entomology organized and oversaw the event.

EVENTS HELD AT THE VALLEY LABORATORY

Tobacco Research Meeting

Ninety-five people attended the Connecticut Agricultural Experiment Station's annual Tobacco Research Meeting held at the East Windsor Scout Hall on February 25, 2020. Dr. Jim LaMondia welcomed growers and spoke about recent developments at the Experiment Station. The meeting addressed a wide variety of issues of concern to growers. Jon Anderson from the Kentucky Fish and Wildlife Resources Department introduced growers to No-till or strip till tobacco production and examples from Kentucky. Thomas Rathier spoke about carbon and nitrogen in well drained tobacco soils. Christina Berger of the DEEP spoke about Worker Protection Standard updates. Jim LaMondia spoke about fungicide residue management in wrapper tobaccos and Low Converter varieties of Connecticut broadleaf and a plant breeding progress update. Joe Bonelli (UConn Cooperative Extension) and Colleen Kisselburgh (Arthur Carroll Insurance) discussed risk management in tobacco and the tobacco insurance program. Martha Dorsey of the Farm Services Administration provided updates on FSA services to growers. Andrew Urbanowicz, Dave Arnold and Paul Polek presented an update on the Connecticut-Massachusetts Tobacco Growers Association. Brianna Dunlap and members of the Tobacco Museum Board had information available about the museum and the need for grower input and support. Jane Canepa-Morrison, Jim Preste and Michelle Salvas assisted with much of the behind the scenes work for the meeting. The meeting qualified for pesticide applicator re-certification credit in Connecticut and Massachusetts and 62 persons received credit.

THE STATION IN THE COMMUNITY

Harvest for the Connecticut Food Bank

CAES sponsored a harvest at Lockwood Farm with the Connecticut Hiking Alliance to harvest fruits and vegetables for the Connecticut Food Bank on August 29, 2019.

UConn-CAES Spring Bedding Plant Meeting

CAES co-sponsored the UConn Bedding Plant Program for Greenhouse Growers, which was organized by Ms. Leanne Pundt and Dr. Rosa Raudales from UConn, in Torrington on February 11, 2020 (35 attendees).

DONATIONS MADE TO THE COMMUNITY

Lockwood Farm

A total of 22,004 pounds of fresh produce, including apples, cabbage, eggplant, peppers, pumpkins, sweet potatoes, tomatoes, and winter squash grown at Lockwood Farm were donated to the Albert J. Solnit Children's Center in Middletown, Connecticut Food Bank in Wallingford, Davenport Dunbar Home Pantry in Hamden, Gianelli's Early Learning Center in Middletown, Hamden/North Haven YMCA in Hamden, Unitarian Society of New Haven in Hamden, Waverly House in New Haven, and Wesley School in Middletown. Farm Manager Richard Cecarelli arranged for the distribution of the produce.

Valley Laboratory

A total of 17,000 pounds of fresh produce including butternut squash, acorn squash, muskmelons, summer squash, sweet corn, tomatoes, peppers and pumpkins grown at the Valley Laboratory were donated to Foodshare of Hartford. Mr. Preste, Drs. Abigail Maynard, David Hill, and James LaMondia generated the fresh produce, and Jim Preste and Dr. LaMondia organized the distribution effort. The Valley Laboratory also donated two bins of pumpkins to Northwest Park in Windsor and loaned irrigation equipment to the Connecticut Epilepsy Foundation in support of their Mud Volleyball Tournament Fundraiser. Mr. Preste coordinated the distribution of the irrigation equipment.

AWARDS AND RECOGNITION RECEIVED BY STATION STAFF

On August 6, 2019, Dr. Wade H. Elmer was presented with an APS Fellow Award at the Annual Meeting of the American Phytopathological Society held in Cleveland, OH.

On August 19, 2019, Dr. Megan Linske was invited to serve on the Wildlife Society's Leadership Institute Committee by President-Elect Gary White.

On October 1, 2019, Dr. Washington da Silva was appointed Assistant Scientist, a gratis adjunct faculty position, for the Dept. of Plant Science and Landscape Architecture at the UConn College of Agriculture, Health and Natural Resources.

On October 29, 2019, Dr. Nubia Zuverza-Mena was accepted as a Level I researcher by the Mexican Council of Science and Technology (CONACYT), as part of their National System of Researchers (Spanish acronym: SNI).

On November 13, 2019, Dr. Nubia Zuverza-Mena was appointed Assistant Research Scientist, a gratis adjunct faculty position, for the Dept. of Plant Science and Landscape Architecture at the UConn College of Agriculture, Health and Natural Resources.

On December 5, 2019, Dr. Washington da Silva was elected to the Board of the Connecticut Farm Wine Development Council as the representative from The Connecticut Agricultural Experiment Station.

On December 9, 2019, Dr. Theodore Andreadis was granted "Honorary Membership" in the Northeastern Mosquito Control Association for scientific contributions to the association and mosquito control professionals in the Northeast.

On December 19, 2019, Dr. Lindsay Triplett and Dr. Christina Robb were awarded the Louis A. Magnarelli Postdoctoral Fellowship Award for their joint proposal entitled "Plant Hormones: Linking Soil Microbes and Predators to Crop Health," which will employ postdoctoral research scientist Dr. Ravi Patel, who brings extensive experience in analyzing phytohormone production in beneficial bacteria.

On February 22, 2020, Dr. Josephine Hyde was awarded the ASM Peggy Cotter Travel Award worth $1,650 for Early Career Branch Members (DC Branch) to attend the ASM National Meeting in June 2020.

On March 12, 2020, Dr. Wade H. Elmer was awarded (in absentia) the Award of Merit in recognition of service to the Northeastern Division of the American Phytopathological Society.

On March 24, 2020, Dr. Joseph Pignatello received the 2019 Soil Science Society of America Journal (SSSAJ) Outstanding Associate Editor Award.

On March 25, 2020, Dr. Megan Linske was elected President-Elect of the Northeast Section of The Wildlife Society.

On April 17, 2020, Dr. Goudarz Molaei was assigned to lead the Vector-Borne Disease subgroup of the "Connecticut Governor's Council on Climate Change (GC3) Adaptation Planning and Implementation Working Group."

On April 20, 2020, Dr. Washington da Silva was awarded the prestigious Schroth Faces of the Future Award from the American Phytopathological Society (APS) and was invited to present his research and vision on

the Future of Virology Research as a keynote lecturer at the Annual APS Meeting “Plant Health 2020” to be held in Denver, CO, August 8-12, 2020. The symposium was designed to acknowledge up-and-coming and forward-thinking scientists who are shaping the future of their respective scientific discipline.

On April 27, 2020, Dr. Jatinder Aulakh was awarded the Experiment Station Associates (ESA) Early Career Scientist Award for his project entitled “Is the Newly Discovered Palmer Amaranth Population in Connecticut Herbicide-Resistant?”

On June 30, 2020, Dr. Christina Robb accepted a 2021 editorial review position for the *Journal of Liquid Chromatography*.

On June 16, 2020, Mr. Joseph P. Barsky was elected as Vice-Chair of the Connecticut State Consulting Committee for Agricultural Science and Technology Education.

On June 23, 2020, Mr. Joseph P. Barsky was elected as Park Naturalist for the Sleeping Giant Park Association.

THE PUBLIC SPEAKS

On August 3, 2019, Jeanne Millet wrote the following to Yonghao Li. “We followed your recommendations and have had excellent results....THANK YOU!”

On August 12, 2019, Kevin Sullivan wrote the following to Theodore Andreadis about Mark Creighton. “You might remember my days on the CNLA Board and our strong belief in the survival of CAES. Today, I had an experience that certainly confirms that our participation in helping maintain the CAES is well worth the effort. My wife Krist and I are attempting to repurpose some of the now dormant nursery land into apiary use. We have a lot to learn!! We recently reached out to Mark Creighton for a beehive inspection. What an outstanding experience....prompt, courteous and very knowledgeable. We are very impressed by the level of information that was imparted while we physically worked through a number of the hives. This is an important part of the horticultural world and Mark certainly demonstrates that CAES is willing and capable of keeping bees in the air. Keep up the good work and feel free to call upon me anytime if I can help advance the mission of the Station.”

On August 29, 2019, Sara Davies wrote the following to Vickie Bomba-Lewandoski. “Thank you so much for taking the time to meet with me. I thoroughly enjoyed the tour of the facility. Everybody that I met was so kind and passionate about their work, it left a great impression on me. I learned a lot about the different areas of entomology and how it is applied in the real world. I appreciate the suggestions of colleges and majors, which will hopefully lead me to a career in a lab like the Connecticut Agricultural Experiment Station. This experience has solidified my decision to pursue entomology. As suggested, I look forward to reaching out to you in the spring about possible summer job opportunities.”

On September 24, 2019, Shavaun Bennett, Yale University Women’s Organization, wrote the following to Theodore Andreadis. “The tour was a wild success!! Thank you for all of the arrangements and for your introductory overview of the history and current work of the Station. It was perfectly geared to the group and the timeframe as were the individual lab tours. So many people came up to me (or emailed!) afterwards to thank me for creating the opportunity. I told them all to encourage their legislators’ support.”

On September 24, 2019, Shavaun Bennett, Yale University Women’s Organization, wrote the following to Goudarz Molaei. “Your talk yesterday on tickborne diseases was fascinating but also perfectly geared to the level of the group and the timeframe within which we were operating. Thank you so much for sharing your lab, your valuable time and your enthusiasm with us.”

On September 24, 2019, Shavaun Bennett, Yale University Women’s Organization, wrote the following to Gale Ridge. “Your talk yesterday on the kinds of insect inquiries and research you handle was fascinating and the perfect culmination to a wonderful tour. Thank you for sharing your lab, your valuable time and your enthusiasm.”

On September 24, 2019, Shavaun Bennett, Yale University Women’s Organization, wrote the following to Vickie Bomba-Lewandoski. “My heartfelt thanks for your efforts in setting up and guiding our tours yesterday. The tour got rave reviews.”

On September 26, 2019, Michael Hillgen-Santa wrote the following to Gale Ridge about Mark Creighton. “I stopped by with that Marble spider a couple weeks ago and you gave me the numbers to your colleague Mark Creighton. He stopped by today and it was a pleasure to work with him. I learned more in an hour than I have with the 15 or so hours or YouTubing beekeeping and reading the entire Beekeepers handbook I have. What an important resource and thanks for introducing me to Mr. Creighton. You folks are the best.

On October 11, 2019, Don Mitchell, Chatham Health District, wrote the following to Gale Ridge. “I just want to thank you for all your help and entertainment over the years. You are a very special scientist and person.”

On November 4, 2019, Dorothy Eagan wrote the following to Goudarz Molaei. “Thank you so much for your service. I have made use of your laboratory three times this summer and consider myself fortunate to have you so available and reliable. Thanks to everyone involved!”

On November 5, 2019, Elizabeth Morin wrote the following to Yonghao Li. “Thank you very much. Perfect timing too as I was literally just getting ready to place next year’s order for the same locations. CAES is the best!”

On November 19, 2019, Kelly Leng, Cheshire Public Schools, wrote the following to Joseph P. Barsky. “Please accept my sincere thanks for making the time to participate in Sophomore Career Day this year! I understand how busy you are and the effort it takes to rearrange schedules and prioritize challenging workloads. By being here today, you show kids they matter. Thank you for sharing information about your career with our students because by doing so, you open up their world to what is possible. The information you provide helps students make appropriate course selections and inspires them to participate in extracurricular and volunteer experiences.”

On January 24, 2020, Kurt Bengtson, Thomaston Tree, wrote the following to Rose Hiskes. “Firstly, I would like to thank you for all your tedious effort and accomplishments with the management guide for arborists in which is a significant tool for success many times over. I believe I have come upon a moderate existence of Japanese Maple Scale on some older plantings of ornamental crabapples in which was seemingly hard to identify for me since I hadn’t really seen it before on crabapples. I understand it was first discovered in Connecticut in 1914. Also, that it is hard to control. I was wondering if you had any control dates available. I thank you for your time and hope the arborist community delivers the appreciation you and your colleagues deserve.”

On March 1, 2020, Hannah Halfpenny, Me Myself and Everyone Else, wrote the following to Gale Ridge. “I am writing to thank you for the fantastic work that you do. I run a Mental Health podcast in Scandinavia, covering the history, science and culture that surrounds different disorders. We recently made an episode on Delusional Parasitosis and during my research I came across an article on statnews.com that mentioned you and the fantastic work that you are doing to help people with DP….Thank you again for being so compassionate and helpful towards people suffering from DP, you are truly an inspiration!”

On March 17, 2020, George Ling wrote the following to Dr. Molaei. “Thank you for your work and these test results. I very much appreciate the speed with which these tests have been conducted.”

On March 18, 2020, Alice Osborn, Wilton Health Department, wrote the following to Dr. Molaei. “We received a number of timely results in today’s mail. As I matched them up with the original transmittal, I thought how many of our townspeople relay their thanks and relief to me. Often submittals are turned in with one-minute stories, existing health issue, fear, worry, concern that the tick was on a child, a parent, or visitor. Surely in these times, it’s a good thing to pass on their gratitude and appreciation for the availability of the CAES Lab. Thank you each.”

On March 30, 2020, Mara Thompson wrote the following to Goudarz Molaei. “Thank you very much for your very quick turnaround in connection with the testing of the specimen you received on my behalf last week. Thank you again for your outstanding response.”

On April 1, 2020, Janna Eastwood wrote the following to Goudarz Molaei. “I wanted to thank you for speaking with me this afternoon. I also wanted to thank you for responding with the testing results so quickly given the current climate with COVID-19.”

On April 14, 2020, Liliane McClenning wrote the following to Yonghao Li. “Thank you very much for sending this information. Hopefully it will be helpful for my friend. Your department is always helpful. Whenever I had a problem related to plants, etc., I always felt secure in asking for advice from your department.”

On April 15, 2020, James Brewczynski, a resident of Hamden, wrote the following to Yonghao Li. “Thank you for your timely and informative reply. The linked info was very helpful regarding mechanical removal as well as comparisons to other berry varieties. It was nice to learn how to differentiate between species. Our community, and I, are very fortunate to have you sharing your expertise with us.”

On April 17, 2020, Carole Reichhelm, a resident of Westport, wrote the following to Yonghao Li. “You’re a total rock-star!!! Can’t thank you enough! Here’s to a great planting season (something to look forward to in all this gloom…..).”

SCIENTIFIC OFFICERSHIPS AND MEMBERSHIPS ON STATE, NATIONAL, OR REGIONAL COMMITTEES

DEPARTMENT OF ANALYTICAL CHEMISTRY

JASON C. WHITE

- Immediate Past President, International Phytotechnology Society
- Managing Editor, *International Journal of Phytoremediation*
- Editorial Board, *Environmental Pollution*
- Editorial Board, *NanoImpact*
- Editorial Advisory Board, *Environmental Science & Technology*
- Editorial Advisory Board, *Environmental Science & Technology Letters*
- Science Advisory Board, Annual International Conference on Soils, Sediments, Water, and Energy
- Advisor, Nanotechnology Advisory Group, Society of Environmental Toxicology and Chemistry
- Member (ad-hoc), FDA Food Emergency Response Network (FERN) Method Coordination Committee (MCC)
- Member, FDA Flexible Funding Model (FFM) Workgroup

BRIAN D. EITZER

- Member, Conservation Commission for the Town of Bethany
- Member, Regional Water Authority Representative Policy Board
- Member, Organizing Committee for the North American Chemical Residue Workshop

CHRISTINA S. ROBB

- Board Member, Eastern Analytical Symposium (Short-Course Vice-Chair 2019, Short Course Chair 2020, Long Range Planning Committee 2020)

DEPARTMENT OF ENTOMOLOGY

KIRBY C. STAFFORD III

- Member, Board, Connecticut Coalition Against Bed Bugs
- Member, Tick IPM Working Group
- Member, NEVBD Tick Working Group
- Member, Tick Biology, Ecology, and Control subcommittee of the Health and Human Services National Tick-Borne Disease Working Group
- Assistant Clinical Professor Department of Medical Sciences, Frank H. Netter MD School of Medicine, Quinnipiac University

MEGAN A. LINSKE

- President-Elect, The Wildlife Society, Northeast Section
- Executive Secretary, The Wildlife Society, Northeast Section
- Workshop Committee Chairperson, The Wildlife Society, Northeast Section
- Awards Committee Member, The Wildlife Society, Northeast Section
- Leadership Institute Mentor, The Wildlife Society
- Leadership Institute Selection Committee Member, The Wildlife Society
- Network and Engagement Committee Member, The Wildlife Society
- Adjunct Faculty, Unity College Distance Education Program

- Postdoctoral Trainee, The Northeast Regional Center of Excellence in Vector-Borne Diseases

GALE E. RIDGE
- Chair, Connecticut Coalition Against Bed Bugs
- Assistant Clinical Professor, Department of Medical Sciences, Frank H. Netter MD School of Medicine, Quinnipiac University
- Member, EPA FIFRA Scientific Advisory Board
- Member, State Health Improvement Plan (SHIP)
- Honorary Member, Connecticut Pest Management Association (CPCA)
- Member, Board, Sustainable Connecticut

CLAIRE E. RUTLEDGE
- Director (board member), Connecticut Tree Protective Association
- Treasurer (since January 2019), Connecticut Tree Protective Association

VICTORIA LYNN SMITH
- Member and Past President, Eastern Plant Board
- Member, National Plant Board Systems Approach to Nursery Certification Committee
- Member, New England Wildflower Society, Connecticut Task Force
- Member, Yale Biosafety and Recombinant DNA Committee
- Member, Northeast Area Association of State Foresters Firewood Working Group
- Member, USDA-APHIS-PPQ Early Detection-Rapid Response Committee
- Member, National Clean Plant Network Fruit Tree Committee

KIMBERLY A. STONER
- Member, Multi-State Research Project NC1173 – Sustainable Solutions to Problems Affecting Bee Health
- Organizer and Member, Connecticut Native Plant, Pollinator, and Wildlife Working Group
- Member, Connecticut Friends of Right-of-Way Habitat Stakeholder Group
- Member, Agriculture and Soils Working Group of the Governor's Council on Climate Change (GC3)
- Member, M.S. Graduate Committee, Benjamin Gluck, University of Connecticut
- Member, Ph.D. Graduate Committee, John Campanelli, University of Connecticut

DEPARTMENT OF ENVIRONMENTAL SCIENCES

DR. JOSEPH J. PIGNATELLO
- Editorial Board, *Molecules*
- Editorial Board, *Environmental Engineering Science*
- Associate Editor, *Soil Science Society of America Journal*
- Editorial Board, *Environmental Research*
- Secretary, The Connecticut Agricultural Experiment Station Research Foundation, Inc.
- Agriculture, Food & Nutrition Technical Board Chair, Connecticut Academy of Science and Engineering

THEODORE G. ANDREADIS
- Adjunct Professor, Department of Pathobiology, University of Connecticut
- Clinical Professor, Epidemiology of Microbial Disease Division, Yale University School of Public Health

- Administrative Advisor, Multi-State Research Project NE-1043: Biology, Ecology & Management of Emerging Disease Vectors
- Administrative Advisor, Multi-State Research Project NE-1306: Management of the Marmorated Stink Bug
- Subject Editor, *Journal of Medical Entomology*
- Member, Connecticut Academy of Science and Engineering
- Member, State of Connecticut Mosquito Management Program
- Member, Selection Committee, Connecticut Century Farm Award

DR. PHILIP ARMSTRONG
- Clinical Associate Professor, Department of Epidemiology of Microbial Diseases, Yale School of Public Health
- Member, Multi-State Research Project NE-1443: Biology, Ecology, and Management of Emerging Disease Vectors
- Guest Editor, *PLOS Neglected Tropical Diseases*

DR. DOUGLAS E. BRACKNEY
- Assistant Adjunct Professor, Section of Infectious Diseases, Yale School of Medicine
- Assistant Adjunct Clinical Professor, Microbial Diseases Division, Yale School of Public Health

MR. GREGORY J. BUGBEE
- President Elect, Northeast Aquatic Plant Management Society
- Panelist, Northeast Aquatic Nuisance Species Panel
- Director, Clear Lake Improvement Association

DR. ANDREA GLORIA-SORIA
- Laboratory Associate, Department of Ecology and Evolutionary Biology, Yale University

DR. GOUDARZ MOLAEI
- Associate Clinical Professor, Department of Epidemiology of Microbial Diseases, Yale School of Public Health
- Editorial Board member, *Tropical Medicine and Infectious Diseases*
- Lead, Vector-borne Disease subtopic of the Public Health Section of Connecticut Governor Council on Climate Change
- Member, Multi-State Research Project NE-1443: Biology, Ecology, and Management of Emerging Disease Vectors

DR. SARA L. NASON
- Adjunct Assistant Research Scientist, Department Plant Science and Landscape Architecture, University of Connecticut

MR. JOHN SHEPARD
- Treasurer, Northeastern Mosquito Control Association

DR. BLAIRE STEVEN
- Adjunct Assistant Research Professor, Department of Natural Resources and the Environment, University of Connecticut
- Editorial Board, *Canadian Journal of Microbiology*

DEPARTMENT OF FORESTRY AND HORTICULTURE

JEFFREY S. WARD
- Chair, Yankee Division, Society of American Foresters (SAF)
- Program Chair, New England Society of American Foresters
- Chair, Connecticut Forest Ecosystem Monitoring Cooperative
- Field Tour Coordinator, 2020 National Society of American Foresters Convention
- Secretary, Connecticut Tree Protection Examination Board
- Secretary, Connecticut Invasive Plant Council
- Member, New England Forestry Foundation's North Central & Transition Hardwoods Exemplary Forestry Standards Technical Advisory Committee
- Member, Yankee Division, SAF, Forest Management and Carbon Task Force
- Member, Audubon Connecticut Science Committee
- Ex-Officio Member, Goodwin Scholarship Committee

JOSEPH P. BARSKY
- Chair, State Consulting Committee for Agricultural Science and Technology Education
- Editor, NESAF News Quarterly, New England Society of American Foresters
- Park Naturalist, Sleeping Giant Park Association
- Member, Consulting Committee, Vernon E. Cleaves Agricultural Science and Technology Program
- Member, Connecticut Environmental Review Team

MARTIN P. N. GENT
- Associate Editor, *Journal of Plant Nutrition*

ABIGAIL A. MAYNARD
- Member, Editorial Board, Compost Science & Utilization
- Ex-Officio Member, Connecticut Council on Soil and Water Conservation
- Member, State Technical Committee
- Member, Steering Committee, 2019 New England Vegetable and Berry Conference
- Member, Agriculture/Soils Sub-Working Group of the Working and Natural Lands Working Group
- Member, Soil Health Subcommittee, Connecticut Council on Soil and Water Conservation

SCOTT C. WILLIAMS
- Adjunct Professor, Department of Natural Resources and the Environment, University of Connecticut, Storrs
- Immediate Past-President, The Wildlife Society, Northeast Section
- Certified Wildlife Biologist, The Wildlife Society
- Associate Editor, *Animals*
- Editorial Advisory Board Member, The Wildlife Professional
- Commissioner, Town of Guilford Inland Wetlands Commission
- Commissioner, Town of Guilford Conservation Commission

DEPARTMENT OF PLANT PATHOLOGY AND ECOLOGY

WASHINGTON DA SILVA
- Adjunct Professor, Universidade Federal Rural do Semi-Árido (UFERSA), Brazil
- Adjunct Faculty, University of Connecticut (UConn)

- Member, Research Thesis Advisor, Southern Connecticut State University
- Member, New England, New York and Canada Tree Fruit Pest Working Group
- Member, Thesis Advisory Committee, Universidade Federal Rural do Semi-Árido (UFERSA), Brazil
- Chair, Working Group, American Phytopathological Society (APS) and the Brazilian Society of Plant Pathology (SBF)
- Member, Connecticut Farm Wine Development Council
- Member, Science/Education Committee, Connecticut Farm Wine Development Council
- Associate Editor, Portuguese Translations for the Plant Health Instructor/APS Education Center

WADE H. ELMER
- Director, The Connecticut Agricultural Experiment Station Research Foundation, Inc.
- Associate Editor, *Crop Protection*
- Senior Editor, APS Press
- Chair, Ornamental Disease Committee, American Phytopathological Society
- Member, Widely Prevalent Fungi List Committee, American Phytopathological Society
- Member, Northeast Research, Extension and Academic Programs Committee for IPM
- Member, Thesis Advisory Committee, University of Connecticut
- Member, Thesis Advisory Committee, University of Texas at El Paso
- Member, Thesis, Advisory Committee, Federal University, Lavras, Brazil
- Member, Thesis Advisory Committee, Federal University, Lavras, Brazil

YONGHAO LI
- Member, Tree Improvement Committee, Connecticut Christmas Tree Grower Association
- Member, Scholarship Committee, Connecticut Nurserymen's Foundation
- Member, Online Communication and Web Portal Committee, National Plant Diagnostic Network
- Member, Honorary Advisory Board, Edgerton Park Conservancy

ROBERT E. MARRA
- Member, Phytopathology Committee, Mycological Society of America
- Member, Forest Pathology Committee, American Phytopathological Society
- Chair, Forest Ecosystem Monitoring Cooperative, Connecticut State Partnership Committee
- Member, Connecticut Conference on Natural Resources Steering Committee. Founding Member
- Immediate Past-President, Executive Committee, Northeast Division of the American Phytopathological Society
- Chair, West Haven Tree Commission

NEIL P. SCHULTES
- Fellow, The Linnaean Society of London
- Vice President and Executive Board Member, Quinnipiac Chapter of Sigma Xi

LINDSAY R. TRIPLETT
- Senior Editor, *Plant Disease*
- Associate Editor, *Phytobiomes*
- Faculty Affiliate, Colorado State University
- Gratis Faculty, University of Connecticut
- Chair, APHIS Widely Prevalent Bacteria committee
- Member, Thesis Advisory Committee, Michigan State University
- Member, Bacteriology Committee, American Phytopathological Society

QUAN ZENG
- Member, New England, New York and Canada Tree Fruit Pest Working Group
- Member, Bacteriology Committee, American Phytopathological Society
- Adjunct Scientist, University of Connecticut

VALLEY LABORATORY

JATINDER AULAKH
- Member, Connecticut Invasive Plants Working Group

CAROLE CHEAH
- Fellow, Cambridge Philosophical Society, UK

JAMES A. LAMONDIA
- Northeast Regional Project NE-1040, "Plant-parasitic Nematode Management as a Component of Sustainable Soil Health Programs in Horticultural and Field Crop Production Systems"
- Senior Editor, *Journal of Nematology*
- Chair, Connecticut Agricultural Information Council
- Member, Century Farm Award Selection Committee
- Ex-Officio Member, Connecticut Tree Protection Examining Board
- Member, CT Vegetable & Small Fruit Growers' Conference Steering Committee
- Member, GLOBAL Globodera Alliance Advisory Board

DEWEI LI
- Associate Editor, *Aerobiologia*
- Editorial Board Member, *Fungal Biology and Biotechnology*

LECTURES, SEMINARS, AND INTERVIEWS

During the year, staff members present formal lectures and seminars to organized groups outside The Station. They also describe their research to organized groups visiting The Station. Occasionally they report their research to elected officials. At still other times newspaper, radio, and TV reporters interview our staff. These occasions are listed below.

ANDREADIS, THEODORE G.

- Hosted a meeting at the Station with Dr. Indrajeet Chaubey, the new Dean of Agriculture, Health and Natural Resources from UConn. Provided an overview of Station organization, funding, facilities, and research, surveillance and diagnostic programs and services with Dr. Jason White and Mr. Michael Last, followed by a brief tour of several departmental laboratories and visits with scientific staff *July 12, 2019*
- Was interviewed for a story about Plant Science Day and Lockwood Farm by Kathy Czepiel, Nutmeg Press *July 16*
- Was interviewed about current West Nile virus activity in the state and the outlook for the remainder of the season by Amanda Cuda, Connecticut Post *July 30*
- Participated in a spotted lanternfly response planning meeting held in Jones Auditorium (10 participants) *August 1*
- Was interviewed about the detection of eastern equine encephalitis virus in mosquitoes collected in Voluntown by Samara Abramson, Fox 61 *August 5*
- Was interviewed about the current situation with West Nile virus and eastern equine encephalitis virus in the state by Sam Kantrow, WTNH TV8 *August 6*
- Presided over a quarterly meeting of the Station's Board of Control held at Lockwood Farm *August 7*
- Was interviewed about the closing of campgrounds in the Pachaug State Forest due to the high levels of eastern equine encephalitis virus by NBC 30 *August 16*
- Was interviewed about the current situation with West Nile virus and eastern equine encephalitis virus in the state by WTIC Radio *August 23*
- Was interviewed about the closing of campgrounds and mosquito pesticide spraying due to the increased detection of eastern equine encephalitis virus in the Pachaug State Forest by Gregory Hladky, Hartford Courant *August 23*
- Was interviewed about the impact of the mosquito pesticide spraying in the Pachaug State Forest by Steven Rosenbaum, NBC Connecticut *August 26*
- Was interviewed about eastern equine encephalitis virus activity in the state and curtailing of afterschool activities in the affected communities by Greg Hladky, Hartford Courant *September 11*
- Was interviewed about the current situation with eastern equine encephalitis virus in southeastern CT and risk of human infection by Brian Hallenbeck, The Day *September 13*
- Was interviewed about the increasing buildup and threat of human infection of eastern equine encephalitis virus in eastern CT by Isa Gutierrez, NBC Connecticut *September 17*
- Participated in a press conference with Senator Richard Blumenthal and officials from the CT Department of Public Health to discuss the current situation with eastern equine encephalitis in CT *September 20*
- Was interviewed about the death of two CT residents with eastern equine encephalitis and increasing risk to the public by Cynthia Drummond, The Westerly Sun *September 23*
- Was interviewed about the death of two CT residents with eastern equine encephalitis and increasing risk to the public by Ed Cara, Gizmodo Media *September 23*
- Was interviewed about the death of two CT residents with eastern equine encephalitis and increasing risk to the public by Isa Gutierrez, NBC Connecticut *September 23*

- Presented welcoming remarks and an overview of the Experiment Station and its various research, regulatory, and public service programs to a visiting group from the Yale University Women's Organization (20 attendees) *September 24*
- Participated in a press conference held at the State Capitol with Governor Ned Lamont, Lt. Governor Susan Bysiewicz, and the commissioners of DPH, DEEP, DOT, and the Department of Agriculture concerning the current status of eastern equine encephalitis in the state, including human and horse cases, mosquito trapping results by CAES, and recommendations on how people can best protect themselves *September 24*
- Was interviewed about the outbreak of eastern equine encephalitis in the northeastern U.S. this year by Dan Goldberg, Politico *September 26*
- Was interviewed about the outbreak of eastern equine encephalitis in the northeastern U.S. this year by Isabelle Philippe, ABC News *September 26*
- Hosted U.S. Senator Chris Murphy who visited the Station for a tour of the mosquito and Biosafety Level 3 laboratories and update on the eastern equine outbreak in CT followed by a press briefing *September 27*
- Participated in a meeting with State Environment Committee Co-Chairs Senator Cohen and Representative Demicco held at the State Capitol to discuss methoprene and its role in mosquito control *September 30*
- Was interviewed about eastern equine encephalitis virus activity in the state, the curtailing of after-school activities in the affected communities, and the risk of human infection by Toni Terzi, Fox 61 *October 1*
- Was interviewed about eastern equine encephalitis virus activity in the state, the curtailing of after-school activities in the affected communities, and the risk of human infection by WSHU Public Radio *October 1*
- Was interviewed about eastern equine encephalitis virus activity in the state, the curtailing of after-school activities in the affected communities, and the risk of human infection by Ellyn Santiago, Patch *October 1*
- Was interviewed about the rising number of human cases of eastern equine encephalitis in Connecticut and adjoining states by Toni Terzi, Fox 61 *October 2*
- Was interviewed about the current situation with eastern equine encephalitis virus in southeastern CT and the continuing risk of human infection and curtailing of outdoor public events with the onset of colder temperatures by Kristen Johnson, NBC Connecticut 30 *October 4*
- Was interviewed about the current situation with eastern equine encephalitis virus in southeastern CT and the continuing risk of human infection and curtailing of outdoor public events with the onset of colder temperatures by Greg Hladky, Hartford Courant *October 4*
- Was interviewed about the current situation with eastern equine encephalitis virus in the state for Connecticut Today with Paul Pacelli, WICC 600 *October 4*
- Was interviewed about eastern equine encephalitis virus activity in the state, the curtailing of after-school activities and public events in the affected communities, and risk of human infection by Kevin Hogan, WFSB *October 8*
- Was interviewed about eastern equine encephalitis virus activity in the state, the curtailing of after-school activities and public events in the affected communities, and risk of human infection by NBC Connecticut 30 *October 8*
- Presided over a quarterly meeting of the Station's Board of Control held at the Valley Laboratory in Windsor *October 16*
- Participated with representatives from the Entomological Society of America and Leadership from the Northeast Regional Center of Excellence in Vector-Borne Diseases in meetings with Congressional representatives from New York, Connecticut, and New Jersey in Washington, D.C. The meetings focused on the role of the Regional Centers of Excellence in research, outreach, and prevention of

vector-borne disease, and stressed the importance of reauthorizing funding to support these and other state and CDC programs as described in the Ticks: Identify, Control, and Knockout (TICK) Act. On October 31, the Senate Health Committee voted to move forward this bipartisan legislation, which has been renamed the Kay Hagan Tick Act, in honor of the former North Carolina Senator who passed away from complications of tick-borne illness *October 28-29*

- Was interviewed about eastern equine encephalitis activity in the northeastern U.S. this year and the prospects for next year by Ray Hardman, CT Public Radio *November 5*
- Participated in a Board Meeting of the Experiment Station Associates held at the Station *November 13*
- Attended a meeting held at the State Capitol with representatives from the Governor's office and commissioners of the Departments of Public Health, Energy and Environmental Protection, and Agriculture to review this year's response to the outbreak of eastern equine encephalitis in the state and plans for next year *November 25*
- Was interviewed about eastern equine encephalitis activity in the northeastern U.S. this year and the prospects for next year by Will Healey, Journal Inquirer *December 5*
- Presented an invited talk entitled "Reflections on the Ecology and Epidemiology of Eastern Equine Encephalitis in the Northeastern United States" at the 65th Annual Meeting of the Northeastern Mosquito Control Association held in Milford, MA (approx. 150 attendees) *December 9-11*
- Was interviewed about the impact of global climate change on mosquito-borne diseases by freelance journalist Oscar Schwartz *December 12*
- Was interviewed about eastern equine encephalitis activity in the northeastern U.S. this year and the impact of global climate change on mosquito-borne diseases by freelance journalist Oscar Schwartz *January 9, 2020*
- Was interviewed about the plans to expand the Mosquito Trapping and Virus Surveillance Program for 2020 to include sites in new regions of the state where the human and equine cases occurred in 2019 by Julia Werth, CT Examiner *January 14*
- Presided over a quarterly meeting of the Station's Board of Control held in Hartford *January 15*
- Hosted and presented a talk entitled "Reflections on the Ecology and Epidemiology of Eastern Equine Encephalitis in the Northeastern United States" at the 3rd Annual Meeting of the Northeast Regional Center of Excellence in Vector-Borne Diseases held at the Station (100 attendees) *January 23-24*
- Presented an update on Experiment Station activities at a meeting of the Experiment Station Associates Board of Directors held at the Station (8 attendees) *January 29*
- Attended a special meeting of the Experiment Station's Board of Control to address the process for appointment of the next Director *February 4*
- Presented an invited remote talk via ZOOM entitled "Reflections on the Ecology and Epidemiology of Eastern Equine Encephalitis in the Northeastern United States" to attendees of the 34th Annual Conference of the Michigan Mosquito Control Association (200 attendees) *February 5*
- Presented a seminar entitled "Reflections on the Ecology and Epidemiology of Eastern Equine Encephalitis in the Northeastern United States" to students and faculty of the Department of Pathobiology at UConn (30 attendees) *February 6*

ARMSTRONG, PHILIP M.

- Was interviewed about the detection of Jamestown Canyon virus in mosquitoes from Connecticut by the Connecticut Post *July 9, 2019*
- Was interviewed about the detection of Jamestown Canyon virus in mosquitoes from Connecticut by News Channel 3 *July 10*
- Was interviewed about the detection of Jamestown Canyon virus in mosquitoes from Connecticut by Fox 61 *July 24*
- Was interviewed about the detection of Jamestown Canyon virus in mosquitoes from Connecticut by News Channel 3 *July 25*

- Was interviewed about the first detection of West Nile virus in Connecticut during 2019 by WTIC *August 1*
- Was interviewed about mosquito and arbovirus activity in Connecticut by the Connecticut Post *August 13*
- Was interviewed about the detection of EEE virus in mosquitoes and camp closure at Pachaug State Forest by WTIC *August 16*
- Was interviewed about the expansion of WNV into new towns by the Connecticut Post *August 20*
- Was interviewed about the mosquito ecology and epidemiology of EEE virus by the Boston Globe *August 20*
- Was interviewed about EEE virus and West Nile virus risk in Connecticut by the Journal Inquirer *August 22*
- Was interviewed about EEE virus ecology and epidemiology by NBC News *August 27*
- Was interviewed about the links between climate change and mosquito abundance/seasonality by NBC Connecticut *August 28*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by the Connecticut Post *September 3, 4*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by WNPR *September 4*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by the Republican-American *September 4*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by WTIC *September 4*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by the Shoreline Times *September 9*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by WTIC *September 16*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by the Republican-American *September 17*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by The Providence Journal *September 19*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by Fox 61 *September 24*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by News Channel 3 *September 24*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by The Connecticut Examiner *September 24*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by WTIC *September 24*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by The Connecticut Examiner *September 26*
- Was interviewed on the current EEE virus outbreak affecting Connecticut and neighboring states by Patch Media *September 26*
- Attended and spoke at a press event at CAES with Senator Chris Murphy about EEE virus and federal support for research and response programs on mosquito- and tick-borne diseases *September 27*
- Was interviewed about the EEE virus outbreak by WTIC *October 1*
- Was interviewed about the EEE virus outbreak by CBS News *October 4*
- Was interviewed about the EEE virus outbreak by the Republican-American *October 4*
- Was interviewed about the EEE virus outbreak by the Connecticut Post *October 8*
- Was interviewed about the EEE virus outbreak by WTIC *October 9*

- Was interviewed about the EEE virus outbreak by the Connecticut Post *October 15*
- Was interviewed about the EEE virus outbreak by the Hartford Courant *October 16*
- Gave a presentation on West Nile virus in Connecticut at the West Nile Virus Forecasting Workshop hosted by the New York Department of Health and SUNY Albany held in Albany, NY (40 attendees) *October 30*
- Was interviewed by the Comcast Newsmakers program to speak about the EEE virus outbreak in New England *November 12*
- Gave a talk entitled "Transmission of Arboviruses by Mosquito Vectors to Live Vertebrate Hosts Is Underestimated by In Vitro Assays" (100 attendees) and attended the executive council meeting of the American Committee of Medical Entomology at the Annual Meeting of the American Society of Tropical Medicine and Hygiene held in National Harbor, MD *November 20-24*
- Gave a talk entitled "Vector Competence of *Aedes albopictus* Populations from the Northeastern U.S. for Chikungunya, Dengue, and Zika Viruses" at the 65th Annual Northeastern Mosquito Control Association Meeting held in Milford, MA (approx. 200 attendees; approx. 15 students) *December 10*
- Gave a talk entitled "Transmission of Arboviruses by Mosquito Vectors to Live Vertebrate Hosts Is Underestimated by In Vitro Assays" (100 attendees) and led a discussion panel on eastern equine encephalitis at the Annual Meeting of the Northeast Regional Center for Excellence in Vector-Borne Diseases held at CAES (60 attendees) *January 23-24, 2020*
- Gave a talk entitled "EEE Outbreak in Connecticut: Risk Assessment and Response to a Rapidly Evolving Crisis" at the Vector Week Conference held in Ft. Collins, CO (150 attendees) *February 27*
- Gave a talk entitled "Mosquito Surveillance for EEE and Other Arboviruses" at the Symposium on Mosquito-borne Diseases in Connecticut held in Jones Auditorium (60 attendees) *March 9*
- Was interviewed about plans to increase mosquito monitoring for EEE virus in Connecticut during 2020 by the CT Examiner *April 20*
- Gave an online lecture entitled "Nature Bites Back: Ticks, Their Diseases, and How to Protect Yourself" to Lathrop retirement communities in Northampton and Easthampton, MA (50 attendees) *April 27*
- Gave an online lecture entitled "Regional Vector-Borne Diseases and Emerging Threats" to participants of the Vector Boot Camp Course, Northeast Regional Center for Vector Borne Diseases (25 attendees) *May 12*
- Gave an online lecture entitled "EEE Outbreak in Connecticut: Risk Assessment and Response to a Rapidly Evolving Crisis" to attendees of the 11th Annual Northeastern Eastern Equine Encephalitis Conference (50 attendees) *May 27*
- Was interviewed about the start and expansion of the mosquito surveillance program by WTIC *June 1*
- Was interviewed about the start and expansion of the mosquito surveillance program by NBC CT *June 5*
- Was interviewed about the current mosquito season by News Channel 8 *June 12*
- Was interviewed about EEE virus by Yale Medicine Magazine *June 16*
- Was interviewed about the state's plans to respond to EEE this year by the Valley Courier *June 23*

AULAKH, JATINDER S.

- Was interviewed about hogweed distribution in Connecticut and chemical and non-chemical options for its control by Amanda Cuda from the Connecticut Post *July 16, 2019*
- Spoke about "Late Summer and Early Fall Weed Management in Christmas Trees" at the CT Christmas Tree Growers Association twilight meeting held in Westport (14 attendees) *July 31*
- Participated in a video conference with weed scientists from the Northeast for setting up ornamental weed management research priorities for 2020-2021 *September 12*
- Attended the annual fall meeting of the Connecticut Christmas Tree Growers Association and gave a talk on weed management updates and control of woody vines and shrubs (45 attendees) *September 21*

- Was interviewed about the first confirmed case of Palmer amaranth in Connecticut by Gregory Hladky from the Hartford Courant *November 13*
- Was interviewed about the first confirmed case of Palmer amaranth in Connecticut by Mackenzie Maynard from WTNH News 8 *November 14*
- Was interviewed about the first confirmed case of Palmer amaranth in Connecticut by Patrick Skahill from Connecticut Public Radio *November 15*
- Presented a poster entitled "Gemini G Herbicide Safety to *Sedum album* and *Sedum rupestre*" (approx. 50 visitors, *January 6-9*), participated in the annual IR-4 group meeting (*January 5*), and served as chair and moderator for the Turf and Ornamental session (*January 7, 9*) at the Northeastern Plant, Pest, and Soils Conference held in Philadelphia, PA *January 5-9, 2020*

AYLOR, DONALD E.

- Presented two invited lectures entitled "The Biophysics of Plant Pathogenic Spore Interactions with Atmospheric Turbulence in Plant Canopies" and "Atmospheric Dispersal of Plant Pathogens Over Multiple Spatial and Temporal Scales" (43 attendees) at the International Conference on Fluid Dynamics of Disease Transmission and Plant and Human Health held in Cargese, Corsica, France *July 28-August 3, 2019*

BARSKY, JOSEPH P.

- Staffed the CAES booth at the Connecticut Tree Protective Association summer meeting held in Farmington *July 18, 2019*
- Participated in a New England Society of American Foresters (NESAF) 2020 planning committee conference call *July 30*
- Participated in an NESAF 2020 planning committee conference call *August 27*
- Served as a judge at the 2019 Regional Agriscience Fair held at The Big E in West Springfield, MA (15 students) *September 13*
- Co-led a biodiversity hike at Sleeping Giant State Park (12 adults) *September 15*
- Participated in an NESAF Executive Committee Meeting in Concord, NH *September 18*
- Participated in an NESAF 2020 planning committee conference call *September 24*
- Participated in a quarterly meeting of the Connecticut State Consulting Committee for Agricultural Science and Technology Education in Wallingford *October 22*
- Participated in an NESAF 2020 planning committee conference call *November 12*
- Spoke on "Careers in Natural Resources" during the Cheshire High School Career Day Event (80 students) *November 19*
- Participated in an NESAF 2020 planning committee conference call *December 3, 17*
- Participated in an NESAF Executive Committee conference call *December 18*
- Participated in an NESAF 2020 planning committee conference call *January 7, 2020*
- Staffed the CAES booth at the Connecticut Tree Protective Association annual meeting held at the Aqua Turf Club in Plantsville *January 16*
- Hosted Lorenzo Pepe, a student at Cheshire High School, for a job shadow experience *February 4*
- Participated in an NESAF 2020 planning committee conference call *February 18*
- Participated in a five-year review of the Agriscience Program held at Westhill High School in Stamford *February 25*
- Participated in an NESAF 2020 planning committee conference call *March 10*
- Participated in an NESAF Executive Committee conference call *March 24*
- Participated in a New England Society of American Foresters Annual Meeting conference call *April 30*
- Participated in a conference call for the New England Society of American Foresters Executive Committee *June 10*

- Participated in a conference call for the Connecticut State Consulting Committee for Agricultural Science and Technology Education and was elected as Vice-Chair *June 16*
- Participated in the Annual Meeting for the Sleeping Giant Park Association and was elected as Park Naturalist *June 23*

BRACKNEY, DOUGLAS E.
- Gave an invited talk entitled "Navigating Anatomical Barriers to Infection: An Arbovirus Tale" at the Rocky Mountain Laboratories in Hamilton, MT (50 attendees) *October 17, 2019*
- Did a SARS-CoV2 tele-Q & A session with high school students from Humanities Preparatory Academy in Brooklyn (approx. 20 student attendees) *April 28, 2020*
- Was interviewed about a study that he is working on, along with Jordan Peccia, a colleague at Yale University, which examines trends of SARS CoV-2 levels in sewage and how they correlate to hospitalizations and confirmed cases by The New Haven Register (*May 27*), NPR (*May 28*), and Connecticut News *May 29*
- Was interviewed about coronavirus in sewage sludge by the Chesterton Tribune (his hometown local newspaper) *June 16*

BRANSFIELD, ANGELA B.
- Participated in the Federal Select Agent Program Responsible Official Workshop held in Washington, D.C. *July 23-25, 2019*
- Participated in the Federal Select Agent Program webinar eFSAP Information System September 2019 Release Updates *September 19*
- Participated in the Sandia National Laboratories' Biosafety Twinning Program held at Yale University *November 22*
- Participated in the Centers for Disease Control and Prevention's webcast Federal Partners Import Permit Regulations *December 4*
- Participated in the Federal Select Agent Program's webinar "eFSAP Information System March 2020 Release Updates" *March 23, 2020*
- Participated in a BioRAFT's EHS Community Connection webinar "Ramp Up & Reopening Checklists – Anticipating Needs" *May 21*
- Participated in the Federal Select Agent Program's webinar "Directors' Updates and Question and Answer Session" *May 27*
- Participated in the Federal Select Agent Program webinar "Operations Section" *June 24*

BUGBEE, GREGORY J.
- Spoke on "Brazilian Waterweed in Connecticut Lakes" at the annual meeting of the Staffordville Lake Association held at the Stafford Springs Public Library (approx. 40 attendees) *July 15, 2019*
- Spoke on "*Hydrilla* in the Connecticut River" at a meeting on Riverfront Recapture in Hartford (12 attendees) *July 17*
- Spoke on "Control of Variable Watermilfoil and Fanwort with ProCellaCOR and Benthic Barriers" at the annual meeting of the Bashan Lake Association held at the East Haddam Grange (approx. 60 attendees) *July 24*
- With Deanna Rackie, gave an Invasive Aquatic Plant Workshop sponsored by the Southbury Conservation Commission held at the Southbury Town Hall (approx. 35 attendees) *August 27*
- Was interviewed about Connecticut's Invasive Aquatic Plant Problems by the Republican-American *August 28*
- Participated in the Northeast Aquatic Plant Management Society Board of Directors meeting held in Lake Placid, NY *September 9-10*
- Judged a Future Farmers of America Science Fair at The Big E in West Springfield, MA *September 13*

- Spoke on “Management of Nuisance Aquatic Vegetation” to the Amos Lake Association at the Preston Public Library (approx. 30 attendees) *September 18*
- Hosted and gave the keynote address entitled “Connecticut Lakes Update” at the Connecticut Lakes Forum held in Jones Auditorium (approx. 70 attendees) *September 21*
- Spoke on “Management of Nuisance Aquatic Vegetation” to the Diamond Lake Association in Glastonbury (approx. 30 attendees) *September 26*
- Gave a talk entitled “Candlewood Lake Grass Carp Program” at the Regional Lake Communities Symposium at Western Connecticut State University (approx. 50 attendees) *September 30*
- With Ms. Summer Stebbins, met with Guilford First Selectman Joe Mazza, and members of the Friends of Lake Quonnipaug at the Guilford Town Hall to discuss weed management strategies (approx. 10 attendees) *October 8*
- Hosted a soil science class from Southern Connecticut State University and spoke on “Soil Testing” (approx. 30 student attendees) *October 28*
- Hosted 5th grade students from the Elm City Montessori School and demonstrated soil testing (6 student attendees) *October 29*
- Gave a talk entitled “*Hydrilla* in the Connecticut River” at the United States Army Corps of Engineers Natural Resource Training Workshop held at the O’Neil Federal Building in Boston, MA (approx. 100 attendees) *November 15*
- With Judy Preston of CT Sea Grant, gave a talk entitled “Connecticut River Estuary Invasive SAV: Are We at the Tipping Point?” at the Long Island Sound Study Habitat Restoration & Stewardship Workgroup Meeting held in Setauket, NY (approx. 30 attendees) *November 21*
- With Ms. Summer Stebbins, gave a talk entitled “Pachaug Pond Aquatic Plant Report 2019” at a meeting of the Pachaug Pond Water Control Authority held at the Griswold Town Hall (approx. 30 attendees) *November 25*
- Spoke on “CAES Aquatic Plant Surveys of Cedar Lake and Management Options” at a meeting of concerned citizens at the Chester Town Hall (approx. 25 attendees) *December 4*
- With Ms. Summer Stebbins, gave a talk entitled “*Hydrilla* in the Connecticut River – What’s going on anyway?” (approx. 100 attendees), proctored the aquatic herbicide supervisory license recertification program, and participated in the Board of Directors meeting held at the Northeast Aquatic Plant Management Society held in Lake Placid, NY *January 14-16, 2020*
- With Ms. Summer Stebbins, spoke on “*Hydrilla* in the Connecticut River” at the Hartford Boat Show (10 attendees) *January 17*
- With Ms. Summer Stebbins, gave two Invasive Aquatic Plant Workshops as part of the 2020 Envirothon held at the Connecticut River Academy in East Hartford (approx. 60 attendees) *January 18*
- With Ms. Summer Stebbins, gave a tour of the Invasive Aquatic Plant Program facilities to officials from CT DEEP (approx. 10 attendees) *January 30*
- Was interviewed about *Hydrilla* in the Connecticut River and the threat to nearby lakes by the Connecticut Examiner *February 11*
- Provided expert testimony before the Environment Committee regarding changes needed in the Lake Beseck winter drawdown legislation Sec. 22a-39h *February 21*
- Gave a talk entitled “Container Gardening Indoors and Out” at the East Hartford Public Library (approx. 12 attendees) *March 9*
- Gave a talk entitled “Container Gardening Indoors and Out” to the Cherry Brook Garden Club at the Community Center in Canton (approx. 65 attendees) *March 10*
- With Ms. Summer Stebbins, gave a talk entitled “Surveillance and Mapping of Invasive Plants in the Lower Connecticut River” via teleconferencing to the Gateway Commission (approx. 15 attendees) *March 26*
- As President-elect of the Northeast Aquatic Plant Management Society, participated in the Spring Executive Committee meeting via conference call *April 14*

- With Ms. Summer Stebbins, presented the results of the CAES 2019 invasive aquatic plant survey of the lower portion of the Connecticut River at a meeting of the CT Resource Conservation and Development Council via ZOOM (approx. 12 attendees) *April 21*
- Gave a presentation entitled "Improving Soil in the Home Garden" via ZOOM as part of the adult learning program at the Cora J. Belden Library in Rocky Hill (approx. 12 attendees) *May 2*
- Participated as a panelist in the Northeast Aquatic Nuisance Species Panel spring meeting via conference call *May 6*
- Was interviewed on "*Hydrilla* in the Connecticut River" by WSHU radio *May 20*
- Presented the results of the 2018-2019 CAES IAPP Invasive Aquatic Plant Monitoring of Candlewood Lake and Squantz Pond to the Candlewood Lake Authority via conference call (approx. 15 attendees) *June 13*
- With Ms. Summer Stebbins, presented the results of the 2019 CAES IAPP Invasive Aquatic Plant Monitoring of the southern section of the Connecticut River at a ZOOM meeting of the CT Resource Conservation and Development Area, Inc. (approx. 25 attendees) *June 25*

CANTONI, JAMIE L.
- Staffed the CAES booth at the Connecticut Tree Protective Association meeting held at The Aqua Turf Club in Plantsville *January 16, 2020*
- Staffed the CAES table at the STEMagination event, sponsored by the Girl Scouts of Connecticut, and held at Naugatuck Valley Community College in Waterbury *February 21*

CHEAH, CAROLE A.
- Presented a summary of Connecticut's mile-a-minute biological control program to the Conservation Commission, Town of Southbury, and toured the biological control site at George Bennett Park in Southbury *September 10, 2019*
- Gave an overview of Connecticut's mile-a-minute biological control program to Town of Greenwich staff and led a tour of the biological control sites (4 attendees) *September 12*
- Led a tour of mile-a-minute biological control sites and discussed the results at the Naval Submarine Base in Groton *October 2*
- Led a tour and developed management strategies for mile-a-minute weed with members of Terra Firma Gardening of Mystic, at Wamphassuc Point in Stonington (3 attendees) *October 8*
- Gave a presentation on "Eastern Hemlock: Prospects for Conservation & Sustainability" at the Appalachian Mountain Club Annual Gathering in Portland (50 attendees) *November 17*
- Gave a tour of the HWA biocontrol site at Salmon River State Forest and the Valley Laboratory insectary for biological control rearing of *Sasajiscymnus tsugae February 20, 2020*
- Was interviewed about biological control by Todd McLeish for an article in Connecticut Magazine *February 21*
- Gave a presentation on the recovery of eastern hemlocks at the 2020 Forest Health Monitoring Workshop held in Jones Auditorium (60 attendees) *March 5*
- Was interviewed on the recovery of eastern hemlocks in CT by Robert Miller for the Danbury News-Times *March 24*
- Was interviewed about the 2020 *S. tsugae* biological control releases by Robert Miller of the News-Times *June 23*
- Presented an overview of the mile-a-minute biological control program in 2019 at the annual Spring Cooperative Agricultural Pest Survey (CAPS) meeting via ZOOM (15 participants) *June 23*

COWLES, RICHARD S.
- Discussed "Managing Christmas Tree Insects and Diseases" to the Massachusetts Christmas Tree Growers Association in Plainfield, MA (35 attendees) *July 13, 2019*

- Discussed "Douglas-fir Needle Midge and Advances in Establishing Bare Root Transplants" at the Connecticut Christmas Tree Growers Association twilight meeting held in Westport (14 attendees) *July 31*
- Attended the Exotic Conifers Association and presented "Preplant Fertilizer Aids Initial Establishment" in Lehighton, PA (35 attendees) *August 8*
- Gave a poster presentation entitled "Sulfur Amendment to Soil for Phytophthora Root Rot Management" at the International Christmas Tree Research and Extension Conference held in Québec City, Canada (40 attendees) *August 25-30*
- Provided an update on "CCTGA Grant Progress" to the Connecticut Christmas Tree Growers Governing Board in Haddam (15 attendees) *September 11*
- Discussed "Research at Allen Hill Farm" to the Experiment Station Associates in Brooklyn (40 attendees) *September 17*
- Presented "Soil Acidification to Protect Bare Root Transplants from Phytophthora Root Rot Infection" for the NH/VT Christmas Tree Growers Association in North Pownal, VT (50 attendees) *September 21*
- Spoke about "Exotic Pests as Threats to Forest Health" to the Northern Connecticut Land Trust Association in Somers *September 22*
- Participated with an ECSU Mycology class in sampling irrigation ponds for Phytophthora at Prides Corner Nursery in Lebanon (15 students) *September 30*
- Spoke about "Bees, Trees, and Neonicotinoids" to the New England Chapter of the ISA meeting held in Springfield, MA (150 attendees) *October 8*
- Presented "Bee Health and Neonicotinoids" to a class on pollinator biology at the University of Rhode Island (12 attendees) *October 10*
- Lectured on "Emerald Ash Borer Chemical Control" at the CT Urban Forest Council's Forest Forum held in Milldale (50 attendees) *October 23*
- Gave a talk entitled "Advanced Topics in Using Neonicotinoids" at the Connecticut Environmental Council meeting held in Wallingford (100 attendees) *December 2*
- Was interviewed regarding the benefits of real vs. artificial Christmas trees by Michael Patrick of the Waterbury Republican-American *December 5*
- Was interviewed regarding the benefits of real vs. artificial Christmas trees by the Danbury News-Times *December 10*
- Presented a talk entitled "Chemical Control of Spotted Wing Drosophila" to blueberry growers at the New England Vegetable and Fruit Conference held in Manchester, NH (70 attendees) *December 12*
- Was interviewed about Christmas tree diseases by Patrick Skahill of CT Public Radio *December 18*
- Spoke about "Insect Pest Update" to the Connecticut Nursery and Landscape Association meeting held in Plantsville (30 attendees) *January 23, 2020*
- Presented "Sustainable Armored Scale Management?" to the New Jersey Christmas Tree Growers Association in Bordentown, NJ (70 attendees) *January 25*
- Discussed "Bagworms, Scales, and Zimmerman Pine Moths" in one presentation, and "Christmas Tree Fertility Basics" to the Connecticut Christmas Tree Growers Association annual meeting held in Middletown (70 attendees) *March 7*
- Discussed "Resiliency: The Key to Future Success" for Rainbow Tree Care, in a virtual meeting https://www.youtube.com/watch?v=BBioGILIzZg (35 attendees) *May 7*

CREIGHTON, MARK H.

- Attended the Apimondia World Beekeeping Conference held in Montréal with lectures on honey bee health and updates on the most current research on *Varroa* mites; he also attended a meeting of The Apiary Inspectors of America and the Canadian Provincial Apiculturist on honey bee health topics and regulatory concerns *September 8-12, 2019*
- Was interviewed for an upcoming feature on honey bee health by Carol Hewitt from the Connecticut

Examiner *September 27*

- Spoke to twenty students taking a course on The Ecology of Food, by Dr. Linda Puth from the Yale University Department of Evolutionary Biology, at the Yale Farm in New Haven *October 9*
- Was interviewed by Cate Hewitt from The Connecticut Examiner for a story on "Beekeepers in Southeast Connecticut," published on October 29 *October 2*
- Gave a presentation on *Varroa* mites and honey bee health at a meeting of the Eastern Connecticut Beekeepers Association at Woodstock Academy and distributed 74 *Varroa* Mite Testing Kits to those who needed them (110 attendees) *January 12, 2020*
- Spoke at the Connecticut Beekeepers Association Bee School at The Connecticut Agricultural Experiment Station in New Haven, where he distributed *Varroa* Mite Testing Kits to 110 students and staffed a display booth on honey bee health *January 18*
- Spoke about honey bee health at the Bee School hosted by the Connecticut Beekeepers Association in Falls Village, and provided *Varroa* Mite Testing Kits to all the attendees, which were funded by the Specialty Crop Block Grant Program of the Agricultural Marketing Service of the U.S. Department of Agriculture, and administered by the CT Department of Agriculture (119 attendees) *February 8*
- Spoke at the Connecticut Beekeepers Association Bee Talks in Middletown about honey bee health and provided *Varroa* Mite Testing Kits as above (90 attendees) *February 13*
- Spoke about the importance of screening for *Varroa* mites at the winter meeting of the Connecticut Beekeepers Association held in Jones Auditorium and provided *Varroa* Mite Testing Kits (110 attendees) *February 15*
- Presented "An Introduction to Beekeeping" at the Northern CT Agricultural Summit held at Asnuntuck Community College in Enfield (30 attendees) *February 29*
- Was interviewed about honey bee behavior by Harlan Levy of the Journal Inquirer *June 23*

CUI, ZHOUQI

- Co-organized a workshop entitled "Effector Visualization: Teaching & Research Tools for Studying Pathogen Effectors During Infection" and introduced the technique of using the dual fluorescence reporter to visualize virulence gene expression in plant pathogenic bacteria (28 adult attendees) *August 3, 2019*
- Presented a poster entitled "Cell-length Heterogeneity: A Population-level Solution to Growth/Virulence Trade-offs in the Plant Pathogen *Dickeya dadantii*" at the Plant Health 2019 conference held in Cleveland, OH (100 adult attendees) *August 5*

da SILVA, WASHINGTON

- Met with Connecticut Commissioner of Agriculture, Bryan P. Hurlburt, four Connecticut winemakers, and Rebecca Eddy Murphy from the CT Dept. of Agriculture, at Preston Ridge Vineyard and presented a talk entitled "The Status of Grape Research at CAES" and discussed future research plans on securing funding for grape research in Connecticut *July 23, 2019*
- Participated in the Connecticut Farm Wine Development Council meeting held in Hartford *July 23*
- Participated in a professional development program sponsored by the local city hall in Divinolândia de Minas, Brazil, to encourage the young local students to pursue higher education and presented two seminars: "From Here to There and Where We Are Heading!" was presented to his High School (Escola Estadual Professor Carvalhais) (100 students) (*October 10*) and "Research at CAES" was presented to Students Instituto Superior de Educação Elvira Dayrell (200 high school students) *October 12*
- Participated in the Connecticut Farm Wine Development Council meeting held in Hartford *December 5*
- Participated in the Connecticut Farm Wine Development Council meeting held in Hartford *February 6, 2020*

- Teleconferenced a presentation entitled “Detection of Multiple Grapevine Viruses in New England Vineyards” to the Annual Meeting of the Northeastern Division of the American Phytopathological Society (100 online attendees) *March 12*
- Participated in the Connecticut Farm Wine Development Council special meeting via ZOOM *April 1*
- Participated as an advisor to Stephanie Preising’s undergraduate honor thesis defense at Southern Connecticut State University via video conference call where she passed with flying colors (22 online attendees) *May 1*

DUGAS, KATHERINE

- Supervised and participated in a spotted lanternfly response planning meeting held in Jones Auditorium (10 participants) *August 1, 2019*
- Scheduled a follow-up conference call for SLF for August 8 and set up and staffed a CAES booth at the Woodstock Fair *August 31*
- Staffed the CAES display table at the Woodstock Fair *September 2*
- With Ms. Rose Hiskes, taught invasive insects and tree of heaven identification to Vernon Greenways volunteers prior to a visual survey for Asian longhorned beetle and the spotted lanternfly along the Vernon Rail Trail (10 attendees) *September 14*
- Gave a talk about garden insects at the Quinnipiac Audubon Riverbound Farm Sanctuary in Cheshire (20 attendees) *September 15*
- With Dr. Lindsay Triplett, Dr. Sara Carson, and Ms. Rose Hiskes, attended and staffed the CAES booth in the Connecticut Building at The Big E in West Springfield, MA (52,447 people attended the fair that day) *September 17*
- Attended and gave a brief update to attendees on the spotted lanternfly at the annual Connecticut Invasive Plant Working Group (CIPWG) meeting in Vernon (61 attendees) *October 24*
- Gave an update on the recent spotted lanternfly interception to the Southbury Garden Club (40 attendees) *November 1*
- Taught an insect taxonomy and identification class to Advanced Master Gardeners at the Haddam Cooperative Extension office (5 attendees) *November 13*
- With Dr. Kirby Stafford and Dr. Victoria Smith, attended and ran the fall State CAPS Committee meeting held at the PPQ office in Wallingford (13 participants) *November 21*
- Attended and staffed a CAPS and Forest Pest booth at the annual CT Association of Conservation and Inland Wetlands Commissions (CACIWC) meeting held in Cromwell, where she also gave a 60-minute workshop talk about the Cooperative Agricultural Pest Survey Program and invasive pest surveys (50 attendees) *November 23*
- Presented a talk on the spotted lanternfly and its recent interception in the state at the CT Pomological Society Meeting held in Middletown *December 3*
- Gave a forest pest update on spotted lanternfly, emerald ash borer, and gypsy moth at the Valley Green Winter Seminar held in Seymour *January 8, 2020*
- Attended and staffed a CAPS and Forest Pest booth at the CT Tree Protective Association Winter Meeting held at the Aqua Turf Club in Plantsville *January 16*
- Staffed a CAPS and Forest Pest booth at the CT Nursery and Landscape Association Winter Meeting held at the Aqua Turf Club in Plantsville *January 22-23*
- Staffed the CAES table at the STEMagination event sponsored by the Girl Scouts of Connecticut and held at Naugatuck Valley Community College in Waterbury *February 21*
- Staffed a booth at the 39th annual CT Flower and Garden Show at the Hartford Convention Center *February 22*
- Taught an Advanced Master Gardener course on insect taxonomy and identification at the Litchfield Cooperative Extension office (15 attendees) *March 9*
- With Dr. Kirby Stafford, Dr. Victoria Smith, and Ms. Gerda Magana, participated in the annual

Spring Cooperative Agricultural Pest Survey (CAPS) meeting via ZOOM (15 participants) *June 23*

DURGY, ROBERT J.

- Presented a lecture describing the Griswold Research Center's propagation of Connecticut Charter Oak seedlings for a tree dedication ceremony at the Enfield Public Library in Enfield (30 attendees) *October 31, 2019*
- Presented a lecture on common beneficial and pest insects in the home garden for the University of Connecticut Advanced Master Gardener Program held in Brooklyn (7 attendees) *November 15*

EITZER, BRIAN D.

- Was the leader of a session on pesticide analysis at the 56th Annual North American Chemical Residue Workshop held in Naples, FL (150 attendees) *July 21-24, 2019*
- Was a participant in the Agricultural Feed Regulatory Program Standards annual meeting held in Mobile, AL *August 27-29*
- Was a participant in the FERN cCAP metrics discussion phone call *September 4*
- Participated in the North American Chemical Residue Workshop's Organizing Committee phone call *September 12*
- Participated in the FERN Northeastern group phone call *September 26*
- Was a participant in the North American Chemical Residue Workshop's Organizing Committee phone call *October 10*
- Was a participant in the Food Emergency Response Network national call *October 17*
- Presented a seminar entitled "Environmental Applications of Mass Spectrometry" to students and professors of the Chemistry Department of Southern Connecticut State University in Danbury (25 attendees) *November 8*
- Was a participant in the conference call of the North American Chemical Residue Workshop's Organizing Committee *November 14*
- Was a participant in the phone call of the Organizing Committee of the North American Chemical Residue Workshop *December 12*
- Participated in the monthly FDA FERN cCAP WebEx call *December 12*
- Attended the American Bee Research Conference and was a participant in the principal investigator meeting of the multi-state Hatch grant on "Sustainable Solutions to Problems Affecting Bee Health" in Schaumberg, IL *January 8-10, 2020*
- Was a participant in the conference call of the North American Chemical Residue Workshop's Organizing Committee *February 13*
- Presented results of research at the Principal Investigator and Stakeholder meeting of the "Protecting Pollinators with Economically Feasible & Environmentally Sound Ornamental Horticulture" Specialty Crops Initiative Grant in San Diego, CA (30 attendees) *February 25*
- Was a participant in the laboratory cannabis potency analysis call *March 6*
- Judged the CT Science and Engineering Fair via a ZOOM call *March 10-11*
- Participated in a conference call of the North American Chemical Residue Workshop's Organizing Committee *March 12*
- Participated in the monthly FDA FERN cCAP call *March 12*
- Participated in the APHL's Cannabis Community of Practice monthly conference call *March 26*
- Was a participant in the North American Chemical Residue Workshop's (NACRW) Organizing Committee's ZOOM call *April 9*
- With Dr. Christina Robb, Mr. Craig Musante, and Ms. Terri Arsenault, participated in a monthly FDA FERN cCAP call *April 9*
- Participated in an EPA/AAPCO lab committee conference call *April 22*
- Participated in an APHL Cannabis Community of Practice conference call *April 23*

- Participated in an NACRW program committee conference call *April 29*
- Participated in an EPA COVID-19 certification and training call *April 30*
- Was a participant in the planning committee phone calls for the Agricultural Feeds Regulatory Program Standards online conference *May 7, 21, 28*
- Participated in the North American Chemical Residue Workshop's Organizing Committee call *May 14*
- Participated in the Food Emergency Response Network cCAP call *May 14*
- Participated in a training on the use of the ASTM website *May 19*
- Participated in the APHL Cannabis Community group phone call *May 28*
- Presented a webinar entitled "Use of LC-HRMS in the Analysis of Pesticides in Foods" at the HPLC in Practice: A Virtual Symposium sponsored by LCGC magazine (250 attendees) *June 24*
- Was a participant in the APHL Cannabis Community of Practice ZOOM meeting *June 26*

ELMER, WADE H.

- With Dr. Rosa Raudales and Ms. Leanne Pundt, assisted in organizing a greenhouse growers meeting on "Water & Nutrient Management in Container Production" held in Jones Auditorium (75 attendees) *July 11, 2019*
- Presented a talk on "Soil Health" at a SARE workshop on "Nutrition's Role in Sustainable Livestock Production Practices 2019" held at Auer Farm in Bloomfield (23 attendees) *July 19*
- Served as Vice Chair of the Diseases of Ornamental Plant Committee and as a member of the Widely Prevalent Fungal Disease Committee, and was presented with an APS Fellow Award at the Annual Meeting of the American Phytopathological Society (APS) held in Cleveland, OH *August 3-6*
- Participated in the Ph.D. committee meeting for Ms. Cora McGehee at UConn in Storrs (5 attendees) *August 14*
- With members of the Connecticut Hiking Alliance, harvested 33 boxes of eggplants, 32 boxes of tomatoes, 32 boxes of apples, and 17 boxes of peppers at Lockwood Farm for Connecticut Foodshare (42 adults, 3 children) *August 25*
- Gave a presentation entitled "Nanoparticles of Cu and Si for Plant Disease Control" at the Fall meetings of the American Chemical Society held in San Diego, CA (23 attendees) *September 26-29*
- Met with Jack Swat (President) and Florian Carle (member) of the CT Chapter of The American Chestnut Foundation at Lockwood Farm and conducted an inventory of Dr. Anagnostakis' chestnut plantings *September 10*
- Moderated and presented the keynote lecture entitled "Nanoparticles for Foliar Feed and Crop Health" at the opening plenary session at the World Conference on Plant Science and Molecular Biology held in Valencia, Spain (25 attendees) *September 17-19*
- With Dr. Jason White, participated in the biweekly Center for Sustainable Nanotechnology (CSN) ZOOM conference meeting *October 1*
- Presented "Innovation Report on Nanotechnology" at the biweekly CSN ZOOM conference meeting (12 attendees) *October 15*
- Met with Mr. Jack Swat (President, CT Chapter of the American Chestnut Foundation) and Dr. Sandra Anagnostakis at Lockwood Farm to inspect chestnut trees and discuss chestnut research *October 16*
- With Dr. Jason White, participated in a ZOOM Conference Meeting on "Marketing the Seed Coating Technology" with Larry Micek of the University of Minnesota *October 29*
- Met with two undergraduate students and Dr. Tim Pusack, of the Marine Ecology & Marine Science at Williams-Mystic in Mystic at Hammonasset Beach State Park to inspect and sample Sudden Vegetation dieback sites *November 5*
- Presented "Try a Little Salt on Your Asparagus" at the Green Café at Yale University (17 attendees) *November 7*
- With Dr. Jason White, participated in a biweekly Center for Sustainable Nanotechnology (CSN) ZOOM conference meeting *November 12*

- Met with Mr. Andrew Bramante of Greenwich High School and his student and discussed a science project with his student *November 19*
- Participated in an Editorial Board Conference Call meeting for the American Phytopathological Society *November 20*
- Presented an invited lecture entitled "Nanoparticles for Crop Health" at the 13th Postgraduate Colloquium held at the Autonomous University of Queretaro, Mexico (69 attendees) *November 22*
- Presented an invited lecture entitled "Use of Nanotechnology in Plant Pathology" at the XIX International Symposium on Plant Disease Management held at the Federal University of Lavras in Lavras, Brazil (64 attendees) *November 26-28*
- Was an invited speaker for CanolaWeek in Saskatoon, Saskatchewan, Canada, and gave a presentation entitled "Nanofertilizers for Crop Health" (240 participants) *December 6*
- With Dr. Jason White and Yu Shen, attended the All Hands meeting of the Center for Sustainable Nanotechnology held in Minneapolis, MN *January 11-13, 2020*
- Was invited to speak to the sugarcane growers in San Martin, Guatemala, on the "Use of Nanofertilizers to Suppress Plant Diseases" and to begin collaborative research on nanoparticles (6 attendees) *February 25-27*
- Teleconferenced a presentation entitled "Engineered Mesoporous Silica Nanoparticles for Plant Health" to the Annual Meeting of the Northeastern Division of the American Phytopathological Society *March 9*
- Teleconferenced with The American Phytopathological Society Press for their quarterly meeting *March 31*
- Participated in the CAES Board of Control ZOOM meeting (8 participants) *April 15*
- Participated as a committee member in Carolina Valdes' (University of Texas, El Paso) qualifying exam via ZOOM (25 online attendees) *April 23*
- Participated in bi-weekly USDA NIFA ZOOM conferences *May 1, 15, 29*
- Participated in an APS Committee chair conference call *June 10*
- Participated in bi-weekly USDA NIFA ZOOM conferences *June 11, 24, 29*

GLORIA-SORIA, ANDREA

- With Ms. Angela B. Bransfield, conducted an interactive outreach activity about mosquitoes and ticks at Tender Care Learning Center in Hamden (approx. 28 attendees, 22 children, 6 adults) *July 11, 2019*
- Gave an invited seminar entitled "Tracking Down Invasions of the Yellow Fever Mosquito, *Aedes aegypti*, at Different Time Scales" at the 552th Connecticut Entomological Society Meeting hosted at Yale University (25 attendees, 5 of them students) *September 20*
- Gave a talk entitled "Population Genetics of Invasive Mosquitoes: The Rise of *Aedes aegypti* and *Ae. albopictus*" at the Medical, Urban, and Veterinary Entomology Section Symposia on Urban Pests and Vectors: Emerging Impacts, Sustainable Management, and Future Research at the Entomological Society of America Annual Meeting held in St. Louis, MO (70 attendees) *November 17-20*
- Gave a CAES Seminar Series talk entitled "Tracking Down Invasions of the Yellow Fever Mosquito, *Aedes aegypti*, at Different Time Scales" held in Jones Auditorium (50 attendees) *December 4*

HISKES, ROSE T.

- With Mr. Jim Preste, staffed an information table in the CNLA Discovery and Education gardens at the Valley Laboratory during the Windsor Garden Club Garden Tour (approx. 100 attendees) *July 13, 2019*
- Staffed the CAES booth at the Connecticut Tree Protective Association summer meeting held at the Farmington Club in Farmington *July 18*
- Answered prepared and impromptu questions from Seabury residents as we toured their community garden plots in Bloomfield. The tour was videotaped and is on YouTube (15 participants) *July 30*
- Participated in a spotted lanternfly preparedness meeting held in Jones Auditorium *August 1*

- Taught “Plant Diseases and Garden Pests” and “Invasive Plants” to the Federated Garden Clubs of Connecticut Garden School held in Jones Auditorium (19 attendees) *September 4*
- Gave a talk entitled “Insect Pests of African Violets” to the Windsor African Violet Society in Bolton (12 attendees) *September 11*
- With Ms. Katherine Dugas, taught invasive insects and tree of heaven identification to Vernon Greenways volunteers prior to a visual survey for Asian longhorned beetle and the spotted lanternfly along the Vernon rail trails (10 attendees) *September 14*
- With Ms. Katherine Dugas and Dr. Lindsay Triplett, staffed the CAES booth at the Eastern States Exposition in West Springfield, MA (total attendance 52,447) *September 17*
- Gave a talk on “Flying Flowers” to the Waterbury Senior Citizens in Waterbury (22 attendees) *October 10*
- Organized and co-led a steering committee and general meeting of the Connecticut Invasive Plant Working Group in Vernon (15 and 61 attendees, respectively) *October 24*
- With Dr. Yonghao Li, taught the Connecticut Tree Protective Association Arboriculture 101 students about tree diseases at the Tree Conditions Lab, Wallingford (42 attendees) *November 6*
- Participated in a Connecticut Invasive Plant Working Group symposium planning committee meeting in Windsor *November 14*
- Taught Advanced Master Gardeners about “Insect Pests of Plants” at the Bartlett Arboretum in Stamford (17 attendees) *November 19*
- Taught the Connecticut Tree Protective Association Arboriculture 101 students about diagnosing insect problems at review night in Wallingford (42 attendees) *December 4*
- Participated in a Connecticut Invasive Plant Working Group symposium planning committee meeting held in Windsor *January 30, 2020*
- Participated in a virtual Connecticut Invasive Plant Working Group symposium planning committee meeting *March 23*
- Participated in a virtual Connecticut Invasive Plant Working Group symposium planning committee meeting *April 21*
- Participated in virtual Connecticut Invasive Plant Working Group symposium planning committee meetings *May 19, 22*
- Participated in a webinar on spotted lanternfly *May 21*
- Participated in a webinar on spotted wing drosophila *May 28*
- Participated in virtual Connecticut Invasive Plant Working Group symposium planning committee meetings *June 16, 30*

HYDE, JOSEPHINE

- Presented a poster entitled “Investigating the Potential for Host Selection in the Establishment of the Microbiota Among Multiple Axenic Mosquito Species” at the American Society for Microbiology (ASM) DC Branch Spring Meeting and attended Early Career Meeting (50-100 attendees) *February 21-22, 2019*

KERIÖ, SUSANNA

- Participated in a ZOOM meeting to plan chestnut-related research with the Connecticut Chapter members of the American Chestnut Foundation *June 5, 2020*
- Participated in a Beech Leaf Disease research update ZOOM meeting coordinated by Ohio State University *June 17*

KROL, WALTER J.

- With Ms. Terri Arsenault, presented a talk entitled “Findings from 2019 Hemp Field Trial in Connecticut” at The Connecticut 2020 Hemp Conference and Trade Show held at Maneeley’s

Conference Center in South Windsor (200 attendees) *February 26, 2020*

- With Ms. Kitty Prapayotin-Riveros and Ms. Terri Arsenault, presented a CAES Seminar entitled "Food Safety and ISO 17025 Accreditation" in the Jones Auditorium *March 4*

LAMONDIA, JAMES A.

- Spoke about "The Importance of Cultivar Testing for Boxwood Blight Resistance or Susceptibility" and "Fungicide Effects on the Boxwood Blight Pathogen" during the AmericanHort Cultivate19 meeting held in Columbus, OH (approx. 40-50 people) *July 15, 2019*
- Participated in the APS Division Forum meeting as Past-Chair and presented a poster entitled "The Effects of Sanitizers on *Calonectria pseudonaviculata* Conidia and Microsclerotia Viability" during the American Phytopathological Society annual meeting held in Cleveland, OH *August 3-6*
- Met with Universal Leaf horticulturalist Ben Green and Universal plant breeder Dr. Marcio Ender from Brazil to discuss the Connecticut tobacco breeding program *August 15*
- Was interviewed about Connecticut broadleaf tobacco by Phil Gruber of Lancaster Farming newspaper *August 27*
- Conducted oral exams for candidates for the Connecticut arborist license and participated in the quarterly meeting of the Connecticut Tree Protection Examining Board in New Haven *September 11*
- Was interviewed about Connecticut shade and broadleaf tobacco by Andrew Nagy of Cigar Aficionado magazine *September 11*
- Was interviewed about breeding for Connecticut wrapper tobacco by Andrew Nagy of Cigar Aficionado magazine *September 12*
- Was interviewed about hemp production in Connecticut and the role of CAES in research and analytical testing by Darcy Cahill for Acres USA magazine *September 20*
- Presented "Fungicide Effects on the Boxwood Blight Pathogen" and "Cultivar Testing for Blight Resistance" as a part of the Boxwood Blight Research Update webinar hosted by AmericanHort (50 participants) *September 24*
- Spoke about European corn borer as a new hop pest in Connecticut and integrated pest management at the CT Hop Growers Association meeting held in South Glastonbury (25 attendees) *October 8*
- Spoke about nematode management research results at the annual meeting of the Northeast Regional Multistate Nematology Technical Committee (NE-1640) held in Honolulu, HI (15 attendees) *October 16-19*
- Spoke about "The History of Connecticut Cigar Wrapper Leaf: The Result of Practical Research and over 380 Years of Tobacco Production" to the Long Hill Garden Club in Trumbull (60 attendees) *October 28*
- Participated in the Connecticut Farm Risk Management Advisory group meeting held in Vernon *October 30*
- Taught a class on identification, biology, and management of tree diseases to students in the Connecticut Tree Protective Association's Arboriculture 101 class in Wallingford (30 attendees) *October 30*
- Was interviewed about beech leaf disease in Connecticut by Gabriel Popkin for Science Magazine *October 31*
- Was interviewed about the Enfield Friends of the library program and the Experiment Station by Vicki Mitchell of the Enfield Press and participated in the dedication of a descendant of the Charter Oak by the Friends of the Library, speaking about the Experiment Station and Valley Laboratory research and services in Enfield (30 attendees) *October 31*
- Chaired the Connecticut Agricultural Information Council meeting regarding Agriculture Day at the Capitol and the Connecticut Outstanding Young Farmer Award in Windsor *January 13, 2020*
- Spoke about "Identification and Management of Boxwood Blight" as a part of the SiteOne Educational Program held in Meriden (70 attendees) *January 14*

- Spoke about "Hops in 2019, New and Emerging Pests" as a part of the Connecticut Hop Growers Association annual meeting held in Northford *January 18*
- Discussed management of foliar diseases at a meeting of the Tobacco Disease Council (20 attendees) *January 22*
- Presented "The Effect of Disease Management Programs on Fungicide Residues in Shade Tobacco" at the Tobacco Workers Conference held in Louisville, KY (100 attendees) *January 22*
- Participated in a review of boxwood blight management tactics for nursery producers (12 attendees), spoke about prevention and management of boxwood blight (350 attendees), and presented best management practices for dealing with boxwood blight for landscapers (50 attendees) as a part of the Rhode Island Nursery and Landscape Association Winter Conference held in Warwick, RI *January 29*
- Spoke about "Boxwood Cultivar Susceptibility and Fungicide Management of Boxwood Blight" at the AmericanHort Boxwood Blight Workshop held in Willamette, OR (70 attendees) *February 4*
- Spoke about fungicide residue management in wrapper tobaccos and Low Converter varieties of Connecticut broadleaf and a plant breeding progress update (95 attendees) *February 25*
- Taught a class on identification, biology, and management of tree diseases to students in the Connecticut Tree Protective Association's Arboriculture 101 class held in Wallingford (39 attendees) *March 4*
- With Dr. Richard Cowles, met with Westfield State University student Joseph Braun to discuss his undergraduate senior research project *March 9*
- Conducted oral exams for candidates for the Connecticut arborist license and participated in the quarterly meeting of the Connecticut Tree Protection Examining Board held at the Station *March 11*
- Was interviewed about nematodes and non-chemical nematode management in Connecticut by Ms. Camille Florin, MS student at the Universite Lumiere, Lyon, France *June 4*
- Conducted oral exams for candidates for the Connecticut arborist license and participated in the quarterly meeting of the Connecticut Tree Protection Examining Board in Hamden *June 10*
- Participated in an SCRI Grant project initiation ZOOM meeting (22 participants) *June 29*
- Was interviewed about the Valley Laboratory by Ken Dixon of the Connecticut Post *June 30*

LI, DEWEI

- Presented a poster entitled "*Phytophthora abietivora*, A New Species Isolated from Diseased Christmas Trees in Connecticut," which was coauthored with Drs. Neil P. Schultes, James A. LaMondia, and Richard S. Cowles, at the 18th Congress of European Mycologists in Warsaw and Białowieża Primeval Forest, Poland *September 16-21, 2019*
- Was interviewed on indoor mold at Staten Island University Hospital by Enxhi Dylgjeri, a journalist from the Columbia Journalism School *October 29*
- Was interviewed about molds of washing machines by Kimberly Janeway, a journalist for Consumer Reports *December 16*

LI, YONGHAO

- Presented a talk entitled "Boxwood Blight" at the CNLA Summer Meeting held in Watertown (60 adults) *July 17, 2019*
- Staffed the CAES booth at the CTPA Summer Meeting held in Farmington *July 18*
- Presented "Plant Pathologist/Diagnostician" in the Career Panel on Regulatory/Government Science as a part of the summer internship program held in New Haven (13 adults) *July 22*
- Spoke about "Needle Cast Diseases of Douglas-fir and Fungicide Treatment" at the CCTGA Twilight Meeting held in Westport (20 adults) *July 31*
- Was interviewed about "Hail, Don't Scold, the Useful Goldenrod" by Robert Miller of the Danbury News-Times *August 20*
- Gave a lecture entitled "Disease Management in Landscapes" for the NOFA Accreditation Course in

Organic Land Care in New Haven (30 adults) *August 22*

- Spoke about "Disease Management in Organic Gardens" at the Cherry Brook Garden Club business meeting in Canton (30 adults) *September 10*
- Presented "Important Diseases in Connecticut Landscapes" for a continuing education program of the Connecticut Chapter of the American Society of Landscape Architects in Watertown (60 adults) *September 13*
- Was interviewed about "This Year's Foliage Will Be Late, but It Sure Will Wow You" by Brigitte Ruthman of the Waterbury Republican-American *September 20*
- Spoke about "Delphinella Shoot Blight of Concolor Fir and Rhizosphaera Needle Cast of Spruce" at the Connecticut Christmas Tree Growers Association Annual Fall Meeting held in Voluntown (50 adults) *September 21*
- Presented "Selection and Care of Houseplants" at the Orchard Valley Garden Club business meeting in Southington (40 adults) *September 24*
- Staffed the Station booth at the event Pup-Up in the Garden at Winterberry Garden Center *September 28*
- Presented "Pruning 101" at the New Hartford Garden Club Business Meeting in New Hartford (21 adults) *October 2*
- Presented "Selection and Care of Houseplants" in the Canterbury Public Library in Canterbury (10 adult attendees) *November 4*
- Presented "Fungi and Fungicides – Every Gardener Needs to Know" for the UConn Advanced Master Gardener Program held in Torrington (16 adult attendees) *November 6*
- Lectured on "Tree Diseases" in the Arboriculture 101 Hands-on Night Class held in Wallingford (27 adult attendees) *November 6*
- Presented "Pruning 101" for the UConn Advanced Master Gardener Program in Vernon (16 adult attendees) *November 7*
- Presented "Plant Diseases and Their Management in Landscapes" for the CT NOFA Organic Land Care Accreditation Program (46 adult attendees) *November 13*
- Spoke about the Plant Disease Information Office and disease diagnostics to a group of visiting Wesleyan University students, led by Professor Rosemary Ostfeld (10 adult attendees) *November 20*
- Staffed the CAES booth at the Connecticut Pomological Society Annual Meeting in Middletown *December 3*
- Participated in a ZOOM meeting for the National Plant Diagnostic Network Web Communication Committee (8 adults) *December 9*
- Staffed the CAES booth at the UConn Extension's Vegetable & Small Fruit Growers' Conference held in South Windsor *January 6, 2020*
- Staffed the CAES booth at the Connecticut Tree Protective Association Annual Meeting held at the Aqua Turf Club in Plantsville *January 16*
- Staffed the CAES booth at a Pre-Season Meeting of the Maple Syrup Producers Association of CT in Lebanon *January 18*
- Participated in the National Plant Diagnostic Network Web Communication Committee ZOOM Meeting (7 adults) *January 24*
- Presented "Recap 2019 Bedding Crop Diseases to Prepare for 2020" at the UConn Spring Bedding Plant Meeting held in Torrington (35 attendees) *February 11*
- Was interviewed about "Maple Syrup Watchers Need Right Conditions for Production" by Ms. Olivia Hickey of Connecticut Public Radio *February 14*
- Presented "Pruning 101" to Bristol Garden Club members in Bristol (38 attendees) *February 20*
- Presented "Gardening with Native Plants" to Tolland/Vernon Garden Club members in Vernon (22 attendees) *February 22*
- Presented "Principles of Organic Gardening" for the education program at the Cheshire Public Library

(27 attendees) *February 24*
- Staffed the CAES booth at the Connecticut Grounds Keepers Association Winter Meeting held in Plantsville *February 26*
- Presented "Notifiable Tree Diseases" at the Forest Health Monitoring Workshop held in Jones Auditorium (60 adult attendees) *March 5*
- Presented "What's Wrong with My Plant and How to Prevent It" at the Northeast Organic Farming Association Winter Conference held in Middletown (22 adult attendees) *March 7*
- Presented "The National Plant Diagnostic Network, Online Communications and Web Portal Committee Updates" and "Connecticut Plant Disease Updates" at the Northeast Plant Diagnostic Network Meeting (remotely) (23 adult attendees) *March 10*

LINSKE, MEGAN A.
- Participated in a Wildlife Society Leadership Institute (LI) mentorship planning call with current LI student Justin Shew *July 19, 2019*
- Gave an invited lecture entitled "Ticks: It's More Than Just Lyme Disease" at the Connecticut Pest Control Conference held in Cromwell (85 attendees) *September 17*
- Was interviewed about developing a landscape monitoring and evaluation plan for tick control by Stephanie Morse, a Cornell MPH program student *October 9*
- Co-presented an invited lecture with Dr. Scott Williams at the CT Urban Forest Council Annual Meeting entitled "Tick-borne Disease Ecology: Concerns for Forest and Public Health Alike" (148 attendees) *October 23*
- Conducted a Workshop Committee conference call as Workshop Chairperson for the Northeast Section of the Wildlife Society to develop programs for the Annual Northeast Fish and Wildlife Agencies Conference in 2020 *October 24*
- With Dr. Scott Williams, Mr. Michael Short, and Ms. Jamie Cantoni, was interviewed by Chris Woodside, Environmental Writer for The Connecticut Health Investigative Team, on current and ongoing research and management pertaining to the link between forest and public health *November 6*
- With Dr. Scott Williams, Mr. Michael Short, and Ms. Jamie Cantoni, met with Jim Tomlinson about management strategies for Japanese barberry on Lyme Land Trust properties *November 6*
- With Dr. Scott Williams, Mr. Michael Short, and Mr. Joseph Barsky, conducted the CT FFA Forestry Career Development Event (CDE) with 11 participating high schools at Lockwood Farm (approx. 50 attendees) *November 22*
- Gave a presentation entitled "New Ticks Rising: Developments in Ticks and Tick-Borne Diseases" at the Forest Health Monitoring Workshop held in Jones Auditorium (60 attendees) *March 5*
- Participated in the Executive Committee meeting of the Northeast Section of the Wildlife Society as President Elect and Workshop Committee Chairperson *June 22*

MAGANA, GERDA
- As the State Survey Coordinator, organized and ran the annual Spring Cooperative Agricultural Pest Survey (CAPS) meeting via ZOOM (15 participants) *June 23, 2020*

MARRA, ROBERT E.
- Joined other CAES staff in the CAES booth at the CTPA summer meeting held at the Farmington Club in Farmington (650 attendees) *July 18, 2019*
- Joined Drs. Victoria Smith and James LaMondia in a site visit to Mianus River Park, in Stamford and Greenwich, along with local, state, and U.S. Forest Service personnel to view an outbreak of Beech Leaf Disease, caused by a foliar nematode (20 adults) *August 21*
- Participated in a webinar on Beech Leaf Disease, hosted by the Ohio Department of Natural Resources *August 28*

- Gave a presentation on the Plant Disease Diagnostics Office to the Yale University Women's Organization (30 adults) *September 24*
- Gave a presentation and walking tour on invasive plants of the Connecticut shoreline to the West Haven Sustainability CT Team (12 adults) *September 28*
- Was interviewed about Beech Leaf Disease by Hearst Connecticut Media reporter Robert Miller *October 18*
- Gave a guest lecture on Fungal Mating Systems to Dr. Jon Hulvey's Mycology class at Eastern Connecticut State University (24 students) *October 25*
- Was interviewed about Beech Leaf Disease by Science Magazine writer Gabriel Popkin *October 31*
- Participated as a member of the Steering Committee for the Connecticut Conference on Natural Resources scheduled at the University of Connecticut on March 16, 2020 *November 6*
- Assisted in staffing the CAES booth at the Connecticut Tree Protective Association Annual Meeting held in Plantsville *January 16, 2020*
- With Dr. Yonghao Li, staffed a CAES booth at a Pre-Season Meeting of the Maple Syrup Producers Association of CT in Lebanon *January 18*
- Presented a Sigma Xi seminar at Quinnipiac University entitled "Accurately Accounting for Decay and Carbon Loss in Trees: A Novel Nondestructive Approach Using Tomography" (45 attendees) *February 27*
- Gave a presentation entitled "Beech Leaf Disease, Oak Wilt, and Introducing the Forest Ecosystem Monitoring Cooperative" at the Forest Health Monitoring Workshop held in Jones Auditorium (60 adults) *March 5*
- Participated in a Beech Leaf Disease Working Group ZOOM meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the U.S. Forest Service (18 attendees) *April 16*
- Presented a webinar entitled "Updates on Beech Leaf Disease and Oak Wilt" to the UConn "Hot Topics" series (120 attendees) *May 28*
- Was interviewed about Oak Wilt and Beech Leaf Disease by Hearst News reporter Robert Miller *June 2*
- Participated in a Beech Leaf Disease Working Group ZOOM meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the U.S. Forest Service (40 participants) *June 17*
- Presented a webinar entitled "Updates on Beech Leaf Disease and Oak Wilt" to the UConn "Hot Topics" series via ZOOM (160 adults) *June 18*
- Gave a presentation on Beech Leaf Disease via ZOOM to the CAPS meeting (40 participants) *June 23*

MAYNARD, ABIGAIL A.

- Reported on Station activities at a quarterly meeting of the Council on Soil and Water Conservation in Middletown (16 adults) *July 11, 2019*
- Reported on Station activities at a quarterly meeting of the Council on Soil and Water Conservation held in Middletown (14 adults) *September 19*
- Participated in a meeting of a committee on Soil Health in Middletown *September 24*
- Reported on Station activities at a meeting of the State Technical Committee in Vernon (29 adults) *September 25*
- Hosted the Kindergarten from Hamden Hall Country Day School at Lockwood Farm (21 students, 3 teachers, 2 parents) *October 18*
- Spoke on "Composting and Utilization of Compost" at the Redding Garden Club (43 adults) *October 28*
- Spoke on "Composting and Utilization of Compost" to two Sustainability classes at Hamden Hall Country Day School (30 students, 2 teachers) *October 29*

- Staffed the CAES display at the Connecticut Farm Bureau Association Annual Meeting held in South Windsor *November 21*
- Organized and moderated the Specialty Vegetables session at the New England Vegetable and Fruit Conference in Manchester, NH *December 10*
- Spoke on "Globe Artichokes and Belgian Endive" in the Specialty Vegetable Session at the New England Vegetable and Fruit Conference held in Manchester, NH (114 attendees) *December 10*
- Reported on Station activities at a quarterly meeting of the Council on Soil and Water Conservation in Hamden (11 attendees) *December 19*
- Reported on Station activities at a meeting of the State Technical Committee held in Tolland (29 adults) *January 22, 2020*
- Participated in a conference call of the New England Vegetable and Fruit Conference Steering Committee *February 3*
- Participated in a meeting of the Agriculture/Soils Sub-Working Group of the Working and Natural Lands Working Group in support of Governor Lamont's Council on Climate Change in Hartford *February 13*
- Spoke on "Composting and Utilization of Compost" to the Garden Club of New Haven in Jones Auditorium (72 adult attendees) *March 2*
- Was interviewed about the effects of the early spring on agriculture by Kathy Czepiel of the Daily Nutmeg *March 19*
- Made a video in the greenhouse at Lockwood Farm showing how to produce transplants for experiments for lower school science classes at Hamden Hall Country Day School (1 teacher, 32 students) *April 14*
- Was interviewed about home composting by Michelle Acri from Connecticut Magazine *May 4*
- Participated in a ZOOM meeting of the soil health subcommittee of the Council on Soil and Water Conservation *May 6*
- Reported on Station activities at a quarterly ZOOM meeting of the Council on Soil and Water Conservation (15 adults) *June 17*
- Participated in the G3 Governor's Council on Climate Change, Agriculture/Soils Working Group ZOOM meetings *June 25, 29*

McMILLAN, JOSEPH R.

- Presented a talk entitled "The Biology and Control of Mosquitoes and Their Diseases in Connecticut" at the Willow Plaza Community Center in Waterbury (approx. 15 attendees) *August 13, 2019*
- Presented a poster entitled "Mosquito and Arbovirus Community Composition in the Northeast U.S." at the American Society for Tropical Medicine and Hygiene Annual Meeting held in National Harbor, MD *November 20-24*
- Gave a talk entitled "Assessing the Generality of Multi-vector Species Contributions to Arboviral Transmission in the Northeast U.S." at the 65th Annual Northeast Mosquito Control Association's meeting held in Milford, MA (approx. 200 attendees; approx. 15 students) *December 10*
- Gave a poster entitled "Larviciding Catch Basins and Its Impact on West Nile Virus Transmission in Two Connecticut, U.S. Towns" at the Annual Meeting of the Northeast Regional Center of Excellence in Vector-Borne Diseases held in Jones Auditorium *January 23, 2020*
- Presented on CAES research as a part of the UConn Student One Health research symposium in Storrs (approx. 50 attendees, approx. 35 students) *February 8*

MOLAEI, GOUDARZ

- Spoke on "Passive Tick Surveillance and Testing Program: Tracking Ticks and Associated Pathogens in Connecticut" to employees of Pitney Bowes in Shelton (20 attendees) *July 16, 2019*
- Was interviewed about tick bite prevention, tick removal, and tick-borne pathogen testing by New York

Magazine *July 18*

- Hosted Dr. Hasan Fadlallah, a Yale Microbiology Fellow, at the Tick Testing Laboratory and discussed TTL services and research on mosquito- and tick-borne pathogens *August 14*
- Gave an invited talk entitled "Nature's Revenge: Resurgence of Eastern Equine Encephalitis as a Serious Mosquito-Borne Virus" at the Canterbury Public Library (10 attendees) *September 14*
- Hosted two groups of the Yale University Women's Organization in the Tick Testing Laboratory (approx. 40 attendees) *September 24*
- Was interviewed on tick and Lyme disease hotspots in Connecticut by the Norwich Bulletin *September 24*
- Hosted a tour group of students from Wesleyan University in the Tick Testing Laboratory (approx. 20 student attendees) *November 20*
- Was interviewed on the range expansion of the lone star tick and its implications for tick-borne disease dynamics in the Northeast to be later available as a podcast by the Managing Editor for the New England Journal of Medicine *November 21*
- Served as a community partner in Wesleyan University's Civic Engagement, Environmental Studies 281 GIS Service Learning Lab, where he advised students on tick infection mapping in Connecticut (approx. 20 students) *December 5*
- Was interviewed on the lone star tick and other tick issues by the New England Journal of Medicine: www.nejm.org/doi/full/10.1056/NEJMp1911661 *December 5*
- Was interviewed on the lone star tick and other tick issues by Eyewitness News 3: www.wfsb.com/news/lone-star-tick-a-growing-threat-to-humans-pets-as/article_1ed003de-1853 -11ea-8d01-3be1d90cb66c.html *December 6*
- Was interviewed on the lone star tick and other tick issues by the Hartford Courant: www.courant.com/news/connecticut/hc-news-insects-climatechange-spreading-deer-humandiseases-20191207-u5z74m5emvav7nqddhxfqr56pe-story.html *December 6*
- Was interviewed on the lone star tick and other tick issues by the Vineyard Gazette: https://vineyardgazette.com/news/2019/12/19/rapid-spread-lone-star-ticks-alarmsexperts *December 9*
- Was interviewed on the lone star tick and other tick issues by WTNH News 8: www.wtnh.com/top-news/lone-star-tickpopulation-increasing-expanding-in-connecticut/ *December 10*
- Was interviewed on the lone star tick and other tick issues by WFUV news (NPR affiliate in New York City) *December 11*
- Was interviewed on the range expansion of the lone star tick and its implications for altering tick-borne disease dynamics in the Northeast by Bloomberg News *January 2, 2020*
- Was interviewed on the implication of the warmer winter for tick activity in 2020 by Eyewitness News 3 *January 15*
- Gave two talks entitled "Host Association of the Asian Tiger Mosquito, *Aedes albopictus* (Skuse)" and "Passive Tick Surveillance: Tracking Ticks and Tick-borne Pathogens in Connecticut," and co-authored two posters entitled "Passive Tick Surveillance in Connecticut: Spatiotemporal Associations of Infections and Co-Infections in *Ixodes scapularis* (Acari: Ixodidae)" and "Lone Star Rising - Continued Range Expansion of *Amblyomma americanum*, the Lone Star Tick, in Connecticut" at the Annual Meeting of the Northeast Regional Center for Excellence in Vector-borne Diseases held in Jones Auditorium (65 attendees, 15 student attendees) *January 23*
- Was interviewed about this year's tick season and concern over tick-borne diseases during the Coronavirus pandemic (https://www.huffpost.com/entry/coronavirus-tick-season-lyme_l_5e8f0a98c5b6b371812caabd) by Huffpost *April 9*
- Was interviewed about measures to protect against tick-borne diseases during the Coronavirus pandemic on the "Let's Go There" show on Channel Q radio *April 10*
- Gave an invited talk via ZOOM on the impact of climate change on vector-borne diseases to "Earth Day 2020 Climate Action: Joining the Conversation," Cheshire Academy, and served as a panelist (20 student attendees, 25 attendees total) *April 22*

- Was interviewed on "Tick Season--What You're Seeing So Far, and What's Expected as We Enter the Summer" by WTIC-AM/FM *May 28*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by WTIC-AM/FM *June 23*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by Channel 3 Eyewitness News *June 23*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by Brian Scott-Smith, a Media Consultant *June 24*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by News 8 WTNH *June 25*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by Rich Kirby, Patch Media *June 25*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by WSHU-NPR *June 24*
- Was interviewed about range expansion of the lone star tick in Connecticut and throughout the Northeast by News 12 *June 29*

NASON, SARA L.

- With Drs. Nubia Zuverza-Mena and Jason White, participated in a conference call regarding the CT Governor's Taskforce on PFAS contaminants with CT Department of Public Health Deputy Commissioner Janet M. Brancifort and other DPH staff members *July 15, 2019*
- Served as a judge for student presentations at the Plant Health and Protection Research Symposium held at CAES *August 8*
- Participated in meetings of the Remediation and Human Health committees that advise the Connecticut Interagency PFAS Taskforce in Hartford *August 16*
- Participated in a meeting of Connecticut chemists working on PFAS analysis in Rocky Hill *August 28*
- Attended the second meeting of the Connecticut Interagency PFAS Taskforce and participated in a PFAS Sampling Subcommittee meeting in Hartford *August 28*
- Toured the lab of Dr. Vasilis Vasiliou and met with postdoc Jeremy Koelmel to discuss future research collaboration at the Department of Environmental Health Sciences at the Yale School of Public Health *August 29*
- Participated in meetings of the Connecticut PFAS Taskforce in Hartford: Human Health Committee (*September 10*), Remediation Committee (*September 12*), and full Task Force *September 18*
- Participated in a conference call with Drs. Andrea Tokranov and James Gray of the U.S. Geological Survey to discuss PFAS analysis methods *September 19*
- Participated in a conference call for the Benchmarks and Publications for Non-Targeted Analysis group *October 2*
- Presented a poster entitled "Hemp Phytoremediation of AFFF Contamination at the Former Loring Air Force Base" and volunteered at a career networking event for students at the 35th Annual International Conference on Soils, Sediments, Water, and Energy held in Amherst, MA (approx. 800 attendees) *October 22-23*
- Gave a talk entitled "Use of LC-HRMS to Assess Chemical Transformations During Anaerobic Digestion" (approx. 70 attendees), gave a poster entitled "Hemp Phytoremediation of AFFF Contamination at the Former Loring Air Force Base," and chaired a session at the Society for Environmental Toxicology and Chemistry North America meeting held in Toronto, Canada *November 3-7*
- Presented a poster entitled "Hemp Phytoremediation of AFFF Contamination at the Former Loring Air Force Base" at the Sussex Plant Biology Symposium in New Haven *November 15*
- Hosted a visit from Dr. Krystal Pollitt of the Department of Environmental Health at Yale University

November 12

- Mentored students on science fair projects at the Sound School in New Haven *November 21*
- Gave a talk entitled "Assessment of PFAS Phytoremediation at the Former Loring Air Force Base" at the Yale Symposium on Per- and Polyfluoroalkyl Substances: Challenges and Opportunities (approx. 40 attendees) *December 13*
- Mentored students on science fair projects at the Sound School in New Haven *December 5*
- Gave a seminar entitled "Plant Uptake of Organic Contaminants: Mechanisms and Impacts" to the Plant Science and Landscape Architecture Department and Environmental Engineering Department at the University Connecticut, Storrs, and met with faculty and students (approx. 40 attendees including approx. 30 students) *February 7*
- Coached science fair students at the Sound School in New Haven *February 6, 13, and 27*
- Coached science fair students at the Sound School, New Haven, and had students participate in the online CT State Science Fair *March 5, 9-13*
- Participated in a conference call for the Benchmarks and Publications for Non-targeted Analysis working group *April 2*
- Presented a poster entitled "Analysis of PFAS Contaminated Soil from Loring Airforce Base Using Iterative Exclusion and FluoroMatch Software" at the virtual SETAC SciCon Meeting *May 3-7*
- Participated in two conference calls for the Benchmarks and Publications for Non-targeted Analysis working group *May 15, 26*
- Participated in two conference calls for the Benchmarks and Publications for Non-targeted Analysis working group *June 15, 25*

PETRUFF, TANYA A.

- Gave a talk entitled "Changes in Diversity of Connecticut Mosquitoes Since 2005" at the 65th Annual Northeast Mosquito Control Association Meeting held in Milford, MA (approx. 200 attendees; approx. 15 students) *December 11, 2019*

PIGNATELLO, JOSEPH J.

- Met with Indrajeet Chaubey, Dean of the College of Agriculture, Health and Natural Resources, University of Connecticut, Storrs and introduced the activities of the Environmental Sciences Department *July 12, 2019*
- Gave a keynote lecture entitled "Some Properties of Wood-Derived Char Important for Their Interactions with Organic Compounds" at the International Symposium on Organic Geochemistry held at Peking University, Beijing, China (approx. 300 total attendees; approx. 100 students) *August 7-9*
- Gave a keynote talk at the International Workshop on Pollutants in Agro-Environments at Nanjing Agricultural University in Nanjing, China (approx. 200 attendees, approx. 50 students) *October 12-15*
- Gave a departmental seminar at the State Key Laboratory of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Nanjing China (approx. 80 attendees, approx. 60 students) *October 16*
- Participated in a Council meeting of the Connecticut Academy of Science and Engineering, Rocky Hill *October 30*
- Gave a talk entitled "Some Ways to Modify Chars for Enhanced Binding of Certain Organic and Inorganic Contaminants" at the ASA-CSA-SSSA Annual Meeting held in San Antonio, TX (approx. 75 attendees total; approx. 45 students) *November 9-14*
- Participated in a Progress Report video workshop for the SERDP grants program *May 20*

PRAPAYOTIN-RIVEROS, KITTY

- Participated in a US FDA Sample Analysis Data Exchange - IT Implementation Phase work group WebEx call *August 6, 2019*

- Presented ISO/IEC 17025 audit/transition with new standard 2017 version and on the mentor laboratory panel discussion at the 2019 Animal Feed Regulatory Program Standards (AFRPS) Face-to-Face Meeting held in Mobile, AL (approx. 100 attendees) *August 27-29*
- Participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File *March 17, 2020*
- Participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File *April 7, 21*
- Participated in the CT Weekly Office Hours for Teams with Microsoft Customer Success Manager *April 6, 13, 17, 20, 27*
- Participated in a Technical Call for the Funding Opportunity Announcement for Animal Feed Regulatory Program Standards with optional funding for Preventive Controls for Animal Foods *April 14*
- Attended the Connecticut Power Platform Discussion to discuss utilizing Microsoft Power Apps and Power Automate *April 21*
- Participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File *May 5, 19*
- Participated in the CT Weekly Office Hours for Teams with Microsoft Customer Success Manager *May 4, 11, 18, 25*
- Participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File *June 2, 16*
- Participated in the CT Weekly Office Hours for Teams with Microsoft Customer Success Manager *June 1, 8, 15, 22, 29*
- Participated in a 2020 Animal Feed Regulatory Program Standards Annual Face-to-Face Virtual Meeting *June 23, 24*

RIDGE, GALE E.

- Was interviewed about lightning bugs and their high populations in Connecticut this year by Mark Zaretsky from the New Haven Register *July 25, 2019*
- Was interviewed about the status of native Goldenrod as an important plant for pollinators and why it has been classified as a weed by Bob Miller of the News-Times *August 20*
- Presented a talk about bed bugs to the Southern Mental Health Authority in Norwich (47 attendees) *September 6*
- Spoke about bed bugs to affordable housing and property owners in Hartford (31 attendees) *September 12*
- Conducted a training about managing bed bugs on public transportation for the Greater Bridgeport Transit and provided a copy of the CCABB bed bug bus poster from a previous campaign, which they plan to display in their bus fleet (15 attendees) *September 18*
- Was interviewed about yellowjackets by Catherine Bowton from the Republican-American *September 25*
- Spoke about bed bugs to Sound Community Services of New London (34 attendees) *September 26*
- Was interviewed about yellowjackets by Rachael Rooney, Channel 3 Eyewitness News *September 30*
- Was interviewed about insects that overwinter by Mary Jo DiLonardo, Senior Editor/Writer of the Mother Nature Network *September 30*
- Was interviewed about the brown marmorated stink bug, *Halyomorpha halys*, by Mike Agogliati from Channel 3 News *October 1*

- Staffed a CAES exotic pest insects and worms table at the 19th Bethany Harvest Festival (2,000 attendees) *October 6*
- Traveled to the ABC studio in New York City to record an episode for a new children's game show for Disney called "The Big Fib," which is scheduled for release in 2020. The premise of the Big Fib show is to have a child guess the real expert from the fake expert, while introducing child audiences to more unusual professions. The Insect Information Office has been receiving calls from concerned Connecticut citizens about three Asian earthworm species collectively called the crazy snake worms. They are increasingly becoming established in Connecticut with a track record of causing serious ecological harm to infested areas of the Northeastern forest biome *October 10*
- Participated in a workshop and fellow collaborative meeting with Dr. Josef Gorres from the University of Vermont as part of "earthworm day" sponsored by the University of Connecticut (70 attendees) *October 19*
- Presented a talk about bed bugs to the Connecticut Nurses Association in Middletown (19 attendees) *October 30*
- Held Bed Bug Forum XI in Jones Auditorium at the Experiment Station (74 attendees) *November 7*
- Gave a lunchtime lecture on bed bugs and Delusory Parasitosis at UConn's Hospital for Special Care in New Britain (45 attendees) *November 20*
- With Mike Lipsett, was interviewed on the magazine program CT-Style (Channel 8) about bed bugs and what and what not to do in managing bed bugs at home *November 21*
- Spoke about bed bug evolution, behavior, and biology at the annual Connecticut Environmental Council meeting held in Wallingford (60 attendees) *December 3*
- Presented a lecture about bed bugs and Delusions of Infestations at a winter conference sponsored by the University of New Hampshire in Concord, NH (67 attendees) *January 10, 2020*
- Was interviewed on the effects of the warm winter weather on insects in Connecticut by Channel 3 *February 3*
- Presented a talk about bed bugs at the Manchester town board meeting as they dealt with a long-term bed bug infestation in a town apartment building *February 4*
- Was interviewed about the effects of the warm winter on insects and ticks by Robert Miller from the Danbury News-Times *February 11*
- Was interviewed about a warmer winter and its effects on insects by Kaitlyn McGrath from NBC Connecticut *February 18*
- Was broadcast on Channel 3 TV about insects and the warm winter weather *February 19*
- Was interviewed about bed bugs in ride shares by Channel 3 TV *February 25*
- Was interviewed about the warm winter and insects by WICC Radio *February 26*
- Attended and gave a talk about Delusions of Parasitosis at the New Jersey Mosquito Control Association annual conference held in Cape May, NJ *March 4-6*
- Presented a webinar about bed bugs to students at Southern Connecticut State University for their Environmental Health Training Program *April 15*
- Was interviewed about the Giant Asian hornet and the likelihood of its establishment in the Northeast by Lissette Nuñez, FOX 61 News *May 4*
- Was interviewed about the Giant Asian hornet and the likelihood of its establishment in the Northeast by Kate Sheehy from the New York Post *May 4*
- Was interviewed about bees in Connecticut by Harlan Levy of the Journal Inquirer *June 22*
- Was interviewed about fireflies and environmental degradation by Kathleen Connelly of The Day *June 23*

ROBB, CHRISTINA S.

- Participated in a long range program planning meeting for the Eastern Analytical Symposium *July 26, 2019*

- Represented the Department of Analytical Chemistry at the Connecticut National Guard (CTNG) Joint Staff SFE concepts and objectives meeting at Camp Nett, Niantic *September 25-26*
- Discussed abrin analysis with the Division of Infectious Diseases, Wadsworth Center, New York State Dept. of Health *November 8*
- Assisted in running the Eastern Analytical Symposium (EAS) as vice-chair of short courses (*November 17*) and a member of the board attending the board meeting long-term program planning meeting (*November 18*), 2020 program meeting (*November 19*); and presented an electronic poster at EAS entitled "Abrin Analysis by LC/MS," co-authored by Dr. Walter Krol and Dr. Kirk Gaston of the Forensic Chemistry Center of the FDA *November 20*
- Participated in the Eastern Analytical Symposium board meeting and accepted the position of short-course chair for 2020 *December 6*
- Participated in an FDA FERN monthly call *December 12*
- Participated in a monthly FDA FERN CCAP call *February 20*
- Participated in a monthly FDA FERN cCAP WebEx call *March 12*
- Participated in an Eastern Analytical Symposium (EAS) long range planning committee meeting *March 31*
- Participated in meetings for the Eastern Analytical Symposium (EAS) board members (*May 15*), long range planning (*May 31*), and short courses *May 26*
- Presented a poster entitled "Improving the Detection of the Molecular Indicators of *Abrus precatorius* with LC-MS" at the American Society of Mass Spectrometry meeting *June 1-4*
- Participated in meetings for the Eastern Analytical Symposium short courses (*June 1, 30*) and long range planning *June 2*

RUTLEDGE, CLAIRE E.

- Dr. Rutledge's intern, Ester Kim, presented a talk entitled "Sun and Shade: How Important Is Light in the Capture of Parasitic Wasps by Yellow Pan Traps?" in Jones Auditorium (40 attendees) *August 8, 2020*
- Was interviewed about the emerald ash borer by Julia Werth of the Connecticut Examiner, which led to the article https://ctexaminer.com/2019/08/26/a-die-off-of-3-5-of-connecticuts-forests-within-5-years-from-invasive-ash-borer/ *August 23*
- Taught "Insects That Eat Trees" for Arboriculture 101 in Wallingford (45 adults) *October 6*
- Presented a talk entitled "The Future of Ash in Connecticut" at the Connecticut Urban Forest Council in Plainville (60 adults) *October 23*
- Taught "Tree Conditions Laboratory" for Arboriculture 101, at the Connecticut Tree Protective Association office in Wallingford (45 attendees) *November 6*
- Participated in the 44th meeting of the EFSA-ALPHA working group on Pest Surveys on *Agrilus anxius* via telephone that was held in Parma, Italy (4 participants) *December 9*
- Gave a talk entitled "Little Trees Get Eaten Too" to the Greater New Haven Bonsai Club in New Haven (25 adults, 1 youth) *January 14, 2020*
- Helped to organize and run the annual meeting of the Connecticut Tree Protective Association held at the Aqua Turf Club in Plantsville (800 attendees) *January 16*
- Presented "Biological Control of Emerald Ash Borer in Connecticut" at the Yale Forest Forum, New Haven (40 attendees) *February 13*
- Presented "Biological Control of Emerald Ash Borer in Connecticut" at Western Connecticut State University's Biological Sciences seminar in Danbury (45 attendees) *February 20*
- Presented "The Emerald Ash Borer in New London" at the New London Public Library in New London (18 attendees) *February 25*
- Gave a presentation entitled "Progress in Emerald Ash Borer Biological Control" at the annual Forest Health Monitoring Workshop held in Jones Auditorium (60 participants) *March 5*

SCHULTES, NEIL P.

- With Dr. Quan Zeng, presented a "Toolbox Webinar" on "Fire Blight IPM Using Non-Antibiotic Control Methods" for the Northeastern Integrated Pest Management Center (140 attendees) *October 9, 2019*
- Presented a talk entitled "Fire Blight IPM Using Non-Antibiotic Control Methods" at the 81st New England, New York, Canadian Fruit Pest Management Workshop in Burlington, VT (50 attendees) *October 22-23*
- Presented the first lecture in a three-lecture series on "Genetically Modified Plants in Agriculture" in a Yale Course Sci 031 "Current Topics in Science" (8 students) *October 25*
- Presented a talk entitled "Fire Blight IPM Using Non-Antibiotic Control Methods" for the 5th Northeastern Integrated Pest Management Center online conference (49 viewers) *October 30*
- Presented the last lecture in a three-lecture series on "Genetically Modified Plants in Agriculture" in a Yale Course Scie 031 "Current Topics in Science" (8 students) *November 1*
- Presented a poster entitled "Nucleobase Transport in Fire Blight Pathogen and Host" at the annual Ian Sussex Plant Biology Symposium held in Jones Auditorium (75 participants) *November 15*

SHEPARD, JOHN J.

- Participated in a regional conference call (DE, MA, NJ, NY and PA) and gave a summary of mosquito trapping and arbovirus surveillance data *July 12, 2019*
- Was interviewed about Mosquito Trapping and Testing results by the Connecticut Post *July 16*
- Spoke to two tour groups from the Yale University Women's Organization about the CT Mosquito Trapping and Arbovirus Surveillance Program and EEE (24 attendees) *September 24*
- Was interviewed about mosquito trapping and identification by Fox 61 *September 24*
- Spoke to a group of visiting students from Wesleyan University on the Mosquito Trapping and Arbovirus Surveillance Program (9 attendees) *November 20*
- Gave an invited talk entitled "Arbovirus Activity in Connecticut, 2019" at a Pesticide Resistance Workshop at the 65th Annual Meeting of the Northeastern Mosquito Control Association held in Milford, MA (approx. 200 attendees; approx. 15 students) *December 9-11*
- Was interviewed about *Culiseta melanura* habitats and Eastern Equine Encephalitis by freelance journalist, Oscar Schwartz *January 10, 2020*
- Spoke about "Mosquito-Borne Viruses in Connecticut" to 5th graders at O'Connell IB World School in East Hartford (18 students) *January 14*
- Gave an invited seminar entitled "Connecticut Mosquitoes and the Viruses They May Transmit" at a meeting of the Potapaug Audubon Society in Old Lyme (25 attendees) *February 6*
- Gave a lecture entitled "Eastern Equine Encephalitis Virus in Connecticut" to Dr. Kirsten Martin's Environmental Health class at the University of St. Joseph in West Hartford (10 students, 1 faculty) *March 2*
- Gave two invited talks entitled "Mosquito-Borne Viruses in Connecticut" and "Biology, Ecology, and Feeding Behavior of Mosquitoes in Connecticut" at a Mosquito and Biting Fly Training Workshop held at CAES and sponsored by Central Turf & Irrigation (105 attendees) *March 3*
- Gave a talk entitled "Biology, Ecology, and Feeding Behavior of Mosquitoes in Connecticut" at a Symposium on EEE and Other Mosquito-Borne Diseases in Connecticut held in Jones Auditorium for local public health officials (58 attendees) *March 9*
- Presented "Establishing and Maintaining Mosquito Colonies" as part of a webinar entitled "Insecticide Resistance in Mosquitoes: Practical Guidance and Tips for Performing Your Own Monitoring Assays" for the Northeast Regional Center for Vector Borne Diseases (62 attendees) *April 1*
- Presented "Mosquito Collection Techniques and Specimen Processing" and "Taxonomic Identification of Adult Female Mosquitoes" as part of a webinar "2020 Boot Camp" for the Northeast Regional Center

for Vector Borne Diseases (20 attendees) *May 14, 19*
- Provided an update about the CT Mosquito Trapping and Arbovirus Surveillance Program on a Northeast Arbovirus Surveillance Situational Awareness call (39 attendees) *May 14*
- Provided an update about the CT Mosquito Trapping and Arbovirus Surveillance Program on a Northeast Arbovirus Surveillance Situational Awareness call (21 attendees) *May 28*

SHORT, MICHAEL R.
- Staffed the CAES display at the 31st Annual Conference on Urban and Community Forestry held in Southington (150 attendees) *October 23, 2019*
- With Dr. Scott Williams, Dr. Megan Linske, and Mr. Joseph Barsky, hosted and served as judges at the FFA Forestry Career Development Event held at Lockwood Farm (48 students, 12 teachers) *November 22*

SMITH, VICTORIA L.
- Participated in the summer meeting of the Connecticut Nursery and Landscape Association, held at Planters Choice Nursery in Monroe (approx. 200 participants) *July 17, 2019*
- Participated in a career panel for the CAES Summer Intern program, directed by Dr. Lindsay Triplett, held in Jones Auditorium (15 participants) *July 22*
- Participated in a spotted lanternfly response planning meeting held in Jones Auditorium (10 participants) *August 1*
- With Dr. Robert Marra, coordinated a site visit to the newly-documented occurrence of beech leaf disease in Fairfield County. Individuals from the towns of Greenwich and Stamford, DEEP foresters, CAES, and the Durham (NH) Field Office of the U.S. Forest Service participated *August 21*
- With Ms. Tia Blevins, participated in a demonstration of mobile inspection applications, presented by DAS-BEST, in Hartford (25 participants) *September 12*
- With Ms. Tia Blevins and USDA officer Eric Chamberlain, certified the cold treatment facilities at Blue Hills Orchard in Southington. Cold treatment certification will facilitate export of CT apples to Israel *September 26*
- Participated in a meeting with CT DEEP Division of Forestry, "Prepping for the 2020 Forest Action Plan," held at CFPA Headquarters in Rockfall (22 participants) *October 3*
- Was interviewed on the recent report of a spotted lanternfly in Southbury by Kaylee Pugliese of the Waterbury Republican-American *October 10*
- Was interviewed on the recent report of a spotted lanternfly in Southbury by Katrina Koerting of the Danbury News-Times *October 15*
- Participated in the annual meeting of the U.S. Forest Service Cooperators, held at the Full Moon Resort in Big Indian, NY, and presented results of the 2019 aerial survey of pests and diseases, and general forest health issues, including beech leaf disease and spotted lanternfly (30 participants) *November 6-7*
- Participated in the autumn meeting of the Cooperative Agricultural Pest Survey committee, held at the USDA Plant Protection and Quarantine offices in Wallingford (13 participants) *November 21*
- Participated in the CT Tree Protective Association winter meeting, held at the Aqua Turf Club in Plantsville *January 16, 2020*
- Participated in the CT Nursery and Landscape Association Winter Symposium held at the Aqua Turf Club in Plantsville (approx. 200 participants) *January 22, 23*
- Consulted with Prides Corner Farms, a 600-acre nursery in Lebanon, on regulations for selling nursery stock on the Internet, including Amazon.com *February 21*
- Organized and participated in the annual Forest Health Monitoring Workshop held in Jones Auditorium. There were 8 presentations on topics ranging from progress in EAB, new ticks in CT, beech leaf disease, and effects of forest mast on wildlife, and one discussion about the general health

of CT forests. Presentations are archived on the CAES website at https://portal.ct.gov/CAES/Publications/Publications/Forest-Health-Monitoring-Workshop-2020 (60 participants) *March 5*
- Was interviewed regarding the effects of the ongoing virus pandemic on the Connecticut nursery industry by the CT Examiner *May 26*
- Participated in the annual Spring Cooperative Agricultural Pest Survey (CAPS) meeting via ZOOM (15 participants) *June 23*

STAFFORD, KIRBY C. III
- Participated in a conference call about a tick academy coordinated by the Tick IPM Working Group *July 2, 2019*
- Was interviewed about gypsy moth by Patrick Skahill, WNPR Public Radio *July 12*
- Participated in a spotted lanternfly response planning meeting held in Jones Auditorium (10 participants) *August 1*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group and presented on tick integrated tick management *August 12*
- Was interviewed about the gypsy moth outbreak by Patrick Skahill, WNPR *August 14*
- Hosted a visit by Yale Microbiology Fellow Dr. Hasan Fadlallah *August 14-15*
- Spoke on ticks and tick-borne diseases at the Falls Avenue Community Center in Watertown (15 attendees) *August 23*
- Was interviewed about the Asian longhorned tick and lone star tick by Robert Miller, Danbury News-Times *August 26*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group and presented on ticks and integrated tick management *August 26*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group and presented on tick integrated tick management *September 9*
- Spoke on ticks and tick-borne diseases at the Burlington Garden Club meeting in Burlington (28 attendees) *September 12*
- Participated on two panels at a meeting of the Armed Forces Pest Management Board specifically on ticks in Silver Spring, MD *September 16-17*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group *September 23*
- Spoke on ticks and tick-borne diseases to the Hartland Trust in East Hartland (34 attendees) *September 23*
- Spoke on tick-bite prevention at an Eversource safety meeting in Hartford (30 attendees) *September 25*
- Participated in an Asian longhorned tick project call *September 27*
- Spoke on ticks and tick-borne diseases at the Posser Public Library in Bloomfield (30 attendees) *October 2*
- Participated in a meeting on the Connecticut Forest Action Plan in Middlefield (22 participants) *October 3*
- Was interviewed about the spotted lanternfly by Matt Dwyer, WTIC-AM *October 15*
- Was interviewed about the spotted lanternfly by Kate Rayner, NBC-CT *October 16*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group *October 21*
- Spoke to the Bristol Garden Club at the Bristol Public Library about ticks, tick-borne disease, and tick management (40 attendees) *October 24*
- Spoke on “Ticks: It’s More Than Just Lyme Disease” at the annual meeting of the Connecticut Environmental Health Association in Portland (60 attendees) *November 1*
- Spoke on “Lyme Disease and Tick Control” at the annual meeting of the Connecticut Master Gardener Association in Jones Auditorium (40 attendees) *November 2*

- Presented a talk entitled “Review of the ‘Natural’ Product Minefield for Bed Bug Control” at Bed Bug Forum XI in Jones Auditorium (68 attendees) *November 7*
- Participated in conference calls of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group *November 14, 18*
- Spoke to Wesleyan University students touring the Station about Entomology *November 20*
- Participated in a meeting of the Cooperative Agricultural Pest Survey in Wallingford (13 participants) *November 21*
- Presented a talk entitled “Tick Surveillance: A Review of Methods by Species” as part of a tick surveillance webinar (191 attendees) *December 2*
- Participated in a conference call of the Tick Biology, Ecology and Control subcommittee of the Tick Borne Disease Working Group *December 2, 16*
- Spoke on managing an exploding expansion of tick and other vector-borne diseases at the Northeast Region Pesticide Safety Education & Certification meeting at the EPA Region 1 Laboratory in North Chelmsford, MA (40 attendees) *December 4*
- Was interviewed about the published research with a rodent-targeted oral Lyme disease vaccine by Angus Chen, NPR station WBUR *January 6, 2020*
- Presented a CAES Seminar entitled “Maggots and Murder: An Introduction to Forensic Science” in Jones Auditorium (approx. 60 attendees) *February 5*
- Was interviewed about the effects of the mild winter on tick activity by Robert Miller of the Danbury News-Times *February 5*
- Spoke on invasive ticks and tick-borne diseases at the Yale Forestry Forum in New Haven (20 attendees) *February 6*
- Was interviewed about the rodent Lyme disease vaccine bait and general tick control by Mike Wollschlager, CT Magazine *February 18*
- Was interviewed about the active tick surveillance program by Ed Stannard, New Haven Register *February 20*
- Presented a poster and participated in the conference “Vector Week” sponsored by the Centers for Disease Control and Prevention in Fort Collins, CO *February 25-28*
- Was interviewed about ticks and tick bite prevention as people go outdoors by Kaitlyn McGrath, NBC Universal *April 2*
- Was interviewed about tick activity and the need for personal tick bite prevention by Robert Miller, News-Times *April 7*
- Presented a webinar on ticks and tick control for the Connecticut Horticultural Society *April 23*
- Was interviewed about ticks and infection rates by Erica Moser, The Day *April 29*
- Was interviewed about tick bite prevention and landscaping as people go outdoors by Taylor Quimby, New Hampshire Public Radio *May 1*
- Recorded an interview/PowerPoint presentation on tick control with Dr. Stephen Rich, University of Massachusetts, for a tick webinar to be aired in June *May 5*
- Participated in the public tick IPM working group conference call *May 13*
- Presented a webinar on tick taxonomy for the NEVBD virtual “boot camp” (17 attendees) *May 19*
- Presented a webinar on the principles for tick control for the NEVBD virtual “boot camp” (17 attendees) *May 20*
- Participated in an NEVBD leadership call *May 22*
- Presented a webinar on integrated tick management for the National Environmental Health Association (295 attendees) *May 28*
- Presented a webinar on tick management for the Midwest Center of Excellence for Vector Borne Disease *May 29*
- Presented a webinar on ticks and tick management for the Town of Bloomfield and the Bloomfield Land Trust (40 attendees) *June 3*

- Presented a webinar on "Strategies and Barriers to the Prevention of Tick-Borne Disease" for the Northeastern IPM Center (40 participants) *June 10*
- Participated as a panelist on the "Tick Management and Control" webinar, which was recorded in May for the Tick Talk webinars with Dr. Stephen Rich at the University of Massachusetts (450 attendees) *June 10*
- Participated in a conference call of the Tick IPM Working Group *June 10*
- Participated in the annual Spring Cooperative Agricultural Pest Survey (CAPS) meeting via ZOOM (15 participants) *June 23*
- Was interviewed live about the lone star tick on WVIT NBC-CT *June 30*

STEBBINS, SUMMER E.
- Gave a talk entitled "Invasive Aquatic Plants in Connecticut" to the Friends of Bolton Lakes at their Annual Fall Forum (approx. 30 attendees) *October 22, 2019*
- Hosted a table at the Yale Career Fair *January 31, 2020*
- Participated in a conference call on Connecticut's Boat Launch Steward program *February 25*

STEVEN, BLAIRE T.
- Presented a talk entitled "Assessing the Resilience of Biocrusts by Tracking Their Recovery from Disturbance" at Biocrust4 held in North Stradbroke Island, Australia (95 attendees; approx. 40 students) *August 25-30, 2019*
- Gave a seminar entitled "Can the Apple Flower Microbiome Provide a Probiotic for Fire Blight Disease?" to the Department of Plant Science and Landscape Architecture at the University of Connecticut in Storrs (approx. 25 attendees, 15 of them students) *September 20*
- Participated in the "Mystery Scientist" program for the coastal wetlands-focused climate change module being developed for high school science educators (https://www.youtube.com/watch?v=EzN-U3TzOl0&feature=youtu.be) *Various dates in September*

STONER, KIMBERLY A.
- Was interviewed about bees and Pollinator Pathways by Julia Werth of the Connecticut Examiner *July 3, 2019*
- Was interviewed about Pollinator Pathways by Susan Shea of Northern Woodlands Magazine *July 8*
- Was photographed at Keeler Meadows, Wilton, with Mary Ellen Lemay, Louise Washer, and Donna Merrill, co-founders of the Pollinator Pathway movement for Connecticut Magazine *July 24*
- Spoke on "What You Can Do to Help Bees" at a Teach-In on the Climate Crisis and Environment, sponsored by Together We Rise at St. Stephens Church in East Haddam (45 attendees) *July 27*
- Consulted with Dina Brewster, Executive Director of CT NOFA, about equipment and information for harvesting and processing seed of native pollinator plants *July 30*
- Was interviewed on camera in the Urban Oasis on the CAES New Haven campus about factors in losses of honey bee colonies by Sam Kantrow of WTNH - 8 *July 30*
- Was interviewed live on-air about bees, pollinator habitat, and the Pollinator Pathway by Lucy Napathanchil on the program "Where We Live," CT Public station WNPR *August 2*
- Was interviewed about the insect apocalypse and the current status of the state bee checklist by Greg Hladky of the Hartford Courant *August 14*
- Organized and spoke at a workshop for photographing insects on flowers and submitting photos to iNaturalist for identification and documentation of sightings at Wakeman Town Farm, Westport (25 attendees) *August 17*
- Presented a poster entitled "Using Color Sorting and Palynology to Track Pesticide Residues in Trapped Honey Bee Pollen to a Plant Genus" at the COLOSS (Prevention of Honey Bee Colony Losses) meeting, and participated in the meetings of the Nutrition and Apitox Task Forces in Montreal, Quebec

(150 participants) *September 7-8*

- Presented a talk to the South Central Connecticut Regional Council of Governments on "Pollinator Habitat in Connecticut" (22 attendees) *September 24*
- Presented a talk entitled "Whatever Happened to IPM?" at the Protecting Pollinators in Urban Landscapes Conference in Cincinnati, OH (85 attendees) *October 8*
- Was interviewed about pollinator habitat by Palia Sognlin of the Yale Daily News *October 11*
- Spoke on "Planting for the Bees' Needs" to the Southington Garden Club (35 attendees) *October 22*
- Met with representatives of the Connecticut Botanical Society, Dr. Robert Askins of Connecticut College, and Eversource at a utility right-of-way adjacent to the Groton Open Space Association Avery Hill Farm to discuss vegetation management in the rights-of-way for high voltage transmission lines in relation to habitat for pollinators, rare plants, and other organisms of interest (9 participants) *October 23*
- Spoke at the SALT (Smaller American Lawns Today) Conference at Connecticut College on "Pollinator Habitats: Recent Research" (80 attendees) *November 9*
- Was interviewed about honey bee losses and pesticides by Lindsey Vickers of Metro West Daily News in Massachusetts *December 10*
- Spoke on "Planting for the Bees' Needs" to elementary school teachers and managers of nature centers at the Kellogg Environmental Center in Derby (16 attendees) *December 10*
- Was interviewed live about planting for pollinators on the bilingual radio program Juntos Podemos by Caprice Taylor Mendez on La Voz Hispana Radio, 103.5 FM and archived on their Facebook page *January 6, 2020*
- Was interviewed about bee health, including both honey bees and native bees, by Mark Zaretsky of the New Haven Register *January 10*
- Organized and led a meeting of the Connecticut Native Plants for Pollinators and Wildlife Working Group at CAES in New Haven (24 attendees) *January 14*
- Was interviewed about pesticides, particularly neonicotinoids, and bees by Jennifer Sass, Senior Scientist, Natural Resources Defense Council *January 24*
- Spoke on "Planting for the Bees' Needs – Pollinator Habitat" to the Branford Land Trust at the Wallace Willoughby Library in Branford (55 attendees) *January 28*
- Was interviewed about a recently published paper about plant sources of pollen collected by honey bees by Greg Hladky of the Hartford Courant *January 29*
- Was interviewed about a recently published paper about plant sources of pollen collected by honey bees and about utilization of native and non-native plants by Jeannette Ross of the Wilton Bulletin *January 30*
- Presented "Planting for the Bees' Needs" at the Leetes Island Garden Club in Guilford (25 attendees) *February 11*
- Presented current research on pollen trapped at ornamental plant nurseries via webinar as part of a meeting of the Specialty Crops Research Initiative annual meeting in San Diego, CA (24 attendees) *February 25*
- Spoke on "Pollinators and Planting for the Bees' Needs" at the Northern CT Agricultural Summit held at Asnuntuck Community College in Enfield (30 attendees) *February 29*
- Met with the Right of Way Working Group of the Connecticut Botanical Society to plan an event and create documents for the upcoming workshop "Advocating for the Biological Value of Your Local Right of Way" in Cheshire (8 participants) *March 2*
- Met via ZOOM with organizers of the Pollinator Pathway network, Sam Droege of the U.S. Geological Survey, and Jim Sirch of the Peabody Museum, about Citizen Science projects in which Pollinator Pathway members could participate (9 participants) *March 9*
- Organized, hosted, and spoke in a workshop entitled "Advocating for the Biological Value of Your Local Right of Way" in Jones Auditorium, and by ZOOM; materials from the workshop were also

shared with the Connecticut Land Conservation Council on their website and through their listserv (29 participants) *March 12*

- Presented a webinar entitled "Preserving Native Bee Diversity" for the Connecticut chapter of Wild Ones, a native plant conservation organization, via ZOOM (31 attendees) *April 11*
- Presented a webinar entitled "Planting for the Bees' Needs" for the Ecological Agriculture class of Dr. Eric Vukicevich at Connecticut College (28 attendees) and the webinar was recorded for additional students who were not able to attend *April 15*
- Participated in the Agriculture and Working Lands Subgroup of the Governor's Council on Climate Change (20 attendees) *April 30*
- Presented a talk entitled "Planting a Pollinator Pathway" for the Green Forum of the Interreligious EcoJustice Network via ZOOM with 61 people online, and the talk was recorded for posting on the YouTube channel for IREJN *May 18*
- Presented a webinar entitled "Planting for the Bees' Needs" for the White Memorial Conservation Center via ZOOM and streamed on the YouTube channel of Jamie Fischer (research director for WMCC); a total of 150 people participated through the two online media. Handouts from the talk are also posted on the WMCC website: https://whitememorialcc.org/special-events/ *May 20*
- Participated in a meeting of the Agriculture and Soils Working Group of the Governor's Council on Climate Change via ZOOM (25 participants) *June 25*

TAERUM, STEPHEN J.

- Presented "Bark Beetles of Connecticut: What Are They, and What Do They Do?" to the Yale Green Café at the Marsh Botanical Garden (18 adults, 1 youth) *October 3, 2019*
- Presented "What Are Protists Doing in the Maize Rhizosphere?" to the Sussex Plant Biology Symposium held in Jones Auditorium (60 attendees) *November 15*

TRIPLETT, LINDSAY R.

- With Dr. Nubia Zuverza-Mena, led a science communication training workshop in the PPE conference room for undergraduate interns (10 students) *July 8, 2019*
- Led summer undergraduate students on a tour of Indigo, a biological products company in Boston, MA; the students toured the different steps of the Research and Development pipeline (10 students) *July 15*
- Attended Plant Health 2019 in Cleveland, OH, where she participated in an August 3rd workshop "The Plant Root System: Gateway to Plant-Beneficial Rhizosphere Microbiome Interactions." She gave an oral presentation entitled "A Group Plot Experiment to Incorporate Agricultural Field Research Training into Summer Undergraduate Internships" (21 attendees) (*August 5*), and a poster presentation entitled "Evaluation of a Single Seedling Treatment with Nanoscale Nutrients to Control Fusarium Wilt Symptoms of Chrysanthemum" (60 attendees) (*August 5*); and coordinated and hosted the final symposium for the Plant Health Fellows summer internship program for undergraduates - ten symposium participants each presented a five-minute summary of their summer research project (45 attendees) *August 8*
- With Ms. Katherine Dugas and Ms. Rose Hiskes, staffed the CAES booth at the Eastern States Exhibition in West Springfield, MA (total attendance 52,447) *September 17*
- Gave three lectures and led two journal discussions on molecular plant-microbe interactions as co-instructor of the Yale graduate course MCDB680, Advances in Plant Molecular Biology (11 students) *October 4, 11, and 25*
- With Dr. Goudarz Molaei, participated in a job recruitment fair at Central Connecticut State University (40 attendees) *February 3, 2020*

VOSSBRINCK, CHARLES R.

- Gave three talks on propagating and overwintering figs in the state at the West Haven Fig Festival held at Savin Rock Park (https://patch.com/connecticut/westhaven/west-haven-international-food-fig-

festival-september-14) (approx. 80 attendees) *September 14, 2019*

WARD, JEFFREY S.

- Was interviewed about the influence of wet May and June on spread and growth of invasive plants by Robert Miller of the Danbury News-Times *July 2, 2019*
- Was interviewed about prescribed burning by Hanna Holcomb of Connecticut Woodlands *July 11*
- Participated in a New England Society of American Foresters (NESAF) 2020 planning committee conference call *July 30*
- Led a field tour of oak stands in Voluntown for the kickoff meeting of the Increasing Resiliency in Southern New England Oak Forests project (10 attendees) *August 14*
- Participated in an NESAF 2020 planning committee conference call *August 27*
- Was interviewed about the importance of acorns for forest ecology by Bob Miller of the Danbury News-Times *September 12*
- Met with Mayor Robert Chatfield to discuss planting sites on the Prospect town green *September 13*
- Spoke on "A Short History of the Connecticut Forest" at the Rockville Public Library in Vernon (8 attendees) *September 19*
- Participated in an NESAF 2020 planning committee conference call *September 24*
- Was interviewed about autumn leaf color by Bob Miller of the Danbury News-Times *October 1*
- Spoke on "Tree and Shrub Identification" for the Glastonbury Garden Club (14 attendees) *October 3*
- Planted a white oak donated by CTPA on the Prospect Town Green with Mayor Robert Chatfield in celebration of the 100th anniversary of the arborist law insuring quality tree care for Connecticut's residents *October 4*
- Participated in a meeting of the Connecticut Invasive Plant Council in Windsor *October 8*
- Participated in an NESAF 2020 planning committee conference call *October 29*
- With Mr. Joseph Barsky, met with staff of White Memorial Foundation, The Nature Conservancy - Connecticut, Regional Water Authority, and CT DEEP - Forestry to provide an update on research discoveries and discuss continued collaborative research (10 attendees) *November 5*
- Planted a white oak donated by CTPA in Mixville Park (Cheshire) with David Rochford in celebration of the 100th anniversary of the arborist law insuring quality tree care for Connecticut's residents *November 8*
- Spoke on "A Short History of the Connecticut Forest" to the Old Guard in West Hartford (108 attendees) *November 12*
- Participated in an NESAF 2020 planning committee conference call *November 12*
- Spoke on invasive plant identification and control in Woodbridge (18 attendees) *November 18*
- Met with CT NRCS staff in Tolland to discuss influence of soils and topographic features on tree growth (6 attendees) *November 19*
- With Mr. Joseph P. Barsky, met with staff of CT NRCS and Regional Water Authority to view consequences of different forest management prescriptions (5 attendees) *December 9*
- Participated in an NESAF 2020 planning committee conference call *December 17*
- Gave two webinars on "Rehabilitation of Degraded Hardwood Stands" for the Cornell University ForestConnect series (317 participants who collectively manage 27 million acres in the United States and Canada) *January 15, 2020*
- Provided an update on current CAES tree research at the Connecticut Tree Protective Association annual meeting held in Plantsville (400 attendees) *January 16*
- Participated in an NESAF planning committee conference call *January 28*
- Participated in an NESAF 2020 planning committee conference call *February 4*
- Was interviewed about barberry characteristics and control by Will Rowlands, Connecticut Gardener *February 4*
- Participated in the initial Technical Advisory Committee meeting for New England Forestry

Foundation's North Central & Transition Hardwoods Exemplary Forestry standards in Littleton, MA *February 6*

- Spoke on "Spring Planting and Tree Selection" for the Cherry Hill Garden Club in Canton (41 attendees) *February 11*
- Co-hosted an Oak Resiliency in Southern New England workshop in Tolland (82 attendees) *February 13*
- As Chair, presided over the Yankee Division, Society of American Foresters annual meeting in Tolland *February 13*
- Participated in an NESAF 2020 planning committee conference call *February 18*
- Was interviewed about barberry characteristics and control by Will Rowlands, Connecticut Gardener *February 25*
- Participated in the initial meeting of the Yankee SAF, Forest Management and Carbon Task Force *February 28*
- Participated in a conference call for the Increasing Resiliency in Southern New England Oak Forests project *February 28*
- Participated in an NESAF 2020 planning committee conference call *March 3*
- Participated in a Forest Ecosystem Monitoring Cooperative conference call to discuss a regional forest health monitoring network *March 4*
- Spoke on "Drought, Defoliation, and Death" at the 24th annual Forest Health Monitoring Workshop held in Jones Auditorium (40 attendees) *March 5*
- Spoke on "A Short History of the Connecticut Forest" for the Madison Garden Club (32 attendees) *March 10*
- Participated in an NESAF 2020 planning committee conference call *March 10*
- Participated in Yankee SAF, Forest Management and Carbon Task Force conference calls *March 17, 27*
- Participated in a Yankee SAF, Forest Management and Carbon Task Force conference call *April 10*
- Participated in a New England Society of American Foresters Annual Meeting conference call *April 30*
- Participated in a conference call with Massachusetts DCR-Division of Water Supply Protection staff to discuss functionality of slash walls *May 8*
- Participated in a Forest Ecosystem Monitoring Cooperative (FEMC) Budget Working group video call *May 11, 15*
- Participated in a Yankee SAF, Forest Management and Carbon Task Force conference call *May 18*
- Spoke on invasive species management for a Connecticut Land Conservation Council web lecture (60 attendees) *May 19*
- Participated in an FEMC Steering Committee video call *May 26*
- Met with Massachusetts DCR-Division of Water Supply Protection staff in Oakham, MA to discuss forest regeneration and collaborative research (6 foresters) *June 11*
- Participated in a Connecticut Invasive Plant Council conference call *June 23*
- Participated in a Yankee SAF, Forest Management and Carbon Task Force conference call *June 30*

WHITE, JASON C.

- Participated in a weekly all-hands ZOOM call for the Center for Sustainable Nanotechnology (CSN) *July 3, 10, and 31, 2019*
- Hosted a bi-weekly CSN Nanochem-plant working group ZOOM call *July 9*
- With Dr. Brian Eitzer, Dr. Walter Krol, Ms. Terri Arsenault, Mr. Craig Musante, and Ms. Kitty Prapayotin-Riveros, participated in a monthly FDA FERN cCAP WebEx call *July 11*
- Participated in a research workshop entitled "Nanotechnology in Sustainable Agriculture: Exploring Safe Pathways from the Laboratory to the Field" at McGill University and gave a lecture entitled "How to Manage the Risks of Nanotechnology in Agriculture" (50 attendees) *July 17-18*

- As a PhD committee member, participated in the Proposal Defense of Mr. Ahmed Ali of the University of Massachusetts Amherst *July 21*
- Participated in a strategic planning meeting and writing session at the University of Minnesota as part of the CSN Phase IIB renewal application for the US NSF *July 23-25*
- Attended the Governor's CT PFAS Taskforce meeting in Newington and joined the Human Health Committee *July 30*
- Participated in a monthly project update ZOOM call for the Nanyang Technological University-Harvard University T.H. Chan School of Public Health Initiative for Sustainable Nanotechnology (NTU-Harvard SusNano) *July 31*
- As a PhD committee, participated in a ZOOM call for Gurpal Singh of the University of Massachusetts Amherst Stockbridge School of Agriculture *August 1*
- Hosted a bi-weekly Center for Sustainable Nanotechnology (CSN) Nanochem-plant working group ZOOM call *August 6*
- With Dr. Brian Eitzer, Dr. Walter Krol, Dr. Christina Robb, Ms. Terri Arsenault, Mr. Craig Musante, and Ms. Kitty Prapayotin-Riveros, participated in the monthly FDA FERN cCAP WebEx call *August 8*
- Was a keynote speaker at the 10th National Conference on Environmental Chemistry (NCEC) 2019 at Nankai University in Tianjin, China, and gave a lecture entitled "Nanotechnology and Agriculture: Balancing Applications and Implications" (150 attendees) *August 14-19*
- Gave an invited lecture entitled "Suppression of Crop Disease with Nanoscale Micronutrients" at Zhejiang University in Hangzhou, China (100 attendees) *August 19-21*
- Participated in a CSN Faculty call *August 19, 30*
- Hosted a bi-weekly Center for Sustainable Nanotechnology (CSN) Nanochem-plant working group ZOOM call *September 3, 17*
- Gave a presentation entitled "Nanomaterial Interactions with Plants: Transformative Chemistry-Driven Work Within the CSN" on a weekly CSN ZOOM all-hands call (50 attendees) *September 4*
- With Dr. Chuanxin Ma, participated in a monthly ZOOM meeting of the Nanyang Technological University-Harvard University T.H. Chan School of Public Health Initiative for Sustainable Nanotechnology (SusNano) *September 6*
- Participated in weekly all-hands ZOOM calls for the Center for Sustainable Nanotechnology *September 11, 18*
- With Dr. Brian Eitzer, Dr. Walter Krol, Dr. Christina Robb, Ms. Terri Arsenault, Mr. Craig Musante, and Ms. Kitty Prapayotin-Riveros, participated in the monthly FDA FERN cCAP WebEx call *September 12*
- Participated in a monthly CSN Faculty ZOOM meeting *September 19*
- Spoke by phone with Mr. Jerry Tardif, who is the CEO/CTO of Technological Solutions LLC, about agricultural applications of his technology *September 20*
- Participated in an APHL-sponsored quarterly Agricultural/State Chemist Call WebEx call *September 20*
- Served on an NSF CBET Career Grant Review Panel at NSF in Alexandria, VA *September 26-27*
- With Dr. Theodore Andreadis, met with the co-chairs of the Environment Committee and others to discuss the current ban on methoprene use for mosquito control in Connecticut *September 30*
- With Dr. Walter Krol and Dr. Chuanxin Ma, participated in a ZOOM meeting for the Nanyang Technological University-Harvard University T.H. Chan School of Public Health Initiative for Sustainable Nanotechnology (SusNano) *October 1, 17*
- Hosted Mr. Hyunho Kang of the University of Minnesota as part of a PhD student laboratory exchange within the Center for Sustainable Nanotechnology (CSN) *October 7-10*
- Hosted a monthly "Nanochem-plant" working group ZOOM call for the CSN *October 8*
- With Dr. Brian Eitzer, Dr. Walter Krol, Dr. Christina Robb, Ms. Terri Arsenault, Mr. Craig Musante,

and Ms. Kitty Prapayotin-Riveros, participated in a monthly FDA FERN cCAP WebEx call *October 10*

- Hosted a ZOOM call focused on computational chemistry and nano-enabled agriculture for the CSN *October 11*
- Participated in a quarterly CAES Board of Control meeting *October 16*
- Gave invited lectures at Nanjing Agricultural University (75 participants) and at the Institute of Soil Science, Chinese Academy of Science (25 participants) in Nanjing, China *October 21-25*
- Participated in a ZOOM call with collaborators and the Technology Transfer Office of the University of Minnesota regarding a patent filing based on data on a nano-enabled agricultural application as part of the CSN *October 29*
- Participated in a ZOOM call to discuss collaborative experiments with the University of California Riverside and the University of Minnesota as part of the CSN *October 29*
- Participated in a weekly CSN ZOOM all-hands call *October 30*
- Welcomed Prof. Chun Song of Sichuan Agricultural University; Prof. Song will be working at CAES for the next year on nano-enabled agriculture with funding from the China Scholarship Council (CSC) *November 2*
- As an invited speaker, gave a lecture entitled "Nanotechnology in Agriculture: Balancing Applications and Implications" at the Golden Jubilee International Conference on New Millennia Agriculture at CCS Haryana Agricultural University in Hisar, Haryana, India (125 attendees) *November 2-8*
- Hosted a monthly "Nanochem-plant" working group ZOOM call for the Center for Sustainable Nanotechnology (CSN) *November 12*
- Participated in a weekly "all-hands" call for the CSN *November 13*
- With Dr. Brian Eitzer, Dr. Walter Krol, Dr. Christina Robb, Ms. Terri Arsenault, Mr. Craig Musante, and Ms. Kitty Prapayotin-Riveros, participated in a monthly FDA FERN cCAP WebEx call *November 12*
- Participated in a Faculty ZOOM call for the CSN *November 14*
- Participated in a ZOOM meeting for the Nanyang Technological University-Harvard University T.H. Chan School of Public Health Initiative for Sustainable Nanotechnology (SusNano) *November 18*
- Hosted a class from Wesleyan University and provided a tour/description of department programs and laboratories (10 attendees) *November 20*
- Participated in an FDA webinar on future funding for the Animal Feed Regulatory Program Standards *December 4*
- Participated in weekly "all-hands" calls for the Center for Sustainable Nanotechnology (CSN) *December 4, 18*
- Gave a presentation entitled "Industrial Hemp: Crop for the Future?" at the CT Department of Agriculture Hemp Listening Session held in Jones Auditorium *December 4*
- Spoke with officials at the U.S. Drug Enforcement Agency (DEA) about THC testing in hemp *December 5*
- Gave a presentation entitled "Nanotechnology in Agriculture: Balancing Applications and Implications" at the NanoDay IV Conference held in Milan, Italy *December 12-15*
- Was interviewed about nanotechnology in agriculture by David Freedman of Scientific American *December 17*
- As a PhD committee member, participated by ZOOM in the PhD Dissertation defense of Dr. Hyunho Kang of the University of Minnesota *December 18*
- Participated in a meeting hosted by DPH at the Legislative Office Building on State Agency Alignment of Priorities *January 7, 2020*
- Hosted a monthly "Nanochem-plant" ZOOM call for the CSN *January 14*
- As Managing Editor, participated in a Microsoft Teams call with Taylor and Francis to discuss the International Journal of Phytoremediation *January 17*

- Participated in a ZOOM call with FDA and other FERN participants to discuss updated reporting requirements *January 28*
- Participated in a 2020 AFRPS Planning Committee call *January 30*
- Participated in ZOOM All Faculty calls for the Center for Sustainable Nanotechnology *February 6, 7, 13*
- Participated in a weekly CSN All Center ZOOM call *February 26*
- Participated in a ZOOM call for the Center for Sustainable Nanotechnology (CSN) to select candidates for the Summer Undergraduate Research Experience (SURE) Program *March 2*
- Participated in FDA FERN WebEx calls regarding analytical assignments for the upcoming Republican/Democratic National Conventions and the Inauguration *March 3, 10, 24*
- Gave an invited keynote presentation entitled "Nanotechnology in Agriculture: Balancing Crop Protection and Food Safety" at the Second Pan-American Nanotechnology Conference held in Aguas de Lindoia, Brazil (50 attendees) *March 3-8*
- Hosted a CSN monthly Nanochem-Plant working group call *March 10*
- Participated in a weekly CSN center-wide ZOOM call *March 11, 18, 25*
- Participated in a monthly FDA FERN cCAP WebEx call *March 12*
- Participated in an FDA 50-state WebEx call *March 19*
- Participated in NERA ZOOM calls *March 24, 30*
- Hosted a ZOOM call with the California Department of Public Health regarding FDA FERN work *March 27*
- Participated in weekly Center for Sustainable Nanotechnology (CSN) center-wide ZOOM calls *April 1, 8, 15, 22, 29*
- Participated in CSN Faculty calls *April 2, 30*
- Participated in the monthly CT Laboratory Preparedness meeting/ZOOM call with the Department of Public Health and other state/federal agencies *April 6*
- Hosted a CSN monthly Nanochem-Plant working group call *April 14*
- Participated in a monthly Northeast Experiment Station Directors ZOOM call *April 14*
- Gave a ZOOM lecture entitled "Nanotechnology in Agriculture: Balancing Applications and Implications" to a Plant Biology course at the University of Massachusetts Stockbridge School of Agriculture (10 attendees) *April 14*
- Hosted a quarterly meeting of the CAES Board of Control via ZOOM *April 15*
- Was interviewed about nanotechnology in agriculture (https://www.utep.edu/science/chemistry/Resources/seminars.html) by Dr. Keith Pannell of the University of Texas for Science Studio, which is a radio show on Texas Public Radio *April 17*
- Participated in a ZOOM call for the Governor's Council on Climate Change (GC3) Science and Technology Working Group *April 22*
- As a committee member, participated in Carolina Valdes' (University of Texas, El Paso) qualifying exam via ZOOM (25 participants) *April 23*
- Participated in a Northeast Experiment Station Directors ZOOM call focused on COVID-19 impacts on activities *April 28*
- Participated in a monthly CT Laboratory Preparedness teleconference call with the Department of Public Health and other state/federal agencies *May 4*
- Participated in a ZOOM call with Department of Analytical Chemistry staff and the staff from the Department of Consumer Protection Foods Division regarding FDA projects and surveillance sample collection *May 5*
- Participated in weekly Center for Sustainable Nanotechnology (CSN) center-wide ZOOM calls *May 6, 13, 20, 27*
- Gave a presentation by ZOOM entitled "Nanoscale Micronutrients to Enhance Crop Disease Resistance: Unintended Consequences in the Rhizosphere?" as part of the Society of Environmental

Toxicology and Chemistry (SETAC) Europe meeting in Dublin, Ireland (85 attendees) *May 6*
- Participated in a ZOOM call with Department of Analytical Chemistry staff and the staff from the Department of Agriculture regarding FDA projects and surveillance sample collection *May 8*
- Hosted a CSN monthly Nanochem-Plant working group call *May 12*
- Gave a presentation entitled "Nanochemistry and Plants: Transformative Chemistry-Driven Work Within the CSN" to the CSN weekly all-center call (60 attendees) *May 13*
- Served remotely on an NSF CBET MRI grant panel *May 14-15*
- Hosted a ZOOM call with Commissioner Bryan Hurlburt (CT Dept. of Agriculture) and Mr. Terry Jones (Vice President of the Board of Control) regarding the Valley Laboratory Construction project *May 21*
- Participated by ZOOM in meetings for the Editorial Advisory Boards of Environmental Science and Technology (*May 26*) and Environmental Science and Technology Letters *May 28*
- Participated in a monthly CT Laboratory Preparedness teleconference call with the Department of Public Health and other state/federal agencies *June 1*
- Participated in weekly CSN center-wide ZOOM calls *June 3, 10, 17, 24*
- Hosted a monthly CSN Nanochem-plant ZOOM call *June 9*
- Participated in the annual meeting of the Northeastern Regional Association of State Agricultural Experiment Station Directors (NERA) by ZOOM *June 10*
- Participated in a monthly FDA FERN cCAP ZOOM call *June 11*
- As a PhD committee member, participated in a WebEx meeting with Ms. Jaya Borgatta and the rest of her PhD committee as part of the year 4 update on her program *June 18*
- Participated by ZOOM in the annual FDA AFRPS face-to-face conference and program review *June 23-24*
- Participated in a CSN panel discussion on maintaining a healthy work-life balance *June 29*
- Participated in a Teams meeting with CSN faculty and Dr. Amarjit Basra of OCP North America to discuss nanofertilizers *June 30*

WILLIAMS, SCOTT C.
- Participated in a conference call for the Northeast Regional Center for Excellence in Vector-Borne Diseases *July 23, 2019*
- Spoke to interns with the South Central Connecticut Regional Water Authority about vector-borne disease ecology research in North Branford *July 30*
- Participated in a collaborative meeting with CT DEEP, CT Audubon, and the Town of Guilford for the Steering Committee of the East River Marsh Management Plan *August 1*
- Was interviewed about developing a landscape monitoring and evaluation plan for tick control by Stephanie Morse, a Cornell MPH program student *October 9*
- With Dr. Megan Linske, co-presented an invited lecture entitled "Tick-Borne Disease Ecology: Concerns for Forest and Public Health Alike" at the CT Urban Forest Council Annual Meeting held in Southington (128 attendees) *October 23*
- With Dr. Megan Linske, Mr. Michael Short, and Ms. Jamie Cantoni, was interviewed about ongoing research linking forest and public health in Westbrook by Chris Woodside, Environmental Writer for the Connecticut Health Investigative Team *November 6*
- With Dr. Megan Linske, Mr. Michael Short, and Ms. Jamie Cantoni, met with Jim Tomlinson about management strategies for Japanese barberry on Lyme Land Trust properties in Lyme *November 6*
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, The Wildlife Professional *December 20*
- Gave an invited lecture entitled "Use of Repellents for Averting Deer and Rabbit Damage" at the UConn Extension's Vegetable & Small Fruit Growers' Conference held in South Windsor (246 attendees) *January 6, 2020*

- Participated in a Leadership Conference Call for the Northeast Regional Center for Excellence in Vector-Borne Diseases *January 7*
- With Mr. Michael Short, spoke about career development to students in the Wildlife Biology class from Lyman Hall Memorial High School (Wallingford) (12 students, 1 teacher) *January 10*
- Was interviewed about the efficacy of reservoir targeted vaccination for *Borrelia burgdorferi* in rodent reservoirs by Jillian Mauro of WLAD-AM *January 10*
- Was interviewed about the efficacy of reservoir targeted vaccination for *Borrelia burgdorferi* in rodent reservoirs by Greg Hladky of the Hartford Courant: https://www.courant.com/news/connecticut/hc-news-ct-researchers-anti-lymedisease-mouse-vaccine-20200119-x5zuum2xmzfu3ahvv5srgbpxzy-story.html *January 14*
- Presented a short talk entitled "Update on an Integrated Tick Management Project with 4-Posters, Bait Boxes, and *Metarhizium anisopliae* in Connecticut" and attended the Annual Meeting of the Northeast Regional Center for Excellence in Vector-Borne Diseases held in Jones Auditorium (80 attendees) *January 23 and 24*
- Gave an invited talk entitled "Deer and Tick-Borne Disease: Concerns for Forest and Public Health Alike" at the Great Mountain Forest/Ackerly Brown lecture series in Norfolk *February 8*
- Was interviewed about the results from the statewide active tick surveillance effort by Ayah Galal of WFSB Channel 3 Eyewitness News: https://www.wfsb.com/news/video-new-tick-threats-emerging-in-connecticut-new-report-says/video_6859f280-b213-5a03-92f9-6c5d0620e874.html *February 21*
- Was interviewed about the results from the active tick surveillance effort by Lissette Nuñez of FOX 61 News: https://www.fox61.com/article/news/local/new-data-released-by-connecticut-researchers-giving-a-closer-look-at-the-tick-population/520-c5f60071-613e-448b-9c01-6ca942f7c1cf?fbclid=IwAR2jZavLCvKk88XkQJ6UB3_IT6hUlEa9cvh8tGdSJ3rOrh1-6P5-hfNVADs *February 21*
- Was interviewed about the mild winter and tick activity by Ray and Joe D from WTIC 1080 Newstalk: https://wtic.radio.com/media/audio-channel/ray-and-joe-d-tick-talk *February 27*
- Was interviewed about tick surveillance efforts throughout Connecticut by Brian Smith of WSHU Public Radio *February 28*
- Was interviewed about the newly discovered Asian longhorned tick and tick ecology and climate by Siobhan McGirl of NBC Connecticut: https://www.nbcconnecticut.com/news/local/first-statewide-tick-study-finds-lyme-disease-in-half-of-all-deer-ticks-collected/2232662 *March 3*
- Gave a talk entitled "Connecticut Oak Mast Drives Tick, Disease Reservoir, and Bird of Prey Abundances" at the Forest Health Monitoring Workshop held in Jones Auditorium (60 attendees) *March 5*
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, The Wildlife Professional *April 15*
- Hosted the Northeast Section of the Wildlife Society's Annual Executive Committee ZOOM Meeting and moved from President to Immediate Past-President *April 23*
- Was interviewed about vaccinating wildlife against zoonotic diseases by Madeline Bodin for Discover Magazine: https://www.discovermagazine.com/health/deadly-animal-diseases-can-jump-to-humans-is-vaccinating-wildlife-the-answer *June 1*
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, The Wildlife Professional *June 4*
- Participated in a ZOOM meeting of the Executive Board of the Northeast Section of The Wildlife Society *June 22*

ZARRILLO, TRACY

- Participated in the BOMBUSS 2.0 conference of scientists sharing methods for bumble bee research, including long-term monitoring, regional surveys, and citizen science, and to set up collaborations with

bumble bee researchers at York University in Ontario, Canada *October 16-18, 2019*

ZENG, QUAN

- Gave a presentation entitled “Bacterial Plant Pathogens and Other Plant Associated Microbes” at the research seminar of the Department of Biomedical Sciences, Quinnipiac University, in Hamden (60 adults) *September 4, 2019*
- With Dr. Neil Schultes and Dr. Dan Cooley (Univ. of Massachusetts), hosted a webinar on fire blight disease management through the Northeastern IPM Center “IPM Toolbox” series and presented “Fire Blight IPM Using Nonantibiotic Materials” (140 attendees) *October 9*
- Presented “Role of the Type III Secretion System During Early Events of Pathogenesis in the Fire Blight Pathogen *Erwinia amylovora* on Apple Flowers” at the New England, New York, and Canada Fruit Pest Management Workshop held in Burlington, VT (50 attendees) *October 22-23*
- Participated in the Northeastern IPM Center online conference (approx. 60 attendees) *October 30*
- Taught two guest lectures entitled “Bacterial Plant Pathogens and Diseases” and lab “Diagnosis of Bacterial Plant Diseases and Isolation of Bacterial Pathogens” at the University of Connecticut (16 students) *November 13*
- Gave an oral presentation entitled “Role of the Type III Secretion System During the Infection of Apple Flowers by a Phytopathogenic Bacterium” at the Sussex Plant Biology Symposium, organized by Yale University’s Department of Molecular, Cellular and Developmental Biology, held in Jones Auditorium (60 attendees) *November 15*

ZUVERZA-MENA, NUBIA

- With Dr. Lindsay Triplett, gave a workshop on Formal and Informal Scientific Communication for the Plant Health and Protection (PHP Program) Fellows at Southern Connecticut State University in New Haven (11 attendees) *July 8, 2019*
- With Dr. Jason White and Dr. Sara Nason, participated in the “PFAS Task Force” series of meetings for the Human Health and Remediation committees *July 30, August 16 & 28, September 10 & 18*
- With Dr. Jason White and Dr. Sara Nason, participated in the PFAS Lab capacity and capabilities at the Dept. of Public Health *August 28*
- With Dr. Sara Nason, participated in the “PFAS and Health Disparities” meeting at the Yale School of Public Health, networking for possible collaborations between Yale, the CT DEEP, and CAES *October 2*
- Presented a talk entitled “Can Ceria Nanoparticles Inhibit the Effects of the Short Chain Perfluoroalkyl Substance PFBS on Plants?” at the Sustainable Nanotechnology Organization annual meeting held in San Diego, CA *November 7*
- Presented a guest lecture entitled “Nanomaterials: Applications and Implications” at the University of Connecticut (UConn) for the class PVS 1000, Biomedical Issues in Pathobiology *November 13*

ADVANCES IN KNOWLEDGE

DEPARTMENT OF ANALYTICAL CHEMISTRY

Service, research, and outreach activities in the Department are conducted within the focus areas of **Food Safety** and **Environmental Monitoring/Remediation**. Activities within each area are often complimentary. A breakdown of samples based on submitting agency is shown below.

Source of Sample	Numbers of samples analyzed
Department of Agriculture	219
Department of Consumer Protection	246
Department of Energy and Environmental Protection	104
FDA, Health Depts., Cities/Towns, Misc. Foundations	53
Proficiency Test Samples	47
University Research Collaborators	1,800
CAES Departments	137
Grand Total	2,606

I. SERVICE ACTIVITIES

Analyses in the Department of Analytical Chemistry are conducted on a wide range of sample types submitted by other state and federal agencies, municipalities, law enforcement, non-profit groups, businesses, university collaborators, and other Departments at the Connecticut Agricultural Experiment Station (CAES). This list is not intended to be all-inclusive.

1. ANALYSES ON BEHALF OF CONNECTICUT DEPARTMENT OF AGRICULTURE

The Department of Analytical Chemistry has three long-standing programs with the CT Department of Agriculture (DoAg) involving the chemical analysis of commercial feed and fertilizer products.

a. Animal Feeds:

- Analysts: John Ranciato, Terri Arsenault, Kitty Prapayotin-Riveros, Brian Eitzer
- Goal: To assure products are in compliance with stated label guarantees and that levels of aflatoxins, if present, are below regulatory limits.
- Summary: This was one of the primary analyses of the Station in the late 1890s. Products for household pets and commercial agricultural operations are collected by inspectors from DoAg. Analytical results are reported to DoAg, who in turn report findings to the product dealer and/or manufacturer and conduct regulatory response as required. In addition, data are reported to the FDA through an online data exchange platform called eLEXNET.

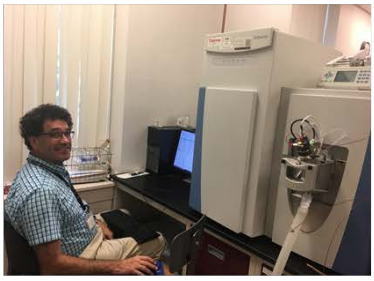
Results: From July 1, 2019 to June 30, 2020, we received 30 feed samples for analysis of aflatoxins, protein, fat, and fiber. Joint funding with the DoAg has been acquired from the FDA to facilitate inclusion in the Animal Feed Regulatory Program Standards (AFRPS); this 5-year cooperative agreement has enabled the Department to bring aflatoxin analysis in animal feeds by liquid chromatography high resolution mass spectroscopy (LC-HRMS) under the scope of ISO accreditation effective February 2018 and we are working toward having the

protein, fat, and fiber analyses accredited as well. All samples were analyzed by the methods for aflatoxin extraction and quantitation (by LC-HRMS) in feed as part of the AFRPS. All but one sample were officially logged out with no aflatoxins detected; this sample had Aflatoxin B1 at 1.10 µg/Kg, which is well below the tolerance of 20 µg/Kg total aflatoxin. Those samples were also analyzed for protein, fat, and fiber. One sample also failed to meet the protein label guarantee: 14.5% was found and the minimum for the sample to pass was 17.4%.

b. Fertilizers:

- Analyst: John Ranciato
- Goal: To assure products are in compliance with stated label guarantees.
- Summary: This was one of the primary analyses of the Station in 1875. Products from residential and commercial agricultural operations are collected by DoAg inspectors. Analytical results are reported to DoAg, who in turn report findings to the product dealer and product manufacturer and take regulatory response as needed.
- Results: From July 1, 2019 to June 30, 2020, we received and completed analysis of 67 samples for macronutrients, such as nitrogen, available phosphoric acid, and potash, and for micronutrients, including but not limited to boron, sulfur, cobalt, magnesium, and iron. Samples deficient in one or more analytes (determined according to the investigational allowances outlined in the Official Publication of the Association of American Plant Food Control Officials) numbered 4 (6%). Analytical findings are turned over to DoAg for regulatory action.






c. Analysis of seaweed samples:

- Analysts: Terri Arsenault, Craig Musante, Michael Ammirata, Brian Eitzer
- Goal: To assess potential contamination of seaweed prior to release for sale.
- Summary: A newer program with the CT DoAg Bureau of Aquaculture involves the chemical and microbial analysis of seaweed being grown commercially in CT for sale to restaurants. The CAES Department of Analytical Chemistry conducts the chemical analysis; the microbial analysis happens at the Department of Public Health (DPH) Laboratory Environmental Microbiology Section. During the current reporting period, 4 samples were received for analysis of moisture content, pesticides by both liquid and gas chromatography with mass spectrometry (LC-MS; GC-MS), as well as polychlorinated biphenyls (PCBs) by GC with electron capture detection (GC-ECD), and select heavy metals by inductively coupled plasma mass spectrometry (ICP-MS). Results are reported to DoAg Aquaculture staff for a decision on regulatory action. No pesticides or PCBs were found, and heavy metals were within acceptable limits for sales of the product.

d. Analysis of hemp samples:

- Analysts: Terri Arsenault

- Goal: To determine the THC content of hemp grown by state farmers prior to the sale of the product.
- Summary: This new program was initiated by the 2018 Farm Bill, which allowed hemp to be grown. In this bill, hemp was defined as *Cannabis sativa L* with less than 0.3% total delta-9 THC. The state plan requires analysis that each hemp variety is tested two weeks prior to harvest. From July 1, 2019 to June 30, 2020, a total of 119 preharvest samples were submitted for analysis. These samples were all analyzed by gas chromatography with flame ionization detection. The Laboratory successfully passed the University of Kentucky hemp proficiency test in the fall of 2019, which demonstrated the ability to get the correct test result. Nine of the submitted samples (7.5%) exceeded the allowable amount of THC. These data are reported back to the Department of Agriculture, which has regulatory authority over the disposition of the crop.

2. ANALYSES ON BEHALF OF CONNECTICUT DEPARTMENT OF CONSUMER PROTECTION, FOOD AND STANDARDS DIVISION

Analyses conducted on food and consumer product samples submitted by the CT Department of Consumer Protection (DCP) are important to public safety. The results of these analyses are reported quickly and can lead to the recall of products that have levels of chemical residues, heavy metals, fungi/mold, or fecal contamination that are deemed unacceptable by DCP. If products are imported into CT from other states or countries, the U.S. Food and Drug Administration leads the regulatory response.

a. Pesticide residues in food:

- Analysts: Walter Krol, Brian Eitzer, Michael Ammirata, Terri Arsenault, and Kitty Prapayotin-Riveros
- Summary: As part of the Manufactured Food Regulatory Program Standards (MFRPS), we determine concentrations of pesticides and total arsenic in fresh and processed foods from local, domestic, and imported sources offered for sale in CT and assure compliance with established tolerances. MFRPS surveillance samples are collected by DCP Inspectors and results are published in periodic Station Bulletins available by mail and at www.ct.gov/caes. From July 1, 2019 through June 30, 2020, a total of 93 samples of food were analyzed for pesticide residues. Of the 93 samples analyzed, 35 (37.6%) contained a total of 80 residues. Of these 35 samples, there was one sample of snap peas from Guatemala that contained tebuconazole, which was a no-tolerance violation. There were 41 different pesticide active ingredients found at an average concentration of 0.209 µg/Kg, and the average number of pesticide residues per sample containing residues was 2.3. During the same time frame, there were 18 fresh and processed food samples analyzed for total arsenic; none of these were found to be violative.
- With U.S. FDA funding and support, the Department has received and expanded ISO/IEC 17025 Accreditation from the American Association for Laboratory Accreditation (A2LA) for this program.

Impact: The Department's MFRPS serves as the sole surveillance and monitoring effort in the state, assuring that the food supply within CT is safe and free from chemical and heavy metal contamination.

b. Miscellaneous samples:

- Analysts: John Ranciato, Brian Eitzer
- Summary: From July 1, 2019 to June 30, 2020, 87 consumer complaint samples were submitted by CT DCP for analysis, including foreign material identification, fecal content determination, product adulteration or tampering, and off taste. For some samples, we rely on the expertise in other CAES Departments, including Plant Pathology and Ecology, Entomology, and Forestry and Horticulture. Samples during the current period included Beef Patties, White Rice, Canned Corn, Bottled Water, Cashews, coconut water, Bacon, Egg roll and shrimp, Organic Garlic Kraut.

3. ANALYSES ON BEHALF OF DEPARTMENT OF CONSUMER PROTECTION, LIQUOR CONTROL DIVISION

Alcoholic beverages sold must be registered and labeled correctly. This requires knowledge of the ethanol content of products.

- Analyst: Terri Arsenault
- Goal: To provide percent ethanol content for label registration and taxation purposes.
- Summary: We analyzed 2 products (wines) for ethanol content. Results were submitted to DCP in support of product label registration. Two additional products were examined to determine if they contained ethanol and needed to be registered, the results indicated that they did not contain ethanol.

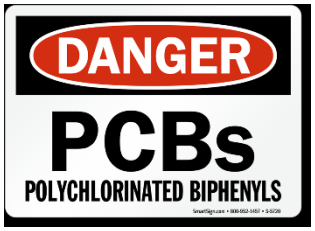
4. ANALYSES ON BEHALF OF DEPARTMENT OF CONSUMER PROTECTION, DRUG CONTROL DIVISION

- Analysts: Terri Arsenault, Walter Krol, Brian Eitzer
- Goal: Cannabidiol (CBD) and THC infused products have become readily available. These products must meet requirements regarding labeling and THC content. Testing of these products for CBD and THC content can ensure that regulations are met.
- Summary: From July 1, 2019 to June 30, 2020, a total of 25 samples of medical balms and concentrates were examined for THC and/or CBD content. Depending on the matrix, these samples can be analyzed by a combination of GC/FID, GC/MS, HPLC/UV, or HPLC/MS. During the past year, a total of 5 samples did not meet the label requirements or THC requirements.

5. Analyses on behalf of Department of Energy and Environmental Protection (DEEP), Waste Management Bureau

a. Analysis of PCBs (polychlorinated biphenyls):

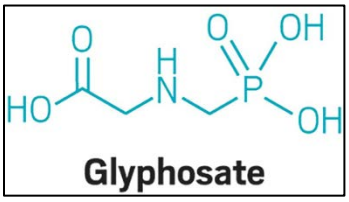
- Analysts: Michael Ammirata, Terri Arsenault
- Goals: To determine the extent of polychlorinated biphenyl (PCB) contamination in submitted samples, with matrices including soil, water, oil, sediments, and surface wipes.
- Summary: From July 1, 2019 to June 30, 2020, 66 samples were analyzed from pre-existing sites or new locations in CT. Sample collection is performed by the DEEP PCB Enforcement Unit as part of mandatory long-term monitoring of these areas. The findings are reported to DEEP for assessment of continued regulatory compliance or to establish remediation criteria. In addition, a proficiency test was completed as part of this program.



b. Analysis of pesticides:

- Analysts: Brian Eitzer, Terri Arsenault, Walter Krol, Christina Robb
- Goals: To ascertain pesticide concentration associated with misapplication or drift in support of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Additional samples are analyzed in support of DEEP surface and groundwater monitoring programs. We also analyzed a set of samples of sediment contaminated after a truck containing pesticides caught on fire. Submitted sample matrices include soil, water, oil, sediments, tank mixes and surface wipes.
- Summary: From July 1, 2019 to June 30, 2020, 37 samples were analyzed under this program.

Impact: The analysis of samples collected from surveillance programs for soil, surface/groundwater and sediments, as well as those that are part of active misapplication investigations, enable DEEP to enforce current state and federal regulations on pesticides and to promote overall environmental and public health.



6. Analyses on behalf of Municipal and Federal Agencies

a. Analysis of samples for FDA Food Emergency Response Network (FERN):

- Analysts: Craig Musante, Terri Arsenault, Brian Eitzer, Christina Robb, Walter Krol, Kitty Prapayotin-Riveros, John Ranciato, Jason C. White

Summary: The Department of Analytical Chemistry continued its work with the FDA as part of the Food Emergency Response Network Chemistry Cooperative Agreement Program (FERN cCAP). This program enables research and analyses on contaminants in food such as pesticides, poisons, toxins, and heavy metals. A special assignment this year was the analysis of highly colored imported food products for metals. Ongoing surveillance included analysis of spices and grains. The Department participated in several FDA and USDA FSIS proficiency tests and challenge exercises. Dr. Christina Robb has continued to investigate methods related to the detection of the plant toxins ricin and abrin by novel LC-HRMS techniques. We have participated in the Sample Analysis Data Exchange bi-weekly meeting, to discuss the NFSDX

(National Food Safety Data Exchange) since May 2019. We are among the few state laboratories that have completed the phase I Sample Data Elements Mapping File and are now in phase II of the User Acceptance Testing (UAT) implementations. This NFSDX will be replacing the eLEXNET on September 1, 2020. Lastly, Dr. Brian Eitzer and Ms. Terri Arsenault are both instructors for FDA courses on LC-MS and GC-MS FERN methods, respectively. These training courses are open to FDA staff and other state laboratories; however, the courses were canceled due to COVID-19.

Impact: The Department's participation in FERN has resulted in the acquisition of highly sensitive analytical equipment and significant funding to support staff, including postdoctoral researchers. In addition to being used for FDA work, these resources are also applied to our state programs in a manner that directly benefits the public health of CT residents.

b. Analysis of samples for municipalities, law enforcement, and other groups:

- Analysts: Terri Arsenault, Brian Eitzer, Walter Krol, Craig Musante, John Ranciato
- Summary: From July 1, 2019 through June 30, 2020, Department staff analyzed samples for municipalities or other groups. We analyzed foods and other products for heavy metals at the request of the New Haven Health Department, Quinnipiack Valley Health District, and Connecticut State Police, and soils on behalf of a community garden.
- ***Impact***: Analyses in support of these organizations can allow them to make decisions that will impact human health.

7. Analyses on behalf of other Station Departments

a. Elemental and Molecular Analysis - Department of Plant Pathology and Ecology:

- Analyst: Chuanxin Ma, Craig Musante, Roberto De La Torre Roche, Nubia Zuverza-Mena, Jason C. White
- Summary: In conjunction with scientists in the Department of Plant Pathology and Ecology, elemental and molecular analysis of several hundred samples of various crops grown in the presence or absence of nanoscale micronutrient amendments was again conducted. This work is being done under a USDA AFRI NIFA grant focused on this topic; the $480,000 grant began March 1, 2016, and includes co-investigators at the International Fertilizer Development Center in Muscle Shoals, AL and the University of Texas El Paso. Work this year investigated the interactive effects of drought, organic matter, and zinc oxide nanoscale and bulk particles on wheat performance and grain nutrient accumulation. A separate set of experiments evaluated how coating of urea with low-dose ZnO nanoparticles promoted wheat performance and enhanced Zn uptake under drought stress. Additional details on this project can be found in the Department of Plant Pathology and Ecology section of this document.

8. Analysis of Check Samples

- Analysts: Walter Krol, Terri Arsenault, Brian Eitzer, Craig Musante, Michael Ammirata, Kitty Prapayotin-Riveros
- Summary: Thirty samples were analyzed during the reporting period as part of annual proficiency testing related to our FDA FERN work, FDA ISO Accreditation program (MFRPs), Animal Feed Regulatory Program (AFRPs), as well as performance evaluation samples for our polychlorinated biphenyl (PCB) regulatory program. All of these testing regimes serve to ensure accurate and reliable laboratory results.

II. RESEARCH ACTIVITIES

Research projects in the Department of Analytical Chemistry include applied and fundamental investigations. Research is often stimulated by our service work and, in turn, research results often impact service activities.

1. Food Safety

Project 1: *Improvement of analytical methods for determination of pesticide residues and heavy metals in food*:

- Investigators: Brian Eitzer, Terri Arsenault, Walter Krol, Christina Robb, Michael Ammirata, Craig Musante, John Ranciato, Jason C. White
- Summary: We continue to participate in or lead several FDA coordinated research projects. This includes the use of high resolution LC-MS and LC-MS/MS platforms for the screening of pesticides, toxins (fungal, plant) and poisons. During the past year, one focus was on analysis of heavy metals in highly colored imported food products. We have achieved ISO Accreditation for two separate FDA programs; one focused on human food (MFRPS) and a second focused on animal feed (AFRPS).

Impact: The development and validation of new more sensitive equipment and analytical techniques will enhance food safety surveillance activities in the state and serve to better protect the public against incidental or intentional adulteration.

- Project 2: *Select Agent Detection in foods: abrin and abrine*
- Investigators: Christina S. Robb, Brian Eitzer, Walter Krol
- Summary: *Abrus precatorius* seeds contain the ribosome inactivating protein abrin. Abrin is the most toxic molecule that we investigate for the FERN program. Detection methods for abrin are of importance to homeland security, toxicology, and public health. The method development for abrin protein is highly challenging as no purified standard or high-quality antibody are commercially available. However, Dr. Christina Robb has worked with both the CDC and the FDA to gain the skills to develop abrin analysis by LC-MS. In tandem with this, Dr. Robb has investigated a novel teicoplanin-based stationary phase for the sensitive analysis of L-abrine. L-abrine is a small molecule biomarker for the protein. Dr. Robb will pursue the use of alternative antibody sources such as alpaca nano-bodies through Wadsworth public health laboratory once the protein LC-MS method conditions are optimized. The project is focused on the analysis of seeds and will also include spiked food samples.

- ***Impact:*** The expected outcome of these projects is to develop robust and sensitive methods that the FDA (and state of CT) could deploy for emergency response, anti-terrorism and/or toxicology purposes.

Project 3: *Nanoparticles in agricultural systems*:

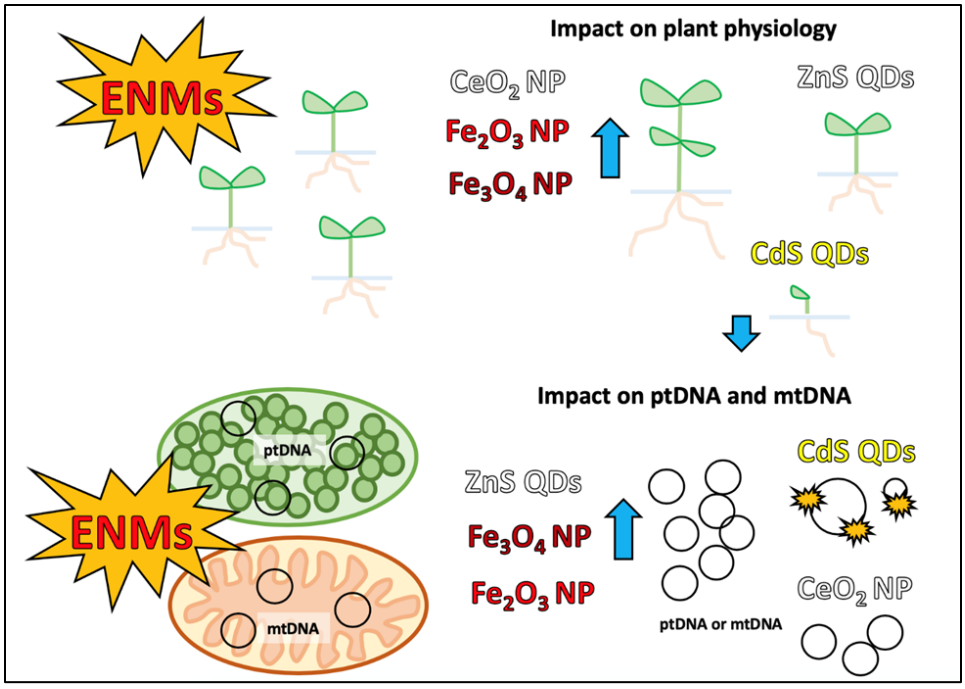
- Investigators: Roberto De La Torre-Roche, Chuanxin Ma, Nubia Zuverza-Mena, Craig Musante, Yu Shen, Ishaq Adisa, Jason C. White
- Summary: Nanomaterials (NM) have at least one dimension less than 100 nm (one billionth of a meter), and possess unique physical and chemical properties not observed at the bulk scale. Nanotechnology, which takes advantage of these useful nanoscale properties, has become widely used in numerous sectors, including electronics, healthcare, cosmetics, pharmaceuticals, food processing, and agriculture. Our work in this area is focused on two separate but related topics; the implications of nanomaterial presence (by accident or design) in agricultural systems and the use of nanoscale nutrients as agricultural amendments to suppress plant disease and increase yield.

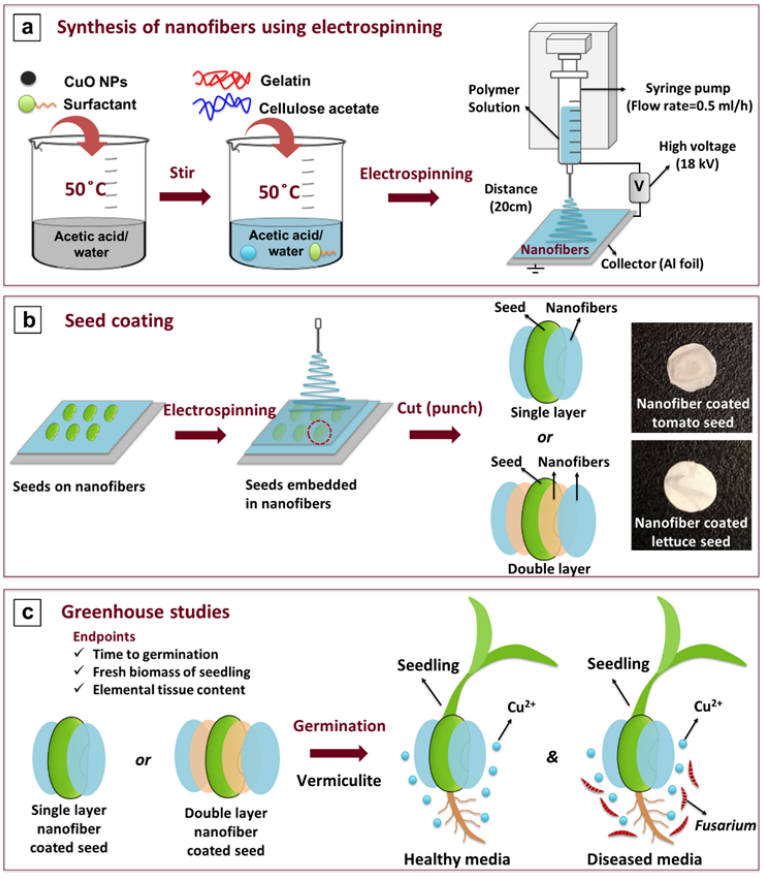
The first project is focused on the fate of nanomaterials in agricultural systems. Although nanomaterial use has been widespread and is increasing rapidly, the consensus among the scientific community is that understanding of the fate and effects of nanomaterials in the environment is still inadequate. Research in

our laboratory has focused on defining the impact (physiological and molecular toxicity, accumulation) of NMs on food crops, with a focus on understanding the mechanisms of plant response. Recent collaborative work with investigators in Italy (University of Parma) mechanistically evaluated and compared mitochondria and chloroplast involvement in response to a number of different NMs at a range of concentrations, both in terms of their functionality and organellar DNA replication as measured by specific genes of interest. A second project with collaborators at the Harvard University T.H. Chan School of Public Health demonstrated that food-grade titanium dioxide particles decrease the bioaccessibility of vitamin D3 under simulated gastrointestinal conditions. Additional collaborators on this project include colleagues at the University of Massachusetts, the University of Texas El Paso, the US National Institute of Standards and Technology, Hasselt University in Belgium, Peking University in China, The Ocean University of China, Zhejiang University, China Agricultural University, Jiangnan University, Nanjing Agricultural University, and the Chinese Academy of Sciences.

The second project is focused on the use of nanoscale nutrients to sustainably suppress crop disease and increase yield. In one set of experiments with collaborators at the Harvard University T.H. Chan School of Public Health, we showed that biodegradable, tunable, biopolymer-based nanofiber seed coatings could enhance agrichemical delivery and seedling development. A second set of projects is occurring as part of our inclusion in The Center for Sustainable Nanotechnology, which is an NSF Center for Chemical Innovation (CCI). Here, we investigated our biomolecules such as proteins and sugars attached to nanoscale particles of Cu upon exposure to plant vascular fluids and how this process of corona formation alters the behavior of the material.

Impact: Our research has demonstrated that the toxicity of nanomaterials to crops can be significantly different from that of the corresponding bulk material. Current investigations are focused on understanding the mechanisms of plant response so as to enable safe design and use of these important materials. For example, when used appropriately, nanoscale versions of select micronutrients can suppress crop disease and increase yield. Such techniques may be critical to sustainably increasing food production so as to achieve and maintain global food security in the coming decades.

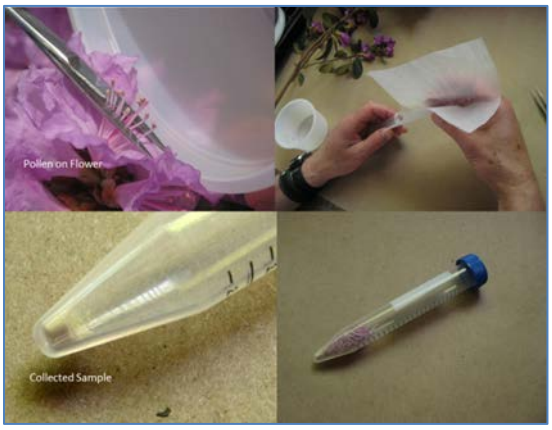

ENMs
Impact on plant physiology
CeO_2 NP
Fe_2O_3 NP
Fe_3O_4 NP
ZnS QDs
CdS QDs
Impact on ptDNA and mtDNA
ptDNA
ENMs
mtDNA
ZnS QDs
Fe_3O_4 NP
Fe_2O_3 NP
ptDNA or mtDNA
CdS QDs
CeO_2 NP


a Synthesis of nanofibers using electrospinning
CuO NPs
Surfactant
Gelatin
Cellulose acetate
50˚C
Acetic acid/ water
Stir
50˚C
Acetic acid/ water
Electrospinning
Polymer Solution
Syringe pump (Flow rate=0.5 ml/h)
High voltage (18 kV)
V
Distance (20cm)
Nanofibers
Collector (Al foil)
b Seed coating
Seeds on nanofibers
Electrospinning
Seeds embedded in nanofibers
Cut (punch)
Seed
Nanofibers
Single layer
or
Seed
Nanofibers
Double layer
Nanofiber coated tomato seed
Nanofiber coated lettuce seed
c Greenhouse studies
Endpoints
✓ Time to germination
✓ Fresh biomass of seedling
✓ Elemental tissue content
Single layer nanofiber coated seed
or
Double layer nanofiber coated seed
Germination
Vermiculite
Seedling
Cu^{2+}
Healthy media
&
Seedling
Cu^{2+}
Fusarium
Diseased media

2. ENVIRONMENTAL MONITORING/REMEDIATION

Project 1: *Protecting pollinators with economically feasible and environmentally sound ornamental horticulture.*

- Investigators: Brian Eitzer, Kim Stoner (Department of Entomology), Richard Cowles (Valley Laboratory), Cristi Palmer (Rutgers University)



Summary: We participated in a multi-year and multi-institution study to examine pesticide use in ornamental horticulture. One part of this study is to understand the translocation of pesticides into the pollen and nectar of plants. Plants were treated with known amounts of five different pesticides and then we analyzed the pollen and nectar from the plants for those pesticides over the next couple of years. Sampling of those plant matrices is very laborious so that only very small amounts of sample are collected. These small sample amounts then require instrumental methods with great sensitivity. Liquid chromatography coupled to mass spectrometry provides this sensitivity. For most systemic insecticides, drench applications resulted in greater than ten times the concentration in nectar or pollen than that resulting from foliar sprays. We have now analyzed several years' worth of samples and are looking to see if, after application, the residues can still be observed.

Impact: Knowledge of the translocation of pesticides to pollen and nectar can be used to guide farmers in the proper use of pesticides so as to insure not only crop pollination but also protection from pests and pathogens.

Project 2: *Determining the effects of pesticide exposure on bumble bee microcolonies*

- Investigators: Brian Eitzer, Kim Stoner (Department of Entomology), David Lehman (EPA), Robert Koethe (EPA)
- Summary: While much has been learned about the effects of pesticides on honey bees, much less is known about their effects on bumble bees. This project is aimed at understanding some of those effects. Pollen was collected at ornamental nurseries and pesticide levels were determined using liquid chromatography/mass spectrometry (LC/MS). After characterization of pesticide content, acetamiprid, a neonicotinoid pesticide was added to the pollen (or syrup) at various doses and the material was fed to bumble bee microcolonies. The acetamiprid-dosed pollen and acetamiprid-dosed syrup were analyzed to confirm their concentrations in these materials. The colonies were then monitored for deleterious effects. After a set time period, the colonies were sacrificed, and various compartments of the colony were analyzed for acetamiprid. In the sample spiked at the highest dose, acetamiprid and two of its metabolites were observed in hive materials. The highest concentrations were seen in the nests, intermediate amounts in the nectar, fecal matter and eggs, with lesser amounts in the bees, larvae, and pupae. These data will then help us to understand how the pesticide has impacted these bumble bees.

Impact: Knowledge of the effects of pesticides on bumble bees can help us to protect these important native pollinators.

3. PLANT HEALTH

Project 1: Plant hormones: Linking soil microbes and predators to crop health

- Investigators: Christina S. Robb, Lindsay Triplett, Ravi Patel
- Summary: Dr. Christina S. Robb and Dr. Lindsay Triplett were awarded the Connecticut Agricultural Experiment Station Louis A. Magnarelli post-doctoral award for their proposal to study the role of protists in the hormonal condition of plants. The main objectives of this study are to develop and

optimize LC-MS methodology for plant hormone analysis, determine the role of protists in hormone-producing soil bacteria, and to determine the effect of protists on the plant hormonal status. Dr. Christina Robb will be guiding the analytical side of this project and working with Dr. Ravi Patel to create sensitive methodologies for determining plant hormones.

Impact: This project will provide meaningful improvement to the field of plant pathology and understanding crop health.

Project 2: Determining molecules of interest to plant pathology

- Investigators: Christina S. Robb, Lindsay Triplett, Quan Zeng
- Summary: Dr. Christina S. Robb in conjunction with Dr. Lindsay Triplett and Dr. Quan Zeng are working on enhanced methods for the detection of compounds of interest to plant health. The principal compounds of interest right now are the alaramone ppGpp and a series of NAD related compounds. The analysis of ppGpp is notoriously difficult; the analytical directive to this compound will be to try some novel stationary phases for detection.

Impact: This project will provide meaningful improvements to the field of plant pathology and the ability to understand crop health.

PUBLIC OUTREACH

Telephone/Internet Inquiries: We receive approximately 100 calls and emails from the public each year requesting information on issues such as pesticides in food and the environment, as well as heavy metals in food, soils, and consumer products. In some instances, we refer the caller to a more appropriate CAES department or state agency.

Station Bulletins: Two CAES Technical Bulletins were published by our Department in the past year: Technical Bulletin 21 and 24. These bulletins are available in printed form and on the CAES website (https://portal.ct.gov/caes).

DEPARTMENT OF ENTOMOLOGY

The Department of Entomology is involved in a variety of service, research, pest surveillance, and plant regulatory activities. The primary service activities are provided through the Insect Information Office (IIO). Staff in this office answer insect-related questions and identify insects and related arthropods for the public, government agencies, growers, and business organizations. All scientists provide information to citizens of Connecticut by answering telephone inquiries, making farm visits, participating in meetings of growers and other groups, and speaking on their research. Most of the research in the Department has a major applied aspect, addressing the integrated management of ticks, pests of field crops, nurseries, and orchards, wood-boring insects, invasive insects, honey bees, and other bee pollinators.

The Office of the State Entomologist at the Connecticut Agricultural Experiment Station, created by the Connecticut General Assembly in 1901, is part of the Department of Entomology with responsibility, in part, to ensure our nursery industry is free of plant pests and certify their products for shipment to other states and outside the United States. The Connecticut Green Industry (i.e., nursery, greenhouse, floriculture, sod, Christmas trees) is the largest agricultural business in Connecticut. The industry estimates that environmental horticulture generates $1.022 billion gross income supporting 48,000 full and part-time jobs in Connecticut. In conjunction with regulatory activities, Department staff conducts a surveillance program in Connecticut for a variety of established pests and for exotic plant pests, some of regulatory concern, that represent a threat to our green industry, forests, and urban ornamental trees and shrubs. Surveillance for plant pests is performed in partnership with the United States Department of Agriculture (USDA) through the Cooperative Agricultural Pest Survey (CAPS) program, Plant Protection Act surveys, and the U.S. Forest Service. For plant diseases of regulatory concern, we work closely with the Plant Disease Diagnostic Laboratory in the Department of Plant Pathology and Ecology. We also conduct forest health surveys and a statewide aerial survey for gypsy moth defoliation (and any defoliation by other insects) and a gypsy moth egg mass survey. The results of our plant and forest surveys for 2019-2020 may be found later in the Department's research activities along with summaries of our regulatory activities. The Office of the State Entomologist and the Apiary Inspector also oversee registration of beekeepers and inspection of honey bee colonies for pests and disease.

The staff of the Department of Entomology also take a lead in providing extensive outreach activities for the Experiment Station by providing information to both children and adults about the Experiment Station's research at public events and at health and agricultural fairs, such as the Eastern States Exposition (Big E) in Springfield, MA; Celebrating Agriculture in Woodstock, CT; the Garden Expo in Fairfield, CT; Norwalk-Wilton Tree Festival; and the Connecticut Flower and Garden Show. The Insect Information Office is located in the Jenkins-Waggoner Laboratory and has a laboratory, office, public reception, and a climate-controlled collections room. While direct visitor consultations were curtailed beginning in March 2020 due to the coronavirus pandemic, samples were still accepted in the atrium or by mail for identification.

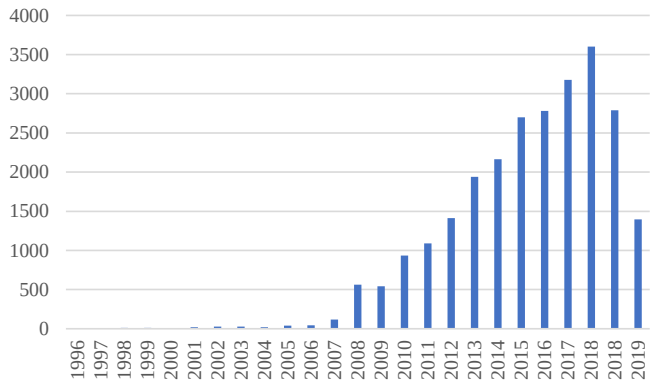
Entrance of Jenkins-Waggoner Laboratory set up to receive samples from the public for insect and plant disease diagnostic evaluation.

Service Activities

Insect Information Office

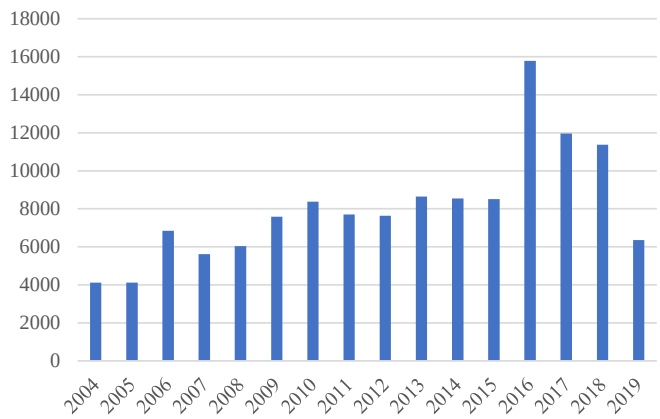
Dr. Gale E. Ridge works in the New Haven Insect Information Office. Insect identification services date back to nearly the inception of the institution (1875) starting with the first Annual Report of The Connecticut Agricultural Experiment Station published in 1877. The Station announced that it was offering to "identify useful or injurious insects, and to give useful information on the various subjects of Agricultural Science for the use and advantage of the citizens of Connecticut."

Table 1. Bed Bug Inquiries 1996-2020



Since 2000, there has been a trend away from traditional communication such as mail and visitors to cell phone and internet. Phone calls remain a primary citizen contact followed by emails.

Table 2. Public Inquiries from 2004-2020



Impact of the IIO is public education to reduce pesticide use and promote non-chemical management of nuisance arthropods, protection of public health, conservation of natural habitat and species, protection of agriculture, and protection of urban structures and buildings. The office directly serves private citizens, pest management professionals, the real estate industry, nurseries, land care businesses, arborists, health departments, other medical professionals, charities, manufacturing, the hospitality industry, schools, colleges, and universities, housing authorities, museums, municipalities, libraries, law enforcement, state government, and the media. Between July 1, 2019 and June 30, 2020, the IIO handled 6,356 requests for information. The dramatic drop from 11,369 inquiries in 2019 was caused by a combination of two events. A cold wet spring delaying arthropod activity and development and the COVID-19 pandemic. For most of late winter to spring, citizens were quarantined by gubernatorial order. This stopped usual springtime activities. At the time of writing this report, the quarantine had been relaxed during June and inquiries jumped to a higher-than-normal summer volume. The current pandemic prompted more citizens to remain home, elevating arthropod discovery. In addition, vacationing slowed as the virus progressed across the United States, particularly in the southern states with citizens preferring to remain "safe at home." The COVID-19 pandemic also impacted bed bug inquiries. These dropped from 2,791 in 2019 to 1,395 in 2020. The pandemic caused a time frame shift from spring to summer with regard to public inquiries volume levels, e.g., spring unusually low, while summer unusually high.

There were 725 categories of inquiries including insects, arachnids, animal, pesticides, insect damage, general entomology, and horticulture. Delusory Infestations (DI) cases continued to rise from 189 in 2016, 243 (2017), 300 (2018), 357 (2019), to 456 (2020). These are time-consuming medical and psychological cases that encompass multiple phone calls, emails, and visits, which often involve collaboration with medical professionals.

A third mild winter followed by a cool, wet spring protected overwintering tick populations. American dog tick, *Dermacentor variabilis*, populations remained high. Black-legged tick, *Ixodes scapularis*, populations were also high. Many tick submissions for Lyme disease testing passed through the Insect Information Office. Additionally, mistaken tick identifications from the public were forwarded to the office for a correction of identification. Gypsy moth activity was negligible, following the outbreak during 2016-2017 and subsequent control by natural pathogens. Pantry pests, termite, and ant inquiries were elevated, because more people stayed at home to find them. The highest inquiry was human feeding bed bugs (1,395) followed in order by DI (456), beetles in general (483), and ants (180). Scabies reporting, which was high last year (N=117), collapsed this year with no reports. However, there was regular reporting by DI clients of erroneous scabies diagnoses and treatments by medical professionals.

Due to the pandemic, the four categories of inquiries, e. g., natural resources, man (inferring buildings and their surroundings) and medical issues, undetermined, and food hierarchy dramatically changed. Thirty-one percent were natural resources, 57% man and medical issues, 1% undetermined, and 11% food-related. Natural resources and man and medical categories flipped in importance as a direct result of the public health crisis responses to the pandemic. More citizens chose to stay inside their homes rather than go outside in their gardens, yards, and properties.

Reports on the spotted Mediterranean cockroach, *Ectobius pallidus*, increased. There were 14 reports. The insect has been slowly migrating south along the Connecticut shoreline from Massachusetts and Rhode Island. It has also moved up the Quinnipiac River watershed into North Haven. The most southerly report so far was from Stratford, CT. The office continued to lead in public outreach by building collaborative relationships and projects with local, state, and federal agencies, particularly health departments, to better serve the needs of Connecticut citizens.

CAPS Survey and Outreach Programs: The Cooperative Agricultural Pest Survey and Plant Protection Act (PPA) (formerly the Farm Bill), supported by the USDA-APHIS-PPQ provides support for pest survey and educational outreach on the identification and risks posed by potential invasive insects and plant diseases. With worldwide trade and travel increasing, we are at an increased risk of foreign plant species, plant diseases, and insect pests being introduced in the U.S. Ms. Gerda Magana became the new State Survey Coordinator in 2020 under the direction of Deputy State Entomologist Dr. Victoria L. Smith. In 2020, the CAPS program conducted a nursery pest survey. Additional orchard pest and *Phytophthora ramorum* surveys are supported by funding from the Plant Protection Act, as well as the continued funding of the Forest and Agricultural Pest Outreach Program with a focus, in part, on the spotted lanternfly. The program also provides guidance on the management and control of detected invasive pests. By raising awareness of invasive pests, we hope to increase public awareness of pest management options and early reporting of potential new pest sightings to federal or state authorities.

Bird & Butterfly Garden: The Bird & Butterfly Garden is a partnership of the Federated Garden Club of Connecticut, the Spring Glen Garden Club of Hamden, and The Connecticut Agricultural Experiment Station. Most maintenance and improvements to the garden are done by farm manager Richard Cecarelli and his staff. The garden is open to the public Monday-Friday, 8:30 a.m.-4:00 p.m., and is closed on weekends and state holidays. The garden creates several favorable habitats for our native birds, butterflies, and pollinating insects and helps us determine which plants may work best in southern Connecticut gardens. Plants are labeled for easy identification. The Bird & Butterfly Garden at Lockwood Farm is listed in the *Nature Conservancy Open Days Directory for New England*.

Jeffrey Fengler observed 14 different butterfly species, 14 species of birds, and 10 other species around the garden at Plant Science Day on August 7, 2019.

Butterflies & Moths	*Birds*	*Other*
Monarch	American Goldfinch	European Honeybee
Eastern Tiger Swallowtail	Eastern Kingbird	Golden Aphid
Spicebush Swallowtail	European Starling	Bumblebee spp.
Cabbage White	Barn Sparrow	Red Milkweed Beetle
Black Swallowtail	Red-tailed Hawk	Small Milkweed Bug
Peck's Skipper	Bluejay	American Tabanid Fly
Common Sulphur	Turkey Vulture	Cicada Killer Wasp
Tawny-edged Skipper	Northern Cardinal	Hummingbird Clearwing Moth
Zabulon Skipper	House Finch	Halloween Pennant Dragonfly
Silver-spotted Skipper	Northern Mockingbird	Widow Skimmer Dragonfly
Common Buckeye	Mourning Dove	
Common Sootywing	American Crow	
Pipevine Swallowtail	Eastern Phoebe	
American Lady	Ruby-throated Hummingbird	

RESEARCH ACTIVITIES

Center for Vector Biology and Zoonotic Diseases

The statewide tick active surveillance program, a lone star tick control project, and an integrated tick management program involve scientists and staff from the Departments of Entomology, Environmental Science, and Forestry and Horticulture under the umbrella of the Experiment Station's Center for Vector Biology and Zoonotic Diseases.

Tick Active Surveillance Program

An active tick surveillance program was initiated in Connecticut in 2019 and continued in 2020 funded in part by a grant from the Centers for Disease Control and Prevention (CDC) through the Epidemiology and Laboratory Capacity (ELC) program at the Connecticut Department of Public Health. The field program is run by Dr. Scott C. Williams (Department of Forestry and Horticulture), Dr. Megan A. Linske, and Dr. Kirby C. Stafford (Department of Entomology) with sampling conducted by research assistant Jamie Cantoni. All the tick testing is conducted by Dr. Douglas E. Brackney and Duncan W. Cozens (Department of Environmental Sciences).

The blacklegged tick, *Ixodes scapularis* Say, is the primary vector for at least seven pathogens that cause human disease; *Borrelia burgdorferi*, the agent of Lyme disease, *Babesia microti* (babesiosis), *Anaplasma phagocytophilum* (anaplasmosis), *B. miyamotoi* (a relapsing fever *Borrelia*), *B. mayoni* (a new Lyme *Borrelia* spp.), the *Ehrlichia muris*-like agent, now *E. muris* subsp. *eauclairensis* (ehrlichiosis) (known only from upper mid-west so far), and Powassan virus.

Ticks are collected at 40 paired publicly-accessible active tick surveillance sampling locations throughout CT's eight counties from April through October with a focus on the blacklegged tick, *Ixodes scapularis*. Other tick species that are being found and tabulated include American dog ticks, *Dermacentor variabilis*, the vector of Rocky Mountain spotted fever, the lone star tick, *Amblyomma americanum*, an aggressive southern species that is becoming established in Connecticut and parts of coastal New England, and the exotic Asian longhorned tick, *Haemaphysalis longicornis*. In calendar year 2019, a total of 2,068 blacklegged ticks, 437 American dog ticks, 3 lone star ticks, and 2 Asian longhorned ticks (total 3,409 for period July 1-June 30). A multiplexed RT-qPCR assay for *Ixodes scapularis* can detect *Borrelia burgdorferi*

s.l., *Babesia microti*, *Anaplasma phagocytophilum*, *Borrelia miyamotoi*, and Powassan virus lineage II. The 2019 testing results for adult blacklegged ticks were *B. burgdorferi* (46%), *B. microti* (13%), *A. phagocytophilum* (9%), *B. miyamotoi* (2%), and Powassan virus (1%). For nymphal blacklegged ticks, the results statewide were *B. burgdorferi* (15%), *B. microti* (6%), *A. phagocytophilum* (5%), *B. miyamotoi* (2%), and Powassan virus (0%). Testing of 351 female and 480 nymphal *I. scapularis* ticks collected January to August 2020 found adult blacklegged ticks were *B. burgdorferi* (48%), *B. microti* (9%), *A. phagocytophilum* (8%), *B. miyamotoi* (2.3%), and Powassan virus (0.6%). For nymphal blacklegged ticks, the results statewide were *B. burgdorferi* (20.6%), *B. microti* (6.4%), *A. phagocytophilum* (4%), *B. miyamotoi* (1.3%), and Powassan virus (0.4%). Lone star ticks are increasing being recovered in areas of the state such as New London County where they have not been collected before.

Lone Star Tick Control Project

The presence of an established lone star tick population in Norwalk first came to light as a result of a June 2017 report from a South Norwalk resident about a deer that was acting strange at Manresa Island. A Connecticut Department of Energy and Environmental Protection (DEEP) Environmental Conservation (EnCon) and Dr. Kirby Stafford found the deceased deer was covered with lone star ticks, *Amblyomma americanum*. Dr. Kirby Stafford, Dr. Scott Williams, and Dr. Megan Linske continued the 4-poster study in 2020 for the control of the lone star tick population on the island in cooperation with staff from the Wildlife Division, CT DEEP. Initiated in 2018, four 4-posters were re-activated June 1, 2020 with feeding stations recharged with corn and permethrin weekly. Ticks are also sampled weekly at established transects. The 4-posters continue to be heavily utilized by the deer. The host-seeking population of adult *A. americanum* in spring of 2020 is down significantly. Nymphal tick numbers remain moderately abundant in the early summer, but lower than in 2018 or 2019.

Integrated Tick Management (ITM) Lyme disease (LD) continues to be the most commonly reported vector-borne disease in the United States. According to the Centers for Disease Control and Prevention, it affected over 360,000 people in 2016. The blacklegged tick, *Ixodes scapularis*, is the vector for *Borrelia burgdorferi*, the causal agent for Lyme disease, and at least six other human pathogens.

The 4-poster utilized by white-tailed deer (left), a fipronil bait box (center), Michael Short applying Met52 (right).

An integrated tick management project was initiated by Dr. Kirby C. Stafford, Dr. Scott C. Williams, and Dr. Megan Linske, with the assistance of technicians Heidi Stuber and Michael Short in 2016-2017 in a cooperative agreement with Dr. Andrew Li at the USDA-Agricultural Research Service, which is funding the study. The five-year study continued in 2020 in the seven neighborhoods originally selected throughout Guilford based on their layout and proximity to large (> 200 acres) pieces of Town- or Land Trust-owned open spaces. The treatments in this ITM study consist of different combinations of untreated controls and homes treated with various combinations of spray applications of the entomopathogenic fungus *Metarhizium anisopliae* (Met52® EC), the fipronil-based rodent bait box (Select TCS®) and the 4-poster passive acaricide application station for the treatment of white-tailed deer (*Odocoileus virginianus*). Twelve '4-posters' (1 per 50 acres) were initially deployed in October 2017. Bait boxes and Met52 were first deployed or applied in June 2018. For 2019-2020, twelve 4-posters were re-deployed and maintained through the adult *I. scapularis* active season in the fall and spring. Again, a total of 540 fipronil-based rodent-targeted bait boxes were deployed at 54 residences and 36 of those residences were treated with Met52 (*Metarhizium anisopliae*) spray application. Dragging for questing nymphs began in mid-May by Heidi Stuber with seasonal assistant Hunter Badey. Live-trapping of white-footed mice by Dr. Scott C. Williams and Dr. Megan A. Linske with the assistance of Michael Short and seasonal assistant Daniel Duque began in June. Each captured mouse is sedated, marked with a unique ear tag, processed for ticks, and a blood sample was taken for serological analysis. Full analysis of the data for the three years of treatment in comparison to the base-line year and the controls is pending. However, initial summary of the data for 2019 shows reductions in host-seeking ticks and ticks feeding on mice for all the treatment combinations in comparison to the control sites.

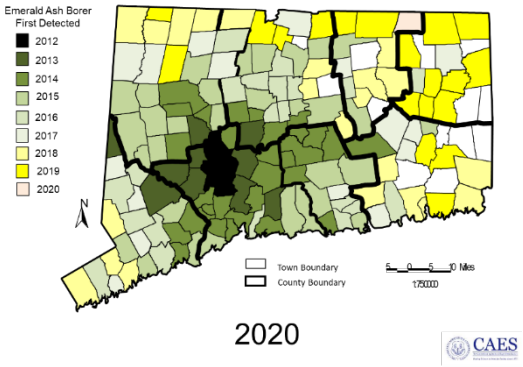
Preparing Europe for Invasion of Bronze Birch Borer

The European Plant Protection Office prepares pest "survey cards" on potential invasive insects to advise member nations on the best methods and practices for surveying for the pest. Due to previous work with *Agrilus anxius* and presentation of the work in Vienna, Austria, Dr. Rutledge was called on to review a survey card on that pest. The card was published in January 2020, and is available at https://efsa.onlinelibrary.wiley.com /doi/pdf/10.2903/sp.efsa.2020.EN-1777

Green funnel trap (left) and purple prism trap (right). (Source: Claire Rutledge, CAES)

Biosurveillance for Exotic Buprestidae and the Wasp Watcher Program

The wasp watcher program was begun in the spring of 2010. *Cerceris fumipennis* is a native digging wasp that provisions its nest with adult Buprestidae, including emerald as borer. It is used a tool for detecting and monitoring emerald ash borer and other invasive buprestid species by intercepting its prey as female wasps return to their nest. The wasp was responsible for the first detection of EAB in Connecticut, and remains our main tool for detecting and monitoring EAB in the state. We are in the 11th year of our Wasp Watcher program. Over the course of the program we have trained 203 watchers. In 2020, due to quarantines due to the COVID pandemic, I was unable to recruit and train new Watchers. Fortunately, 34 veteran watchers returned to cover the state. Since 2010, Watchers have collected over 10,000 beetles and detected EAB in 42 new towns. We have also used this system to examine the native buprestid fauna of Connecticut and have detected over 70 species of beetles with this tool. We have amassed one of the largest collections of buprestids in the country with over 35,000 specimens.



Classical Biological Control of Emerald Ash Borer

Following the detection of emerald ash borer in Connecticut, the determination was made to join the USDA APHIS/PPQ biological control program for EAB. In May 2013, Dr. Claire Rutledge began releases of the gregarious endoparasitoid, *Tetrastichus planipennisi* and the egg parasitoid *Oobius agrili* in Middlebury and Prospect, CT. In 2016, we were able to add another species of parasitoid to the releases, *Spathius galinae*. This parasitoid is a gregarious ectoparasitoid of EAB, and has a much longer ovipositor than *T. planipennisi*. This means that they can parasitize larvae that are feeding in areas of the tree with much thicker bark. The parasitoids are shipped from the USDA APHIS emerald ash borer mass-rearing facility in Brighton, Michigan. Releases have been made in 14 towns in Connecticut altogether, the others being Hamden, Sherman, Cromwell, Litchfield, Plymouth, Simsbury, East Haddam, East Windsor, Weston, Kent, Coventry, Lebanon, and Union. Each release site receives parasitoids for 2 years. We have been fortunate in finding in-state collaborators to aid in releases.

Sentinel log hanging on an ash tree next to the Mill River in Sleeping Giant State Park, Hamden, CT.

After releases, the next step is to determine if the parasitoids have established in the environment. All three species have been recovered at least a full year after the last release. *Tetrastichus planipennisi* has been recovered at 7 sites, and *Spathius galinae*, which we just began releasing in 2016, has been recovered at 2 sites. Parasitism rates of the *S. galinae* in particular are very

Cocoons of the parasitoid *Spathius galinae* in the tunnel of an EAB larvae. Plymouth, CT.

promising, with wasps attacking up to 45% of available EAB larvae. *Oobius agrili*, the egg parasitoid is a tiny wasp, and very difficult to recover. In spring 2019, we were able to detect it at four of its release sites.

Beyond detection at release sites, we want to know how well the parasitoids are spreading in the environment. By peeling ash trees at various distances from the release sites, we can see how well the larval parasitoids are moving. Previous work has shown all three species at least 3 km from the release site in Cromwell. This summer, we are utilizing "sentinel logs," logs with inserted emerald ash borer. These logs are allowing us to examine the spread of the two larval parasitoids to a distance of 14 km from their release site.

We are also using these sentinel logs to examine the persistence of *T. planipennisi* in the environment. The first releases of this larval parasitoid were made in 2013 in northern New Haven County. Surveys in 2015 recovered the parasitoids at both sites. Five years on, the landscape is very different, with a very small ash population and a low EAB population. For the parasitoids to be successful as a population regulator of EAB, they need to be able to persist at low densities of EAB. The sentinel logs are a sensitive tool that enables us to survey without peeling the bark of the newly regenerating ash.

Pollination of Pumpkin and Winter Squash Fields in Connecticut
(Dr. Kimberly Stoner, with the assistance of Tracy Zarrillo and Morgan Lowry)

Pumpkins and winter squash require insect pollination to set fruit, but only three bee species are important pollinators of these crops in the Northeastern US. To determine if natural levels of pollen deposition are sufficient for full fruit production, natural pollination was measured by counting pollen grains on stigmas, and natural pollination was compared to supplemental hand pollination for fruit set, fruit size and seed number. A threshold of 2300 pollen grains per stigma was sufficient for full pollination and fruit production. This threshold was met in 79 out of 80 combinations of site and sample date over 4 years on farms across Connecticut with a wide range of field sizes and pest management practices. Along with stigma collection, bees per flower were counted hourly on 100 flowers along a transect. Counts of bumble bees on female flowers were more closely related to the amount of pollen deposited than counts of bees on all flowers or counts of honey bees or squash bees on female flowers. However, given that pollen deposition was almost always greater than the threshold, despite tremendous variation in bee species abundance, all three species are important in maintaining the necessary level of pollination for fruit production.

Impact: Because pollination is required for pumpkins and squash to set fruit, growers are often concerned about whether they get adequate pollination. We found that they did, over four years and a wide range of farm sizes and pest management practices, with only one farm renting honey bees for pollination (although several farms also had hives year-round on the farm). Many other factors can be involved in whether pumpkins and squash set fruit, so it is important to separate pollination from those factors. Pollination in these crops is highly dependent on just three species of bees, including the common eastern bumble bee

and squash bee as well as the western honey bee, so maintaining the health of all these bee species is very important.

NURSERY AND PLANT INSPECTION ACTIVITIES

Plant inspection and regulatory services are coordinated and conducted through the Office of the State Entomologist, whose members are State Entomologist Dr. Kirby Stafford, Deputy State Entomologist Dr. Victoria Smith, Plant Inspectors Jeffrey Fengler and Tia Blevins, Apiary Inspector Mark Creighton, and State Survey Coordinator Gerda Magana.

Nursery Inspection and Certification. Two hundred nurseries were certified to conduct intra- and interstate business. There were 160 nursery inspections during the growing season.

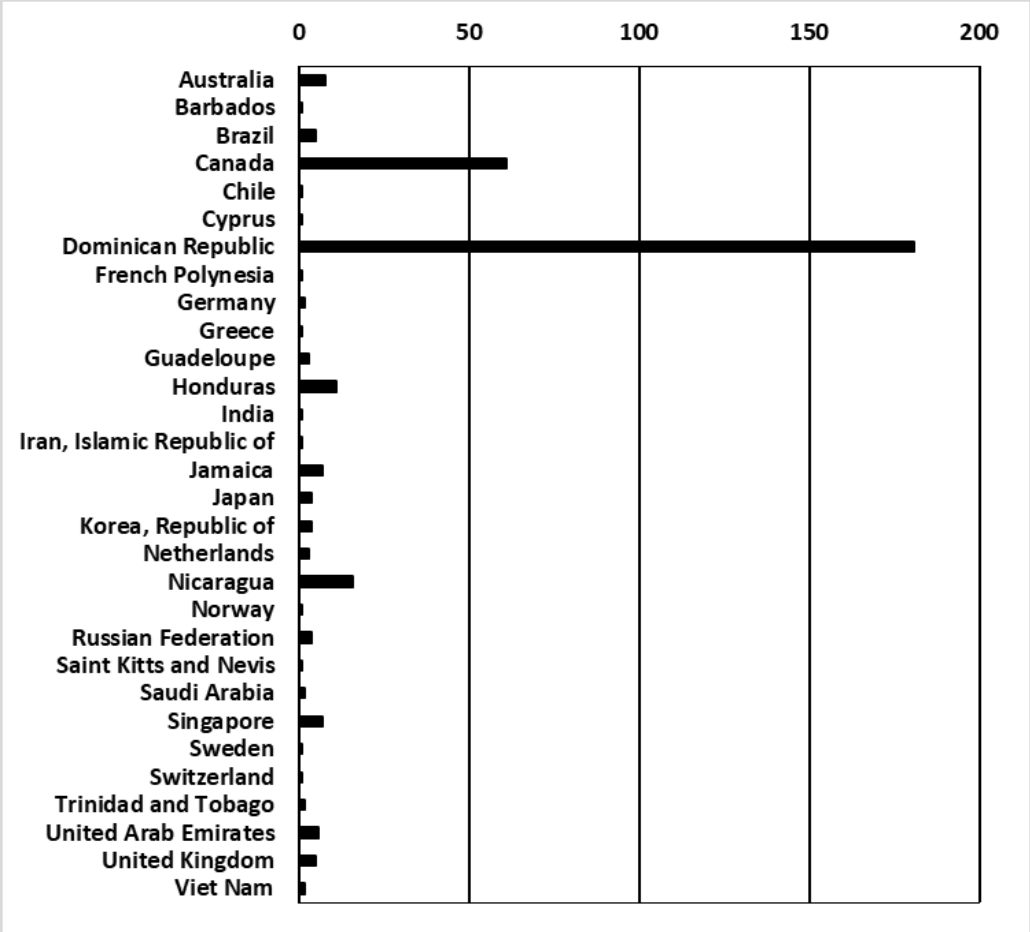
Nursery Insects and Diseases. The most important pests found in nurseries (in order of prevalence) were red headed flea beetle, various aphids, fall webworm, woolly aphids, and thrips. The most important diseases found in nurseries (in order of prevalence) were powdery mildew, cedar apple rust, miscanthus blight, downy mildew, and various fungal leaf spots. Boxwood blight was found at one production nursery; affected and associated plants were removed and destroyed.

Nursery Dealer Permits. Nursery dealer permits were issued to 80 firms.

Phytosanitary Certificates. Three hundred forty-four phytosanitary inspection certificates were issued covering the shipment of the following plant materials to 30 destinations outside the United States. Of the top three destinations, 181 consignments were bound for the Dominican Republic (tobacco), 61 to Canada (ornamental plants), and 16 to Nicaragua (tobacco).

Product	Quantity
Apricot shells (ground, drums)	16
Apricot/vegetable ivory, mixed (ground, drums)	48
Bulbs & Tubers (*Dahlia* & *Gladiolas*) (bags)	9
Bulbs & Tubers (*Dahlia* & *Gladiolas*) (kilograms)	1
Chinese Tree Peony (plants)	30
Greenhouse plants	1,440
Nursery stock	
Plants (containers)	38,863
Orchids (plants)	1,599
Perennials	
Bare root plants	719
Cuttings	37
Plants	900
Seeds, *Festuca* (grams)	23
Seeds, assorted vegetables and herbs (bags)	435
Seeds, assorted vegetables and herbs (kilograms)	63
Seeds, peony	300
Seeds, tobacco (kilogram)	1
Tobacco	
Bales	102,190
Bundles	73,426
Cartons	3,300
Pounds	2
Vegetable ivory (ground, drums)	12
Walnut shells (ground, drums)	319
Walnut slab	1

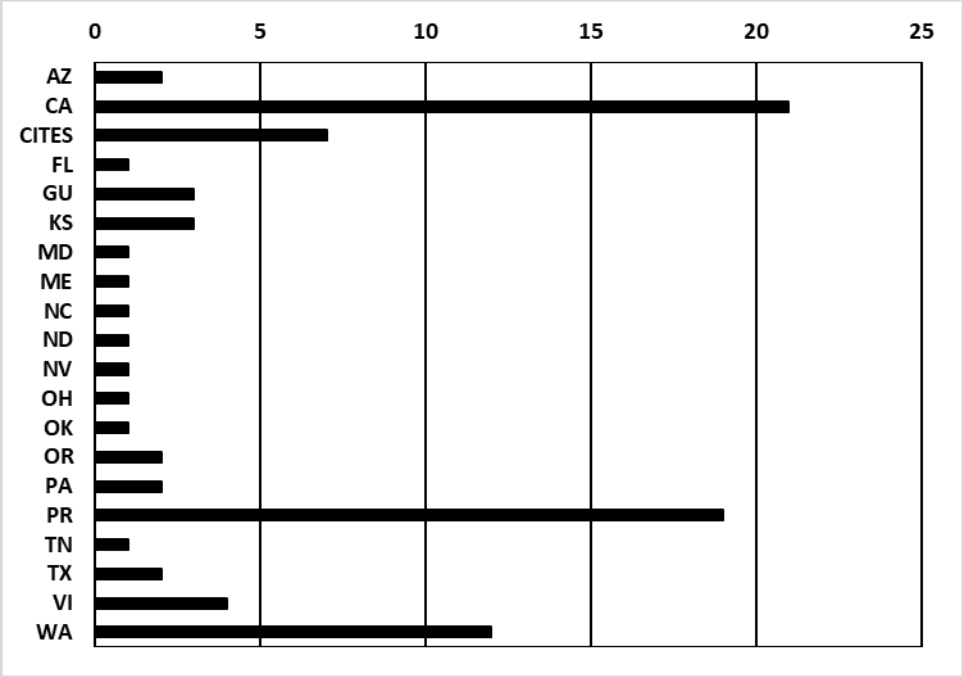
Destinations for out-of-country exports from Connecticut.



Eighty-six inspections were made to assist nurseries moving the following plants interstate, either to destinations in other states or to US Territories and Puerto Rico (20 listed destinations). Of the top three destinations, 21 consignments were bound for California, 19 to Puerto Rico, and 12 to Washington.

Product	Quantity
Nursery stock (containers)	1
(bare root plants)	1,156
Greenhouse plants	1,115
Seed (bags)	30

Destinations for out-of-state export from Connecticut, including US Territories and Puerto Rico.



Special Inspections. Four inspections were conducted for 82 individual plants to assist homeowners moving out of state.

Permits to move live plant pests, noxious weeds, and soil. In 2019, there were 79 PPQ 526 Permits (Permit to move live plant pests, noxious weeds, and soil) approved in CT. There were 7 Controlled Import Permits issued. There were 2 Permits to Receive Soil issued.

Boxwood Blight compliance agreements for shipment to Pennsylvania. Three nurseries met requirements for shipment of boxwood nursery stock to Pennsylvania.

Gypsy Moth. In 2019, we recorded 166,636 acres affected by gypsy moth, primarily in the eastern half of the state. Approximately 153,983 acres were dead, due to successive years of defoliation and drought stress. In December 2019 through March 2020, a gypsy moth egg mass survey was conducted in 80-95% favorable host sites on a 7-mile grid (102 sites) throughout Connecticut. Egg mass counts were low to non-existent in most locations, indicating a low potential for a severe outbreak in 2020.

Hemlock Woolly Adelgid and Elongate Hemlock Scale. These pests have been present in CT for many years and continue to cause patchy damage and decline among the remaining population of hemlocks. Statewide in 2019, 1,482 acres were affected by HWA, and 416 acres were affected by EHS. Scale insects, such as elongate hemlock scale and circular scale, are increasing in some areas, and may be more of a factor in tree damage and mortality than HWA.

Emerald Ash Borer. Emerald ash borer has been detected in all eight counties; the quarantine for this insect was extended statewide to encompass all of Connecticut. Detections and outreach efforts included monitoring of *Cerceris* colonies; trapping was suspended when the state became fully quarantined. During aerial survey, we mapped 175,750 acres affected by EAB, and recorded mortality on 175,475 acres.

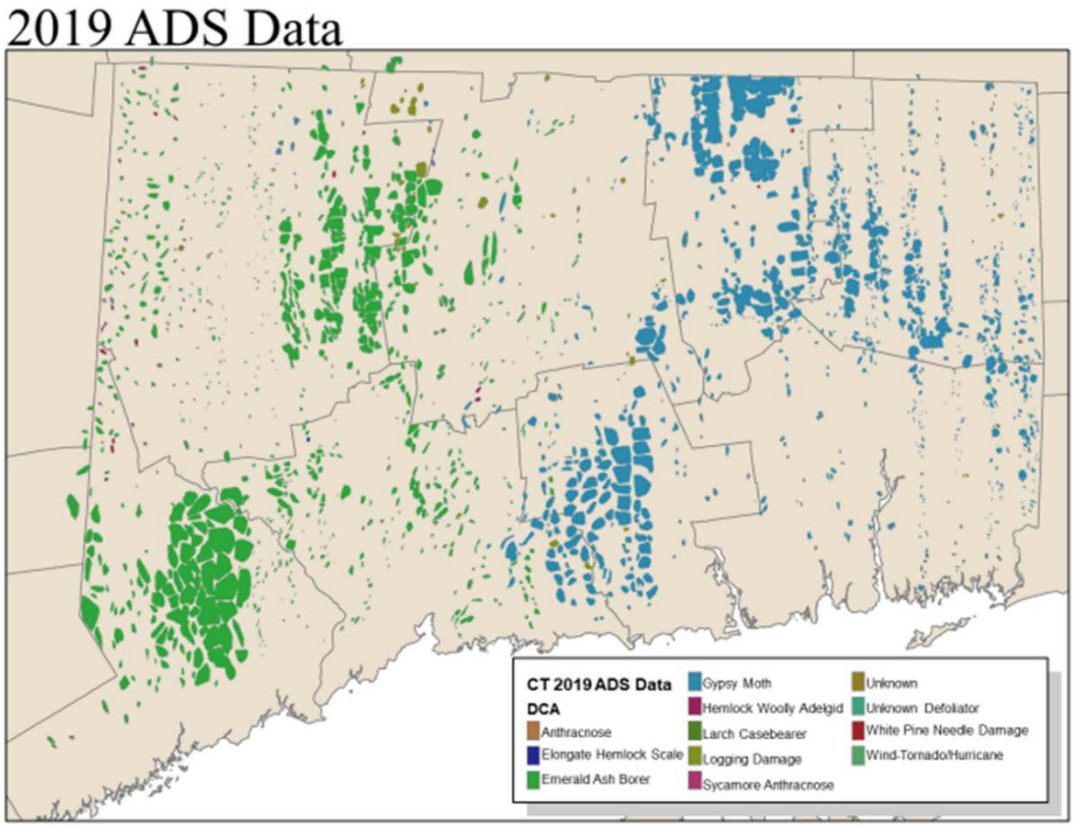
Southern Pine Beetle. This insect was recently detected in CT, and damage estimates are still in the preliminary stage. The infestation appears to be widespread, however.

Cynipid Gall Wasp. Cynipid gall wasp was detected on the Bluff Point Coastal Reserve in New London County and adjoining areas in the town of Stonington in late 2014. The infestation has not been delimited.

White Pine Needle Decline. We recorded 316 acres affected by white pine needle decline.

Apiary Inspection. In 2019, Connecticut had over 562 registered beekeepers maintaining over 5,000 hives. During the 2019 season, 1,273 hives were inspected at 118 apiaries. Unofficial estimates indicate that over 6,000 packages of honey bees were imported into Connecticut for new beekeepers and to replace winter losses. Varroa mite infestation and the viral complex associated with varroa mite infestation was the primary reason for colony mortality. Varroa mite test kit distribution started in the last quarter for 2019 and will continue through 2020 for all Connecticut beekeepers. Connecticut beekeepers continue to lose colonies over winter in high numbers. The Bee Informed Annual Loss report for CT in 2019 was 64.98%, an 11.09% increase from 2017; the winter loss was 54.29%; the summer loss was 21.9%. An educational program, Biology and Management of the Varroa mite in the honey bee will continue to be presented to CT beekeepers in an attempt to increase honey bee survivability. Despite these challenges, beekeeping interest is still strong with over 500 new beekeepers being trained earlier this year. Six certificates were issued for export of honey bees out of Connecticut and over 140 certificates for interstate movement of honey bees.

Areas of forest damage mapped during aerial survey are illustrated below.



4. Special activities:

Email/telephone inquiries concerning emerald ash borer, July 1, 2019 through June 30, 2020: 65
Email/telephone inquiries concerning Asian longhorned beetle, July 1, 2019 through June 30, 2020: 38
Email/telephone inquiries concerning spotted lanternfly, July 1, 2019 through June 30, 2020: 31

Spotted Lanternfly Emergency Response. A Connecticut resident recorded a video of a single adult spotted lanternfly, walking on the pavement of a gas station in Southbury on September 30, 2019, and posted the video to a Facebook site. An initial inspection of the gas station and the surrounding area was conducted on October 4, 2019, with additional surveys and outreach on October 8, 2019. No life stages of spotted lanternfly were found. The area will be a target for visual surveys in 2020.

DEPARTMENT OF ENVIRONMENTAL SCIENCES

I. ENVIRONMENTAL CHEMISTRY PROGRAMS

The Environmental Chemistry component of the Department has been involved in research topics dealing with the interactions of pollutants with environmental particles, the bioavailability of pollutants in environmental solids such as soils and sediments, pollution prevention and remediation, natural chemical processes in the environment, and environmental analytical chemistry applied to characterization of pollution, assessment of human exposure, and remediation options. It covers many types of pollutants, including industrial solvents and chemicals, fumigants, insecticides, herbicides, pharmaceutical compounds, personal care products, perfluorinated alkyl substances, engineered nanomaterials, and greenhouse gases.

A. Interactions of Contaminants with Environmental Particles
(Joseph Pignatello)

1. Effects of air oxidation during and after pyrolysis on the chemical and physical structures of biomass chars and their adsorptive properties towards organic compounds.

(Joseph Pignatello, Yi Yang, and collaborators from Brandeis University, University of North Dakota, and Old Dominion University)

Biomass chars are ubiquitous components of soil and sediment as a consequence of historical wildfires and intentional burning practices. Fire-derived chars, together with fossil fuel carbonaceous soots, impact the carbon cycle and potentially affect soil microbial community structure and exocellular microbial electron transport processes. In many places chars are present in high enough amounts in soil to play a substantial, if not dominant, role in the mobility and bioavailability of organic contaminants that may be present. Char products synthesized from various biomass wastes and added to soil ("biochars") have attracted attention for their ability to improve soil properties, suppress greenhouse gas emissions, and reduce availability of soil pollutants. Many of the functions of chars in these various applications depend on their sorptive properties towards small molecules and ions.

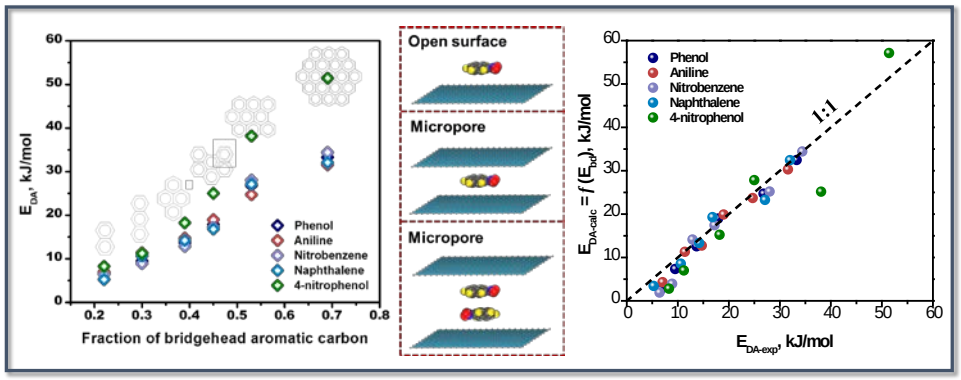
In one such study (Cao et al., 2019), solid-state nuclear magnetic resonance (NMR) spectroscopy was used to characterize the chemical changes induced by including air during pyrolysis. The spectra showed that post-pyrolysis hot air oxidation treatment introduces oxygen functional groups into aromatic rings, primarily C-O and C=O, but also carboxyl groups (COO) identified after spectral editing. Insight into the types and concentrations of oxygen functional groups induced by exposure of biomass chars to hot air has implications for an understanding of the interaction of char with nutrients, natural organic matter, pollutants, and microbes, as well as electron transfer processes in soil.

In an ongoing study (Yang et al., manuscript), we are compared the effects of hot air oxidation during charring as well as aerobic oxidation during simulated weathering in the soil or sediment environment on adsorption of different model compounds. The models are, naphthalene, which is and a ubiquitous industrial pollutant, and paraquat, which is a di-cationic aquatic herbicide. Exposure to air during heating caused various physico-chemical changes in pore/surface structure, matrix chemistry, and surface chemistry that generally increased sorption and sorption rates, including surface area increase, pore size expansion, removal of obstructive substances, and introduction of acidic groups that increased cation exchange capacity (CEC). By contrast, exposure to accelerated ambient aging led to O-incorporation, but not to pore modification. This resulted in sorption suppression of naphthalene by rendering surfaces/pores more hydrophilic, whereas it led to sorption enhancement of paraquat due to increased CEC. Sorption capacity for paraquat is predicted by an equation that includes a CEC^2 term (due to di-cation interaction with pairs

of charges) and a term representing the driving forces (steric, hydrophobic, van der Waals) governing sorption capacity for a comparably-sized reference molecule such as naphthalene. This study provides insights into the effects of different oxidative processes on adsorption of organic compounds by biomass chars.

2. Identification of an important new interaction responsible for adsorption of organic compounds to biomass chars.
(Joseph Pignatello, Jingjing Yang, and collaborators from South China University of Technology, Guangzhou, China)

Biomass chars are a component of the ubiquitous black carbon pool in soil, and synthesized chars ("biochar") are in use or under consideration for practical applications in environmental remediation. In these contexts, chars play an important role as sorbent of organic compounds. During the charring process aromatic rings of larger and larger size form, and both the porosity and specific surface area increase. Historically, surface area and porosity were regarded to be the main properties of chars governing char sorption ability. In this study, we show that the *degree of aromatic condensation* has a previously overlooked direct effect on sorption energy (but not capacity) of chars. Aromatic condensation refers to the mean polyaromatic fused ring cluster size and is a function of heating conditions. Characteristic sorption energy (E_{DA}, kJ/mole) was determined by fitting sorption isotherms to the Dubinin-Ashtakov (DA) model for each of 22 different compounds on a thermoseries of bamboo chars. The fraction of bridgehead carbon, χ_{bh} which correlates with ring cluster size was determined by solid-state ^{13}C nuclear magnetic resonance spectroscopy. For all 22 compounds a strong linear correlation was observed between E_{DA} and χ_{bh}. The E_{DA} also correlated with a binding energy E_{bd} computed by molecular modeling using density functional theory (DFT). DFT reveals that sorption is increased with ring size due to increasing polarizability of the cluster, which strengthens dispersion forces with the sorbing molecule. The findings underscore the direct role of aromatic condensation in sorption energy and suggest that E_{DA}-E_{bd} comparison can be a useful tool for gaining insight into sorption at the molecular level. This work is under review with *Environmental Science and Technology*.



Left, correlation between sorption energy and the bridgehead carbon which is an index of average ring size. Center, the effect of ring size holds for monolayer sorption on an open polyaromatic sheet and both monolayer and bilayer sorption in a slit micropore composed of polyaromatic sheets. Right, experimental versus DFT-computed sorption energy.

3. Direct reaction of a char with a series of substituted phenols: dual oxidative and reductive pathways depending on substituents and conditions.
(Joseph J. Pignatello and colleagues from Kunming University of Science and Technology, China and the University of Massachusetts, Amherst)

Biomass chars are known to be directly redox-reactive toward some organic compounds due to the presence of oxidative or reductive 'sites' on their surfaces, but the mechanisms are still unclear. To address this, a char made anoxically at 500 °C from pure dealkaline lignin was reacted either in the fresh state, or after aging in air for 180-day, with *p*-nitrophenol (NO_2-P), *p*-hydroxybenzaldehyde (CHO-P), phenol (H-P), or *p*-methoxyphenol (MeO-P) under oxic or anoxic conditions. Degradation of the phenolic compounds occurred in all cases. Both oxidation and reduction products were identified, with yields dependent on the presence or absence of air during reaction or during the aging stage. They included oligomers, amines, and ring-hydroxylated compounds, among others. Exposure to air suppressed sorption, annihilated reducing sites on the char, and provided a source of reactive oxygen species (most importantly, hydroxyl radicals) that assisted degradation. Reaction appears to take place predominantly in the sorbed as opposed to the dissolved state of the phenolic compound. Sorption suppression was due to incorporation of hydrophilic groups by chemisorption of oxygen and possibly by blockage of sites by reaction products. Using a published technique that measures electro-chemical storage capacity of carbonaceous materials, fresh char contained comparable electron donor and acceptor capacity, while aged char contained a preponderance of electron acceptor over donor capacity. Under anoxic conditions, both oxidation and reduction occurred. Under oxic conditions or in the case of char aged in air, oxidation predominated, and linear free energy relationships were found between the rate constant and the Hammett or Brown substituent electronic parameter or the standard electrode potential of the phenol (Figure). The results demonstrate that chars possess heterogeneous redox activities depending on reaction pairs, reaction conditions, and aging. The work is under review in *Environmental Science & Technology.*

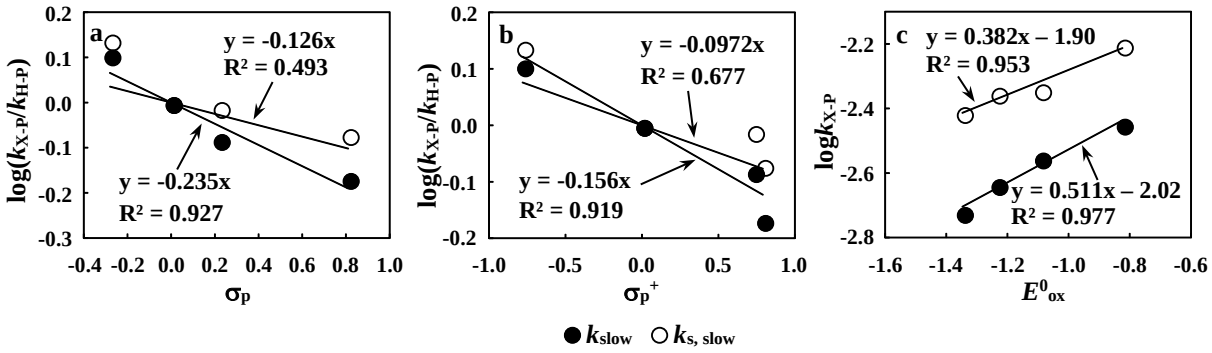


Figure. Degradation by fresh char under oxic conditions. Correlation between rate constant and Hammett (left) or Brown (center) parameters, which reflect the electron-withdrawing capability of the substituent. Right is a correlation between rate constant and the standard one-electron electrode oxidation potential of the phenolic compound (Ar-OH → Ar-O$^{\bullet}$ + e^- + H^+). k_{slow} refers to the over-all slow phase of the reaction and $k_{s,slow}$ refers to the slow phase pertaining to the sorbed amount only.

B. Pollution Remediation
(Joseph Pignatello)

1. Oxidation of organic compounds in water by peroxymonosulfate without activation.
(Joseph J. Pignatello, Yi Yang, and collaborators from the University of Wisconsin, Madison)

Peroxymonosulfate (HSO_5^-, PMS) is an optional bulk oxidant used in advanced oxidation processes (AOPs) for treating water contaminated with organic compounds. Normally, PMS is activated by the (costly) input of energy (heat or light) or reducing agents to generate sulfate and/or hydroxyl radicals, which are highly reactive towards most organic compounds. We reported in a previous Record of the Year, however, that PMS reacts directly with a variety of organic compounds without explicit activation. Contaminated water

can also contain peptidic and proteinaceous toxins. Peroxymonosulfate may thus hold promise for deactivation of proteinaceous contaminants. We studied the oxidation of 19 of the 20 standard proteinogenic amino acids (all except cysteine) by PMS alone without explicit activation. This work is reported by Ruiz et al., 2019. Reaction half-lives at pH 7 ranged from milliseconds to hours. Amino acids possessing sulfur-containing, heteroaromatic, or substituted aromatic side chains were the most susceptible to oxidation by PMS, with rates decreasing in the order methionine > tryptophan > tyrosine > histidine. The rate of tryptophan oxidation did not decrease in the presence of an aquatic natural organic matter. Singlet oxygen resulting from peroxymonosulfate self-decomposition, while detected by electron paramagnetic resonance spectroscopy, was unlikely to be the principal reactive species. Our results demonstrate that peroxymonosulfate is capable of oxidizing amino acids without explicit activation, and that methionine and tryptophan are likely initial targets of oxidation in peptides and proteins.

2. Design of carbonaceous catalysts for environmental remediation.
(Joseph Pignatello, Jingjing Yang, Xiangyu Bi, and collaborators at Universities in the U.S. and China)

We have initiated projects on surface modification of carbonaceous materials such as chars and activated carbon for trapping or trapping and degrading environmental contaminants. Because such materials are inherently strong adsorbents, they serve to gather in and concentrate contaminants out of water or soil, making them more available at reactive sites. For example, we have modified carbons to increase their anion exchange capacity (AEC). The AEC-modified carbons bind phosphate, nitrate and organic anions much more effectively than do the unmodified carbons. Other carbons have been modified to bind reagents that chemically react with adsorbed contaminants, thereby accelerating contaminant degradation. For example, we are working on carbons with enhanced AEC that accelerate alkaline hydrolysis of munitions compounds by adsorbing both the munition molecules themselves and hydroxide ions, which cause their hydrolysis. We have prepared novel carbons that contain N and O atoms incorporated into their structures. These carbons greatly accelerate the oxidation of organic compounds by a peroxide (peroxymonosulfate), without the need for light, heat, or transition metal co-catalysts.

2. Biochars as agents for environmental remediation of soils impacted by crude oil.
(Joseph Pignatello and other collaborators from University of California, Davis, William Jessup University, and Chevron Energy Technology)

Crude oil continues to be a major source of energy worldwide with annual demand increasing from 80.1 to 97.8 million barrels per day from 2003 to 2017. During the exploration, production, and transport of crude oil, environmental releases on soil are frequent. There are tens of thousands of spill sites globally. Novel, cost-effective remediation technologies are of great interest. The impact of biochars on the biodegradation of petroleum hydrocarbons in crude oil impacted soils was evaluated in batch laboratory experiments. Crude oil impacted soils from three separate locations were amended with fertilizer and biochars derived from walnut shells or ponderosa pine wood chips produced at 900°C. The batch reactors were incubated at 25 °C and 75% of maximum water holding capacity and sampled at pre-determined intervals to measure changes in total petroleum hydrocarbons (TPH) over time. Results show that the addition of fertilizer and biochars increased biodegradation rates of TPH. Soil samples amended with ponderosa pine wood biochar achieved the highest biodegradation rate, whereas the walnut shell biochar was inhibitory to TPH biodegradation. The beneficial impact of biochars on TPH biodegradation was more pronounced for a soil impacted with lighter hydrocarbons compared to a soil impacted with heavier hydrocarbons. The function of the biochar is not clear, but circumstantial evidence indicates that biochar absorbs the oil into its pores, providing a steady supply of oil molecules to support a growth of oil-degrading biofilms of microorganisms on external surfaces and large pores. At the same time, biochar may reduce the toxicity of the oil to the biofilms. This study demonstrates that application of some biochars, in combination with fertilizer, has the potential to be a low-technology and ecologically-friendly remediation strategy for crude oil impacted soils. This work is reported in Mukome et al., 2020.

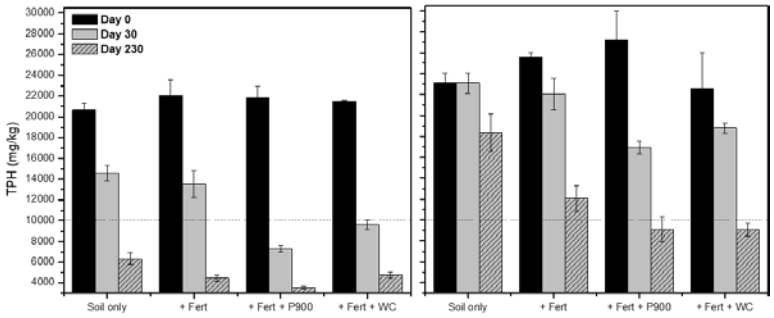
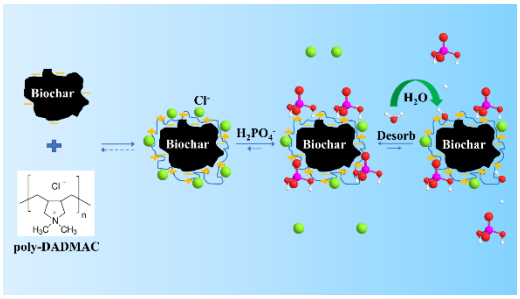


Figure. Change in TPH concentration in a) Soil B (light crude) and b) Soil C (heavy crude) after a 30 and 230 day incubation period. Fert: fertilizer, BC: ponderosa pine biochar (900°C), WC: ponderosa pine wood chips.

3. Removal of excess phosphate in waters and animal wastes by modified biochars and carbons.
(Joseph J. Pignatello, Philip Wang, Santanu Bakshi, Hsin-se Hsieh, and collaborators from University of California, Davis)

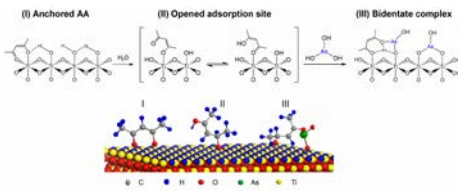
Nutrient pollution can cause water quality degradation and ecosystem disruption, resulting in hypoxia, eutrophication, harmful algal blooms, and economic impacts due to loss of commercial and recreational value of water bodies. The predominant sources of nitrogen (N) and phosphorus (P) include animal feeding operations, fertilizer and manure application to agricultural fields, non-point source runoff, and effluents from wastewater treatment plants. P is often the limiting nutrient. Cost-effective engineering techniques are urgently needed in agriculture to remove excess nutrients from animal wastes, to minimize or mitigate nutrient runoff, and to recycle nutrients back to the land to achieve sustainable food production while protecting the environment. Viable recycling strategies for N and P in organic wastes to date are sparse. This study reports on the develop of modified pyrogenic carbonaceous materials (PCMs) for recovering orthophosphate (PO_4-P). The PCMs include softwood and hardwood biochars and a commercial granular activated carbon (GAC) that were modified by irreversible adsorption of the quaternary ammonium polymer, poly(diallyldimethylammonium) chloride (pDADMAC), which reverses electrokinetic charge and increases PO_4-P sorption. MgO-doped biochars were prepared by a literature method for comparison. Imaging and spectroscopic analyses characterize pDADMAC coverage, MgO doping, and binding of PO_4-P. At environmentally relevant concentrations, PO_4-P sorption by the pDADMAC-treated biochars was ~100 times greater than that of the corresponding unmodified biochars, and was comparable to that of the corresponding MgO-doped biochars on a coating content basis. The pDADMAC-coated carbons bind PO_4-P by ion exchange, while the MgO-doped biochars bind PO_4-P principally by forming an amorphous Mg phosphate species. Susceptibility to competition from other relevant anions (Cl^-, NO_3^-, HCO_3^-/CO_3^{2-}, SO_4^{2-}) and poultry and dairy manure extracts was moderate and comparable for the two types of modified softwood biochars. Sorption to the pDADMAC-treated biochars appears to be more reversible than to the Mg-doped biochars using stepwise water extraction. Greater reversibility may be advantageous for trapping and recycling phosphate. This work is reported in *Journal of Colloid and Interface Science* by Wang et al., 2020.



4. Removal of arsenite from water.

(Joseph J. Pignatello and collaborators from China)

Arsenic contamination in groundwater comes mostly from natural sources and is a worldwide problem posing severe threats to public health in many developing countries. Long-term exposure may cause neurological symptoms, skin lesions, and cancer. The World Health Organization (WHO) has imposed a strict maximum contaminant level (MCL) for arsenic of 10 μg/L. In natural waters, the main forms of arsenic are inorganic arsenite [As(III)] and arsenate [As(V)], depending on the redox potential and pH of the water. Arsenite is the most toxic and labile form in subsurface media. Oxidation of arsenite to arsenate is a widely used strategy to enhance the removal of arsenic from water. However, the formation of unwanted oxidation byproducts is a major concern in drinking water treatment. Herein, a titanium xerogel (TAX) was fabricated with abundant surface hydroxyl groups and anchored acetylacetone (AA) molecules that served as powerful capturing sites for arsenic. The resultant xerogel had high adsorption capacity for arsenic (306 and 254 mg/g for arsenate and arsenite, respectively, at pH 7.0) without the need for any pre-treatment. Columns packed with TAX could effectively lower arsenite concentration from 200 μg/L to less than 10 μg/L for up to 6000 bed volumes, which is more than 10 times greater than those achieved by well-developed iron or zirconium-based nanocomposites. Besides excellent arsenite capturing ability, the TAX was also effective in removing heavy metals and commonly co-existing iron and manganese species in arsenic-contaminated groundwater. Moreover, the TAX had good antibacterial activity toward *Escherichia coli*. These attributes make the TAX a promising point-of-use adsorbent for residents in arsenic-contaminated areas, especially areas lacking infrastructure for water treatment. The results are reported in Zhang et al., 2020.



The adsorption mechanism of As(III) on TAX.

C. Chemistry of the Environment
(Joseph Pignatello)

1. Charge-assisted hydrogen bonding as a cohesive force in soil organic matter.
(Joseph Pignatello, Philip Wang, and Hiro Murano from Meijo University, Japan)

Naturally-occurring organic matter (OM) is a heterogeneous mixture of molecules derived from the degradation of lignin, cellulose, lipids, proteins and other biological polymers. These molecules have different masses, charges, properties, and reactivities. Because OM is ubiquitous in aquatic and terrestrial waters and soils, it plays critical roles in the biogeochemical cycling of carbon, carbon storage, the physical and chemical properties of soil, soil microbial activity, soil structure, mineral weathering, nutrient availability to plants, and the fate and transport of anthropogenic compounds. Solid and adsorbed forms of OM ("SOM") strongly influence soil formation and structure, biological activity, mineral dissolution, metal-ion sequestration, redox reactions, and pH buffering, which are all related to soil health.

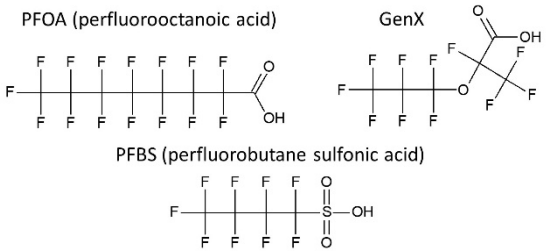
Weak bonds between molecular segments and between separate molecules of natural organic matter (OM) govern its solubility, adsorption, supramolecular association in solution, and complexation with metal ions and oxides. We are testing the hypothesis that especially strong hydrogen bonds, known as (negative) charge-assisted hydrogen bonds, (-)CAHB, contribute significantly to OM cohesion. The (-)CAHB is exemplified by structures such as $(–CO_2···H···O_2C–)^-$ and $(–CO_2···H···O–)^-$. It may form between weak acids with similar proton affinity, and is shorter, more covalent, and much stronger than ordinary hydrogen bonds. Previous published work in the group has shown that disruption of such bonds can result in increased water solubility of SOM and increased sorption of acidic pollutants to carbonaceous solids that have acidic groups on their surfaces capable of undergoing (-)CAHB. Current work focuses on electron microscopic imaging of OM colloids under conditions that are designed to disrupt aggregation due to (-)CAHB.

D. Applied Environmental Analytical Chemistry
(Sara L. Nason)

The Applied Environmental Analytical Chemistry program is an interdepartmental effort between Environmental Sciences and Analytical Chemistry. We focus on developing and testing methods for analyzing environmental contaminants in samples and on applying our methods to field samples and studies that characterize pollution, assess human exposure to contaminants, and investigate contaminant remediation options. Our emphasis is on organic chemical contaminants and our primary analytical technique is liquid chromatography coupled with high resolution mass spectrometry (LC-HRMS) We currently have several projects that focus specifically on per- and polyfluoroalkyl substances (PFAS) and several others that focus more broadly on contaminants in wastewater related matrices.

1. Per- and Polyfluoroalkyl Substances

Per- and polyfluoroalkyl substances (PFAS) are a widespread, emerging class of highly toxic environmental contaminants. PFAS are a key ingredient in aqueous film forming foam (AFFF), used for fighting fires, and have been used in consumer products, such as waterproof and stainproof coatings, Teflon pans, and car waxes, since the 1940s. They are very persistent in the environment as their chemical structure is based on extremely strong the carbon-fluorine bonds. While PFAS are not currently regulated at the federal level, an increasing number of states (including Connecticut) are defining their own limits for PFAS in drinking water, groundwater, and other matrices. Good methods for measuring PFAS and for removing PFAS from the environment will be necessary as knowledge about and regulation of these chemicals increases.



Chemical structures of three common PFAS

a) FluoroMatch: novel software for non-targeted analysis of PFAS in environmental samples
(Sara Nason and collaborators from Yale, the University of Florida, and others)

Over 7,500 PFAS exist, but analytical standards are available for less than 2% of compounds, complicating their analysis. Therefore, approaches such as non-targeted analysis using liquid chromatography coupled with high resolution tandem mass spectrometry (LC-HRMS/MS) are necessary for complete sample characterization. Typically, data processing for this type of analysis is a slow and complicated process. We developed, released, and validated FluoroMatch: a new open source, vendor neutral software program for annotating PFAS in LC-HRMS/MS data. Our software is an important new resource for making this type of analysis more effective and accessible than previous approaches. We have submitted two manuscripts introducing FluoroMatch which we expect to be published later in 2020. The initial manuscript (introduces the software and the second provides a comparison of the new software to an established non-targeted analysis program.

b) Phytoremediation of PFAS at the former Loring Air Force Base
(Sara Nason, Nubia Zuverza-Mena, and collaborators)

The use of Aqueous Film-Forming Foams (AFFFs) has caused widespread contamination with PFAS in areas that have been used for fire-fighter training. Such is the case at the Burn House site of the former Loring Air Force Base in northern Maine, USA (pictured), where the land now belongs to the Aroostook band of the Micmac nation. PFAS are have been dubbed "forever chemicals" as they are extremely persistent in the environment, and exposure to PFAS has been linked to cancer and other diseases.

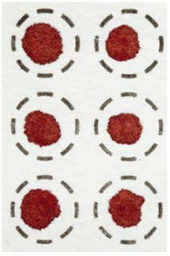
The Burn House at the former Loring Airforce Base.

A group of concerned citizens is attempting phytoremediation at the Burn House site in an attempt to reduce the contamination levels, and we are assisting them with assessing the effectiveness of their efforts. So far, we have determined that perfluorooctane sulfonic acid (PFOS) is the primary PFAS contaminant at the site and have detected a total of 68 PFAS in the soil. Soil samples from this site were used for testing FluoroMatch software (described above).

In summer of 2019, we conducted a pilot study testing the use of industrial hemp plants for PFAS phytoremediation and found that 4 out of 19 quantified PFAS decreased in soil over the course of the growth season, with an additional 5 PFAS showing some evidence of decrease in soil. We detected 8 PFAS in hemp tissue, including PFOS. Hemp is a promising plant for phytoremediation due to its large size, fast growth rate, and high water usage. Continued work is happening in summer 2020.

c) Measuring PFAS to assess human and animal exposures
(Sara Nason, Carlos Tamez., and collaborators from Yale)

While PFAS have been in use for decades, we have only recently become aware of their potential health impacts. Therefore, PFAS contamination is extremely widespread, but there are not yet standardized methods for measuring them in most sample matrices. We are working to develop methods (including sample preparation, instrumental analysis, and data processing) for measuring PFAS in multiple types of samples that will aid in assessing human and animal exposures to PFAS.



Dried blood spots and dog food are two matrices where we measure PFAS.

As part of the work that the Department of Analytical Chemistry does with the US FDA Animal Feed Regulatory Program Standards, we are testing a method for quantifying PFAS in dry animal feeds. Our method is based on the US FDA method for quantifying PFAS in human foods, with some modifications. Our initial test matrices are dog food and dried corn. PFAS in animal food are important to assess due to the possibility of harm to the animals and because of the possibility of bioaccumulation of PFAS in animals intended for human consumption.

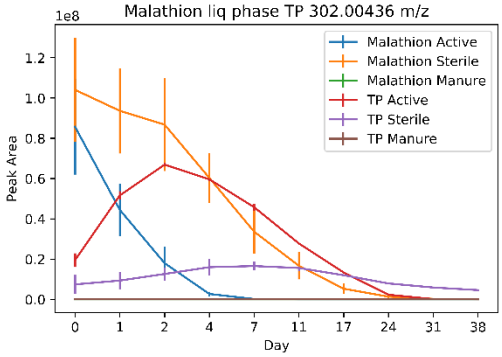
In collaboration with researchers at Yale, we are working on a method for measuring PFAS in dried blood spots. As PFAS have only recently become a health concern, we do not have long-term records human exposure to PFAS. However, long term blood spot archives exist, and could be an important resource for characterizing historic human exposures.

While both of these projects were delayed due to pandemic-related shutdowns, we anticipate continued progress throughout 2020.

2. Organic Microcontaminants (OMCs) in wastewater and related matrices

a) Contaminant transformation during anaerobic digestion
(Sara Nason and collaborators at Johns Hopkins University)

Anaerobic digestion is a common strategy used to produce biogas from waste materials from both farms and wastewater treatment plants. While many organic microcontaminants (OMCs) are present in the sludge and manure used for digestion, we know little about the fate of these chemicals. Digestate is often land applied to agricultural fields, so contaminants and toxic transformation products not destroyed during digestion may reach soil, groundwater, or crop plants intended for human or animal consumption. We designed experiments to examine the transformation of contaminants during anaerobic digestion. Our work has focused on veterinary drugs and pesticides that are likely to be present in digestion in agricultural areas. We found that the pesticides malathion and carbaryl transform extensively during anaerobic digestion and have identified 24 transformation products for malathion and 15 for carbaryl. Continued work focuses on transformation of additional OMCs.



Graph showing degradation of malathion and the formation of a transformation product with a mass to charge ratio of 302.00436 in both active digestion samples and sterile controls.

b) Assessing the impacts of reclaimed wastewater reuse for agricultural irrigation
(Sara Nason and collaborators)

Water scarcity is a problem throughout the modern world and is expected to increase as human population expands and climate change intensifies. Wastewater effluent reuse for agricultural irrigation is an important strategy to reduce demand from surface and ground water sources and is gaining momentum as obtaining freshwater from other sources becomes more difficult. While an important strategy for combating water scarcity, wastewater reuse for agriculture is not without risks. Wastewater effluent can contain higher levels of bacteria, heavy metals, salts, and other contaminants than conventional water sources. Specifically, there is increasing concern over organic microcontaminants (OMCs) such as pharmaceuticals, pesticides, and endocrine disrupting compounds that may be taken up into irrigated crop plants. We have begun to test non-targeted screening methods that will be a novel way to analyze wastewater used for irrigation and exposed food crops. We analyzed a sample of effluent obtained from the New Haven Water Pollution Control Authority in July 2019 and identified 68 OMCs. We have applied for additional funding to continue this work via greenhouse studies and a larger effluent sampling campaign.

c) Chemical trends in wastewater sludge during the COVID-19 pandemic
(Sara Nason, Brian Eitzer, and collaborators at Yale)

Many organic microcontaminants (OMCs) are present in wastes that enter wastewater treatment plants. OMCs include chemicals from many different sources such as pharmaceuticals, personal care products, pesticides, and illicit substances. We expect that use of many of these chemicals was affected by the COVID-19 pandemic, particularly drugs that may be used (or misused) in COVID-19 prevention or treatment. The Peccia Lab at Yale began collecting primary sludge samples from the New Haven Water Pollution Control Authority on March 19, 2019 – shortly before the stay at home order began in Connecticut. While the initial purpose of these samples was to analyze virus concentrations, we are using the extra material to conduct analysis of OMCs and assess trends in their levels over the course of the pandemic and shutdown. We will use suspect screening and non-targeted analysis to identify OMCs in the samples and will report semi-quantitative results describing the trends that we find. Our work uses novel data collection techniques designed to identify and analyze as many OMCs as possible.

CAES researchers visit the New Haven Water Pollution Control Authority.

II. **MOSQUITO PROGRAM**

A. Mosquito Trapping and Testing Program

(Philip M. Armstrong, John Shepard, Tanya Petruff, Michael Misencik, Angela Bransfield)

Mosquito-borne viral diseases constitute an annual threat to human health in Connecticut. A comprehensive surveillance program complemented by science-based controls and timely public outreach are the most effective ways of protecting the public and reducing the risk of human disease. Experiment Station scientists and technicians monitor mosquitoes and eastern equine encephalitis (EEE) and West Nile virus (WNV) activity at 91 locations throughout Connecticut from June-October. The objectives of the surveillance program are to provide: 1) early evidence of local virus activity; 2) information on the abundance, distribution, identity and infection rates of potential mosquito vectors and; 3) information that is used to assess the threat of WNV and EEE to warn the public and guide the implementation of disease prevention and control measures. The CAES is responsible for conducting all mosquito trapping and testing activities.

In 2019, statewide mosquito trapping was conducted from June 3 through October 29. Approximately one-third of the sites were located in densely populated residential locales along an urban/suburban corridor in the coastal southwestern corner of the state extending up through the Connecticut River Valley. Trap sites typically included parks, greenways, golf courses, undeveloped wood lots, sewage treatment plants, dumping stations, and temporary wetlands associated with waterways. Trapping locations in the other regions of the state were established in more sparsely populated rural settings that included

permanent fresh-water swamps (red maple/white cedar) and bogs, coastal salt marshes, horse stables, and swamp-forest border environs.

Mosquito trapping was conducted with CO_2 (dry ice)-baited CDC miniature light traps equipped with aluminum domes, and gravid mosquito traps baited with a lactalbumin-yeast-hay infusion. Traps were placed in the field in the afternoon, operated overnight, and retrieved the following morning. Trapping frequency was minimally made once every ten days at each trap site over the course of the entire season. Adult mosquitoes were transported alive to the laboratory each morning in an ice chest lined with cool packs. Mosquitoes were immobilized with dry ice and transferred to chill tables where they were identified to species with the aid of a stereo microscope (90X) based on morphological characters. Female mosquitoes were pooled in groups of 50 or fewer by species, collection date, trap type, and collection site and stored at -80°C until processed for virus.

Aliquots of each mosquito pool were inoculated into Vero cell cultures for detection of West Nile virus (WNV), eastern equine encephalitis (EEE), and other mosquito-borne arboviruses of public health importance. Isolated viruses were identified by Real Time (TaqMan) reverse transcriptase polymerase chain reaction (RT-PCR) or standard RT-PCR using virus-specific primers. All of the virus isolation work was conducted in a certified Bio-Safety Level 3 laboratory at the CAES.

During 2019, a total of 239,960 mosquitoes representing 15,665 pools were trapped and tested for arboviruses. There were 122 isolations of EEE virus obtained from 15 species: *Culiseta melanura* = 80, *Uranotaenia sapphirina* = 7, Coquillettidia perturbans = 6, *Ochlerotatus canadensis* = 5, *Psorophora ferox* = 4, *Culex salinarius* = 4, *Aedes vexans* = 4, *Anopheles punctipennis* = 3, *Cx. restuans* = 23, *Ae. cinereus* = 2, *Oc. japonicus* = 1, *Cx. pipiens* = 1, *An. walkeri* = 1, and *An. crucians* = 1 collected from 26 locations in 22 towns in six counties (Fairfield, Hartford, Middlesex, New Haven, New London, Windham). The first EEE-positive mosquitoes were collected on July 31, and last on October 17. Four human cases of EEE virus-associated illness (Middlesex, New London Counties) were reported, with three fatalities. Dates of onset of symptoms were from August 21 to September 12. There were six horses (New London, Tolland, Windham Counties), as well as pheasant and partridge flocks (New London County), identified with EEE infections. The majority of EEE virus activity was detected in eastern C, primarily in the southeast corner from the RI border to the eastern Connecticut River Valley.

A total of 82 isolations of WNV were made from 9 species: *Culex pipiens* = 48, *Cx. restuans* = 11, *Culiseta melanura* = 10, *Cx. salinarius* = 5, *Coquillettidia perturbans* = 3, *Ochlerotatus canadensis* = 2, *Aedes vexans* = 1, *Anopheles punctipennis* = 1, and *Cs. morsitans* = 1, collected from 26 locations in 23 towns in six counties (Fairfield, Hartford, Middlesex, New Haven, New London, Windham). The first WN positive mosquitoes were collected on July 30, and last on September 25. The majority of WN virus activity was detected in densely populated urban and suburban regions in Fairfield, Hartford, and New Haven Counties. One human case of WN virus-associated illness, which was locally acquired (Fairfield County), with a date of onset on August, was reported. Additionally, there was one horse case of WN virus reported.

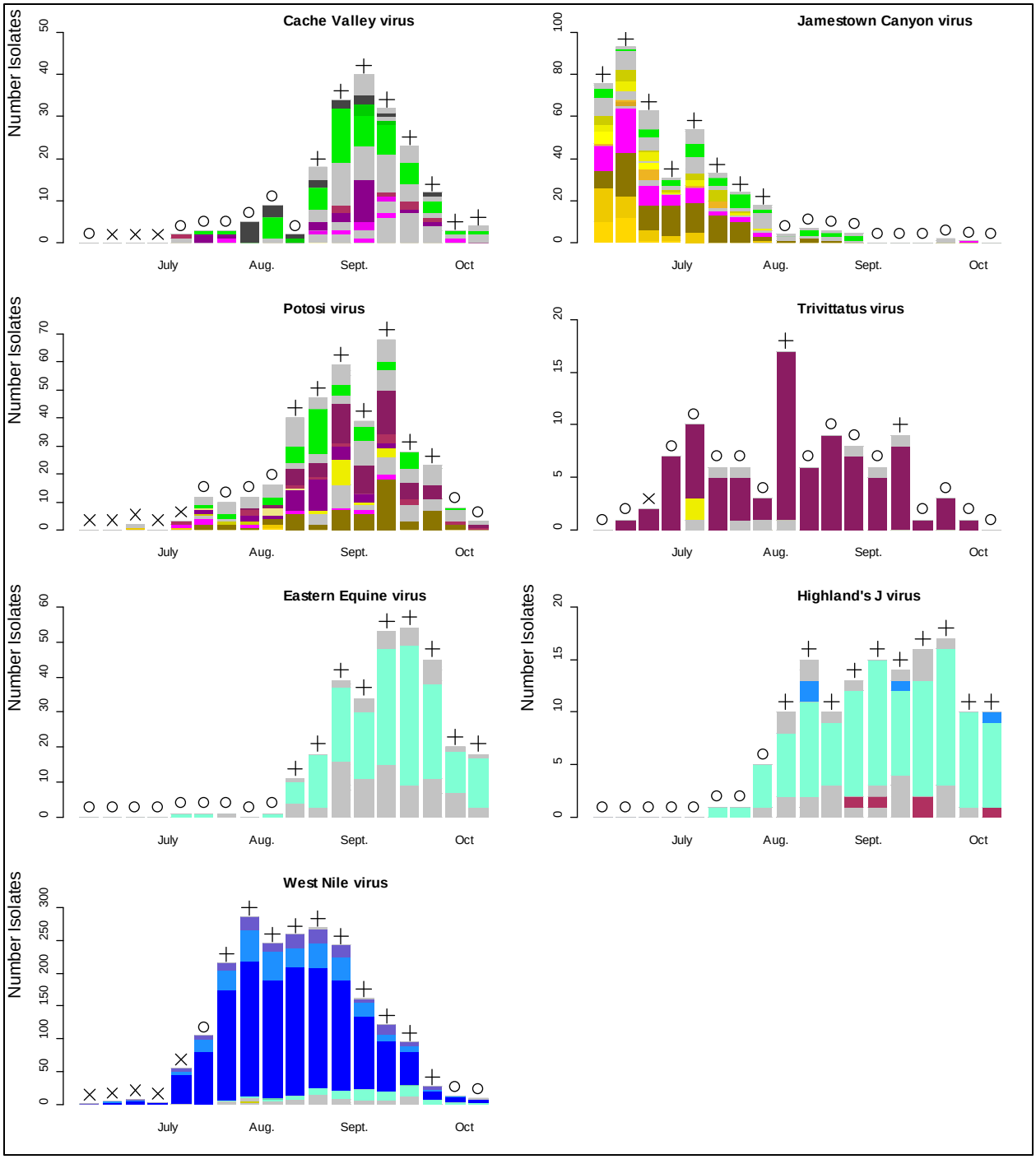
Other mosquito-borne viruses isolated included: Highlands J = 43 isolates from 9 species (August 12 – October 9), Jamestown Canyon virus = 23 isolates from 9 species (June 4 – September 4), Cache Valley virus = 2 isolates from 1 species (September 10 – September 30), Potosi virus = 2 isolates from 2 species (August 14 – September 24), and Flanders virus = 1 isolate from 1 species (July 8).

Impact: Participation in the statewide surveillance program provides timely information about levels of virus activity in the mosquito population which is used to monitor virus amplification within enzootic transmission cycles, and assess risk of human infection. This information is used to inform the public and health care providers of these risks, guide disease prevention and mosquito control efforts, and prevent disease outbreaks. In addition, this large-scale sampling effort also informs our understanding of the ecology of mosquitoes and mosquito-borne viruses. Additional studies on the role of different mosquito species to serve as vectors of viral pathogens may be used to target anti-vector interventions more effectively.

B. Population Genetics of Mosquitoes and Epidemiology of Mosquito-borne Viral Diseases

1. Patterns of mosquito and arbovirus community composition and ecological indexes of arboviral risk in the northeast United States
(Joseph McMillan, Theodore Andreadis, and Philip Armstrong)

In the northeast United States (U.S.), mosquitoes transmit a number of arboviruses, including eastern equine encephalitis, Jamestown Canyon, and West Nile, that pose an annual threat to human and animal health. Local transmission of each virus may be driven by the involvement of multiple mosquito species; however, the specificity of these vector-virus associations has not been fully quantified. We used long-term surveillance data consistently collected over 18 years to evaluate mosquito and arbovirus community composition in the State of Connecticut (CT) based on land use classifications and mosquito species-specific natural histories using community ecology approaches available in the R package vegan. We then used binomial-error generalized linear mixed effects models (GLMMs) to quantify species-specific trends in arbovirus detections. The composition of mosquito communities throughout CT varied more among sites than among years, with variation in mosquito community composition among sites explained mostly by a forested to developed land use gradient. Arboviral communities varied equally among sites and years, and only developed and forested wetland land use classifications were associated with the composition of arbovirus detections among sites. Overall, the avian host arboviruses, mainly West Nile and eastern equine encephalitis viruses, displayed the most specific associations among species and sites, while in contrast, the mammalian host arboviruses (including Cache Valley, Jamestown Canyon, and Potosi viruses) associated with a more diverse mix of mosquito species and were widely distributed throughout CT. We find that avian arboviruses act as vector specialists infecting a few key mosquito species that associate with discrete habitats, while mammalian arboviruses are largely vector generalists infecting a wide diversity of mosquito species and habitats in the region. These distinctions have important implications for the design and implementation of mosquito and arbovirus surveillance programs as well as mosquito control efforts.



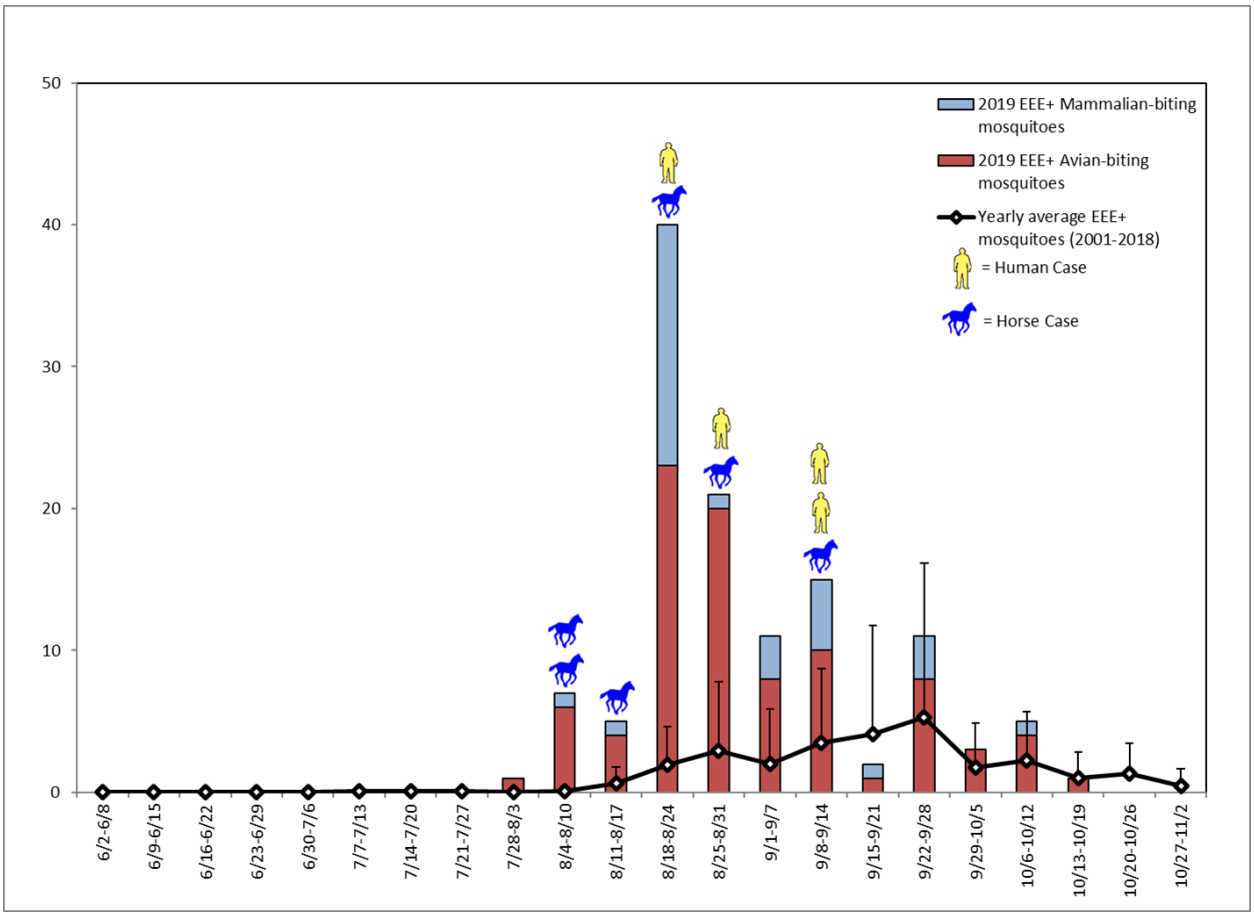
Seasonal arbovirus detection trends in mosquito species across all sites and surveillance seasons.

Impact: This investigation quantified arbovirus detection likelihoods across mosquito species in order to characterize the general risk of arboviral exposure to human populations in the presence of diverse mosquito communities. Our results provide insights into the ecological and epidemiological complexity of zoonotic arboviruses and inform both the design and implementation of arboviral surveillance and control.

2. Emerging Arboviral Epidemics: a Single-State's Experience with Eastern Equine Encephalitis

(Philip Armstrong in collaboration with Stacy Brown, Justine Cormier, Jessica Tuan, Audun Lier, Declan McGuone, Firas Kaddouh, Sunil Parikh, Marie Louise Landry, Kevin T. Gobeske)

Eastern equine encephalitis virus (EEEV) is a single-stranded, positive-sense RNA arbovirus within the *Alphavirus* genus of the *Togavirus* family. EEEV is maintained in enzootic cycles between ornithophilic *Culiseta melanura* mosquitoes and passerine birds in hardwood swamps. Epizootic cycles develop when virus infects mammal-biting bridge vector mosquitoes, and then spreads to dead-end hosts including humans and horses, occasionally triggering outbreaks. Mechanisms of viral or ecologic changes that could sustain epizootic patterns are of great public health interest. In this study, we describe the diagnosis, clinical features and epidemiology of four cases from Connecticut during a three-week period in September 2019, signifying a sharp rise in EEE incidence, and coinciding with notable shifts in vector host infection patterns in the Northeast. All cases were geographically clustered, rapidly progressive and neurologically devastating. Diagnostics showed initial granulocytic cerebrospinal fluid (CSF) pleocytosis and striking false negative antibody results through a large commercial laboratory. Viral infection was detected only upon retesting at the Centers for Disease Control. Weather patterns preceding our cases increased the productivity of mosquito larval environments and may have fostered *Cs. melanura* overwintering and early reproduction, per our trap collection timelines. Indeed, EEEV+ mosquito counts were greater than for any other arbovirus in our region, reaching 20X normal in Connecticut. As the climate warms, seasonal persistence of infected vectors and early reintroduction of virus via migrating avian hosts into optimized environments may heighten risk patterns more consistently.



Epidemic curve of EEE in Connecticut in mosquito populations, horses, and humans.

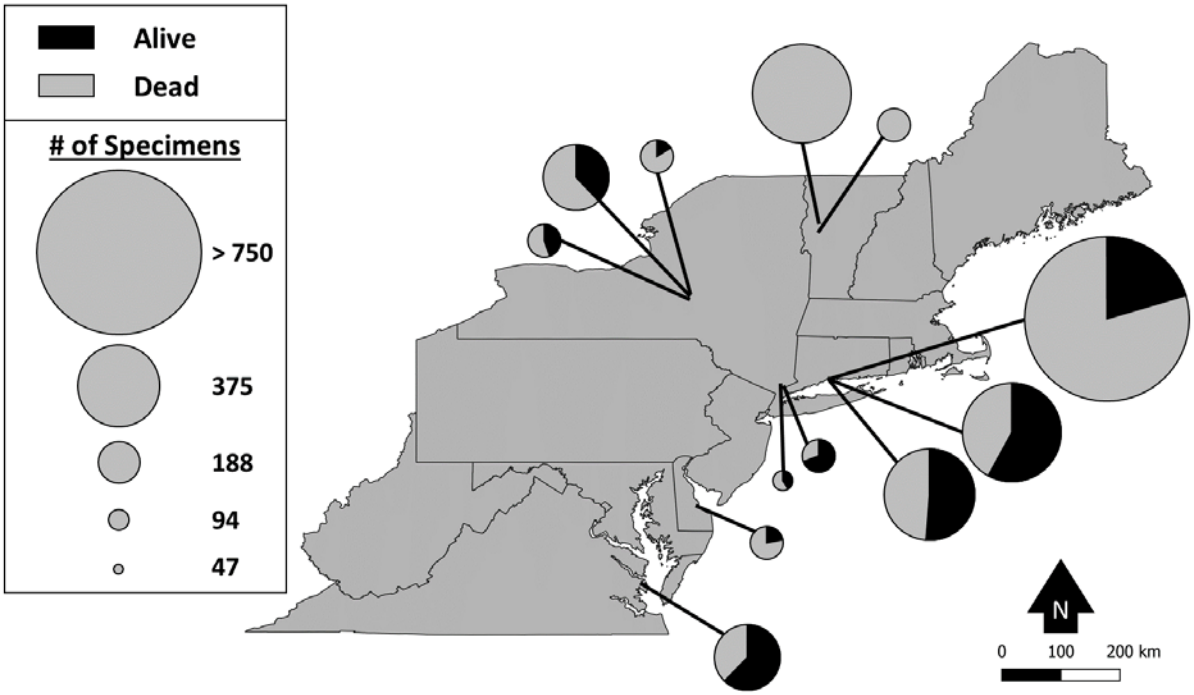
Impact: In this study, we explore crucial diagnostic challenges, clinical findings and ecologic characteristics revealed in the present EEE outbreak that will inform future clinical practice Coordination between public health and hospital settings to improve surveillance, clinical detection and community education will be essential for gaining control of this potentially devastating neuroinvasive disease. Our State's experience shows the importance of bringing all facets together to mitigate risk for the public.

3. Pesticide Resistance Monitoring Network: Establishing a Centralized Network to Increase Regional Capacity for Pesticide Resistance Detection and Monitoring

(Joseph McMillan, Theodore Andreadis, and Philip Armstrong in collaboration with James Burtis, Joseph Poggi, Scott Crans, Scott Campbell, Amy Isenberg, Janice Pulver, Patti Casey, Kerry White, Craig Zondag, John R. Badger, Russell Berger, John Betz, Stacey Giordano, Malgorzata Kawalkowski, John Petersen, Gregory Williams, and Laura Harrington)

Pesticide resistance in disease vector field populations 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 (US). 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 US. A regionwide survey was distributed to vector control agencies to determine needs and refine program development. In response to expressed needs, a specimen submission system was established, allowing agencies to submit *Culex pipiens* and *Aedes albopictus* for pesticide resistance testing. To support the program, NEVBD 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 US 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 x LC-99) methoprene resistance was detected in *Cx. pipiens*, but not in *Ae. albopictus*. Resistance to pyrethroids was detected in many locations for both species but no resistance to either Bti or *L. sphaericus* was detected. Our results highlight the need for increased pesticide resistance testing at a regional scale in the US and we provide guidance for building a centralized pesticide resistance testing program.

Impact: The wide-spread resistance we detected to methoprene and pyrethroids in the northeast US highlights the need for increased surveillance in the US, particularly given the broad use of these same active ingredients for vector control and agriculture. These monitoring efforts are particularly important as new and re-emerging mosquito-borne diseases increase in the US, and the burden of endemic infections, including West Nile virus and Eastern Equine Encephalitis (EEE) virus, increase. The increasing threat to public health from vector-borne diseases necessitates a well-organized and informed effort to ensure that the few tools available for vector control remain viable. The NEVBD pesticide resistance monitoring system demonstrates that a centralized system, integrated with the local public health community of practice, can enhance the detection of pesticide resistance at a regional scale.



Results of the bioassay tests for methoprene resistance for *Cx. pipiens* populations. Pie charts show the percent mortality and the size of each pie chart relates to the number of specimens tested from each town.

4. Vector-Host Interactions of the Asian Tiger Mosquito, *Aedes albopictus*, An Invasive Vector of Human Diseases

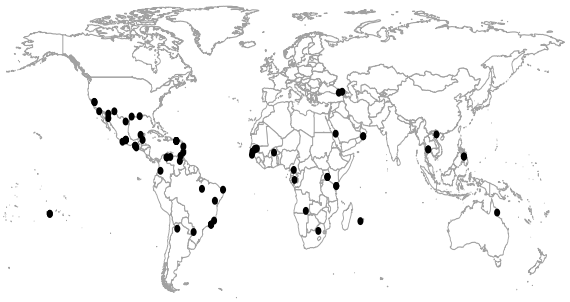
(Goudarz Molaei, Eliza Little, Olivia Harriot, Karen Akaratovic, Jay Kiser, Charles Abadam, and John Shepard)

As an invasive mosquito species in the United States, *Aedes albopictus* is a vector of arboviruses including dengue, chikungunya, and zika, and might also be involved in occasional transmission of other arboviruses such as West Nile, Saint Louis encephalitis, eastern equine encephalitis, and La Cross. In order to investigate vector-host interactions of *Ae. albopictus*, engorged specimens were collected from a variety of habitat types using the Centers for Disease Control and Prevention light traps, Biogents Sentinel 2 traps, and modified Reiter gravid traps, and sources of blood meals were determined by taking advantage of mitochondrial *cytochrome b* gene in PCR assays. The objectives of our study were to: 1) quantify degrees of *Ae. albopictus* interaction with various vertebrate hosts as sources of blood meals, 2) identify vertebrate hosts that serve as hosts for *Ae. albopictus* and may also contribute to maintenance and amplification of arboviruses, and 3) investigate potentials of *Ae. albopictus* as a bridge vector of arboviruses to humans. Analysis of 961 engorged specimens of *Ae. albopictus* sampled between 2017-2019 indicated that 96%, 4%, and less than 1% obtained blood meals from mammalian, reptilian, and avian hosts, respectively. Domestic cat was the most frequently identified (50%) host for *Ae. albopictus* followed by Virginia opossum (17%), white-tailed deer (12%), and human (7%) together representing 86% of all identified blood hosts. Our findings highlight the importance of *Ae. albopictus* as a vector of zoonotic pathogens to humans. A small proportion of blood meals acquired from avian hosts in mixed blood meals suggests that this species may occasionally contribute to epidemic/epizootic transmission of arboviruses as a bridge vector.

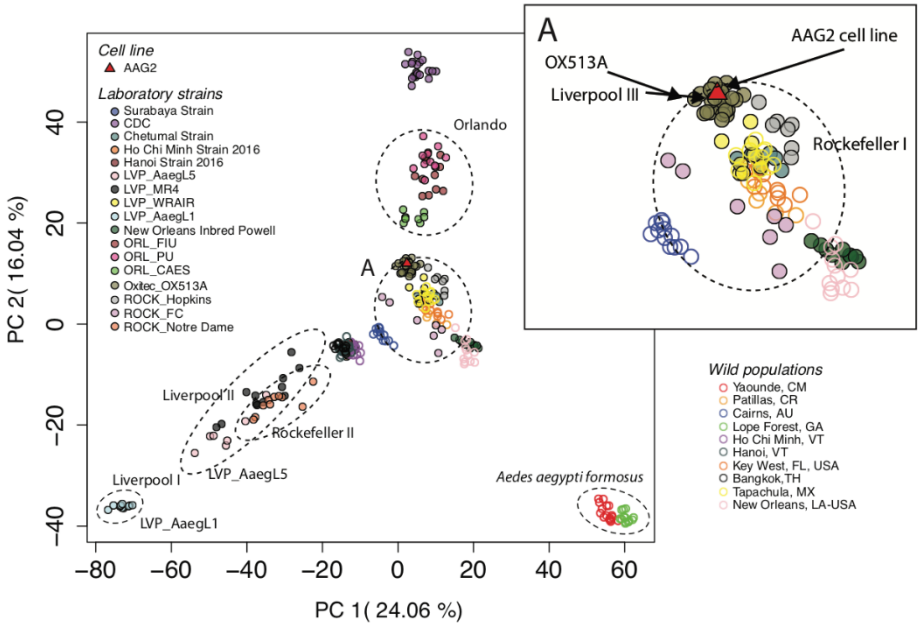
Impact: Detailed knowledge of the vector-host interactions of mosquito populations in nature is essential for evaluating their vectorial capacity and for assessing the role of individual vertebrates as reservoir hosts involved in the maintenance and amplification of zoonotic agents of human diseases. Our study clarifies the host associations of *Ae. albopictus* in the mid-Atlantic region of the U.S., identify vector host preferences as the most important transmission parameter, and determined the risk of human infection with Zika and other arboviruses likely transmitted by this important mosquito species.

5. Genetic diversity of laboratory strains of A*edes aegypti*
(Andrea Gloria-Soria in collaboration with Jeffrey R. Powell)

The yellow fever mosquito (*Aedes aegypti*), is the primary vector of dengue, Zika, and chikungunya fever, among other arboviral diseases. It is also a popular laboratory model in vector biology due to its ease of rearing and manipulation in the lab. Established laboratory strains have been used worldwide in thousands of studies for decades. Laboratory evolution of reference strains and contamination among strains are potential severe problems that could dramatically change experimental outcomes and thus is a concern in vector biology.



We analyzed laboratory and field colonies of *Ae. aegypti* and an *Ae. aegypti*-derived cell line (Aag2) using 12 microsatellites and ~20,000 SNPs to determine the extent of divergence among laboratory strains and relationships to their wild relatives. We found that 1) laboratory populations are less genetically variable than their field counterparts; 2) colonies bearing the same name obtained from different laboratories may be highly divergent; 3) present genetic composition of the LVP strain used as the genome reference is incompatible with its presumed origin; 4) we document changes in two wild caught colonies over ~16 generations of colonization; and 5) the Aag2 *Ae. aegypti* cell line has experienced minimal genetic changes within and across laboratories. This work was published on *PLoS Neglected Tropical Diseases*, *13*(12), p.e0007930.

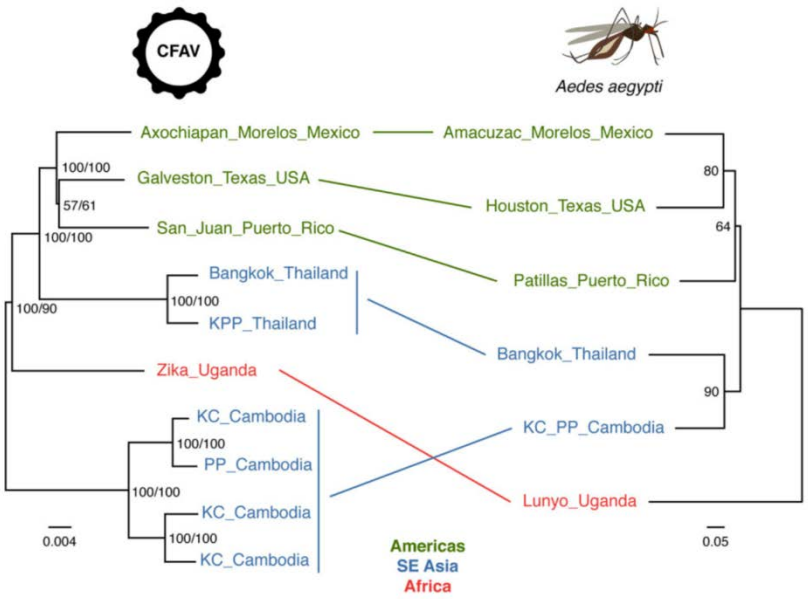


Impact: These results illustrate the degree of variability within and among strains of *Ae. aegypti*, with implications for cross-study comparisons, and highlight the need of a common mosquito repository and the implementation of strain validation tools.

6. Global population genetics of *Aedes aegypti*

a) Insect specific viruses in *Aedes aegypti*
(Andrea Gloria-Soria in collaboration with Louis Lambrechs group at the Pasteur Institute, France)

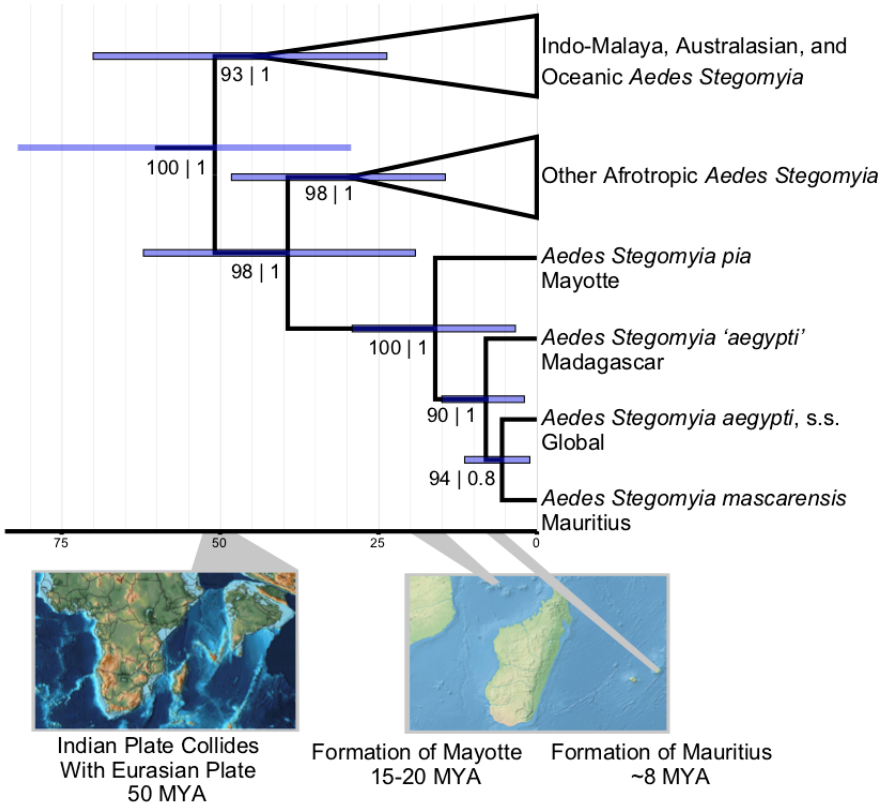
Flaviviruses encompass not only medically relevant arthropod-borne viruses (arboviruses) but also insect-specific flaviviruses (ISFs) that are presumably maintained primarily through vertical transmission in the insect host. Interestingly, ISFs are commonly found infecting important arbovirus vectors such as the mosquito *Aedes aegypti*. Cell-fusing agent virus (CFAV) was the first described ISF of mosquitoes more than four decades ago. Despite evidence for widespread CFAV infections in *A. aegypti* populations and for CFAV potential to interfere with arbovirus transmission, little is known about CFAV evolutionary history. Here, we generated six novel CFAV genome sequences by sequencing three new virus isolates and subjecting three mosquito samples to untargeted viral metagenomics. We used these new genome sequences together with published ones to perform a global phylogenetic analysis of CFAV genetic diversity. Although there was some degree of geographical clustering among CFAV sequences, there were also notable discrepancies between geography and phylogeny. In particular, CFAV sequences from Cambodia and Thailand diverged significantly, despite confirmation that *A. aegypti* populations from both locations are genetically close. The apparent phylogenetic discrepancy between CFAV and its *A. aegypti* host in Southeast Asia indicates that other factors than host population structure shape CFAV genetic diversity. The work was published in *Virus Evolution*, Volume 6, Issue 1, January 2020.



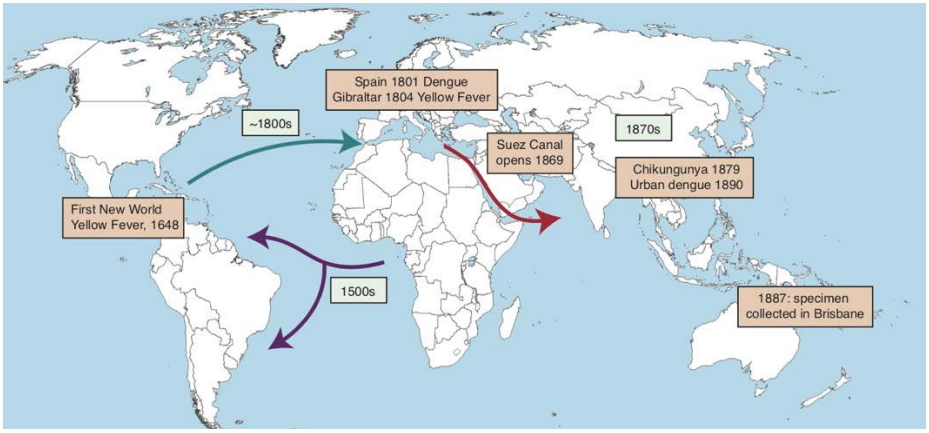
***Impact*:** ISFs have been shown to interact with arboviruses *in vitro* and *in vivo* and can be ecologically associated with arboviruses in nature. Additional knowledge about understudied members of the *Flavivirus* genus contributes to improve our understanding of the evolutionary history of the genus, and more reliably anticipate the public health threats associated with some of its members. Furthermore, better characterization of ISFs could lead to the development of strategies that reduce arboviral transmission by their insect vectors.

b) Identification of *Aedes aegypti* close relatives in the South Western Indian Ocean
(Andrea Gloria-Soria in collaboration with Jeffrey R. Powell (Yale), John Soghigian (NC State), Vincent Robert and Gilbert LeGoff (IRD-FR), and Anna-Bella Failloux (Pasteur Institute, FR)

Aedes aegypti is among the best studied mosquitoes due to its critical role as vector of human pathogens and ease of laboratory rearing. Until now, this species was thought to have originated in continental Africa, and subsequently colonized much of the world following the establishment of global trade routes. However, populations of this mosquito on the islands in the southwestern Indian Ocean where the species occurs in close proximity to its nearest relatives, referred to as the Aegypti Group, have received little study. We re-evaluated the evolutionary history of *Aedes aegypti* and its nearest relatives, using three datasets: nucleotide sequence data, 18489 SNPs, and 12 microsatellites. We found that: (1) The Aegypti Group diverged more than 16 MYA from its nearest African/Asian ancestor. (2) Southwestern Indian Ocean populations of *Ae. aegypti* are basal to continental African populations. (3) After diverging 6 MYA from its nearest formally described relative (*Ae. mascarensis*), *Ae. aegypti* moved to continental Africa less than 85,000 years ago, where it very recently (< 1,000 years ago) split into two recognized subspecies *Ae. aegypti formosus* and a human commensal, *Ae. aegypti aegypti*. (4) The Madagascar samples form a clade more distant from all other *Ae. aegypti* than the named species *Ae. mascarensis*, implying that Madagascar may harbor a new cryptic species. (5) There is evidence of introgression between *Ae. mascarensis* and *Ae. aegypti* on Reunion, and between the two subspecies elsewhere in the southwestern Indian Ocean, a likely consequence of recent introductions of domestic *Ae. aegypti aegypti* from Asia. This work is currently under consideration for publication in *Molecular Ecology*.

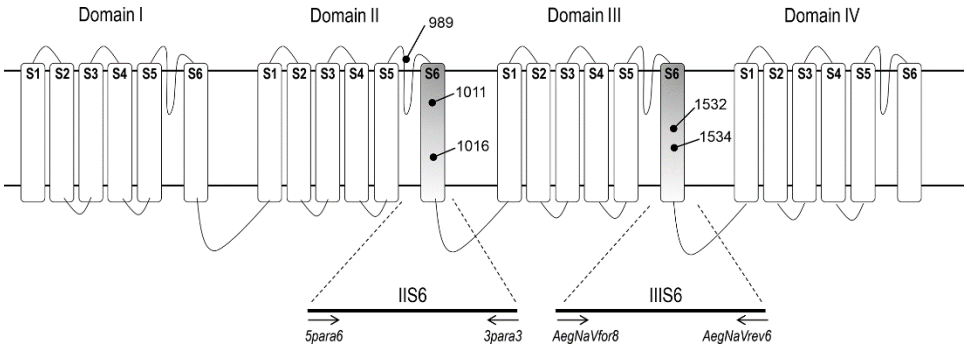


Impact: *Ae. aegypti* is among the best studied mosquitoes, yet from an evolutionary standpoint, there is still much to be learned. The arbovirus competence of members from the Aegypti group remains unknown. Our work aims to reveal a more complete picture of the evolutionary history of the Aegypti group to better understand how *Aedes aegypti* came to be such a good vector of arboviral diseases worldwide. This information will subsequently aid the development of tools to ultimately reduce disease burden.



7. <u>Evolution of insecticide resistance in *Aedes aegypti*</u>
(Andrea Gloria-Soria in collaboration with Ademir Martins (Fio Cruz, BR) and Jeffrey R. Powell (Yale) groups)

Aedes aegypti is the primary vector of dengue, chikungunya, Zika, and urban yellow fever. Insecticides are often the most effective tools to rapidly decrease the density of vector populations, especially during arbovirus disease outbreaks. However, the intense use of insecticides, particularly pyrethroids, has selected for resistant mosquito populations worldwide. Mutations in the voltage gated sodium channel (Na_V) are among the principal mechanisms of resistance to pyrethroids and DDT, also known as "knockdown resistance," *kdr*. Here we report studies on the origin and dispersion of *kdr* haplotypes in samples of *Ae. aegypti* from its worldwide distribution. We amplified the IIS6 and IIIS6 Na_V segments from pools of *Ae. aegypti* populations from 15 countries, in South and North America, Africa, Asia, Pacific, and Australia. The amplicons were barcoded and sequenced using *NGS* Ion Torrent. Output data were filtered and analyzed using the bioinformatic pipeline Seekdeep to determine frequencies of the IIS6 and IIIS6 haplotypes per population. Phylogenetic relationships among the haplotypes were used to infer whether the *kdr* mutations have a single or multiple origin. We found 26 and 18 haplotypes, respectively for the IIS6 and IIIS6 segments, among which were the known *kdr* mutations 989P, 1011M, 1016I and 1016G (IIS6), 1520I, and 1534C (IIIS6). The highest diversity of haplotypes was found in African samples. *Kdr* mutations 1011M and 1016I were found only in American and African populations, 989P + 1016G and 1520I + 1534C in Asia, while 1534C was present in samples from all continents, except Australia. Based primarily on the intron sequence, IIS6 haplotypes were subdivided into two well-defined clades (A and B). Subsequent phasing of the IIS6 + IIIS6 haplotypes indicates two distinct origins for the 1534C *kdr* mutation. These results provide evidence of *kdr* mutations arising *de novo* at specific locations within the *Ae. aegypti* geographic distribution. In addition, our results suggest that the 1534C *kdr* mutation had at least two independent origins. We can thus conclude that insecticide selection pressure with DDT and more recently with pyrethroids is selecting for independent convergent mutations in Na_V. This work was published on *PLOS Neglected Tropical Diseases*, *14*(4), p.e0008219.



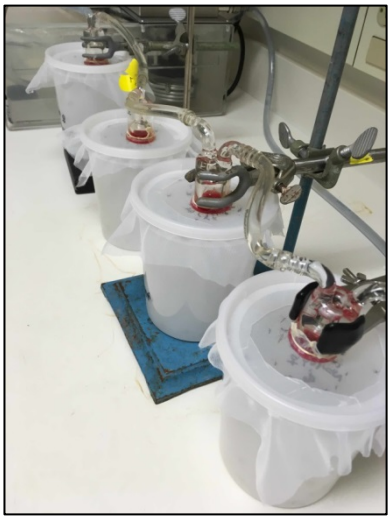
Impact: Insecticide resistance is a global threat for the control of *Aedes aegypti*, the mosquito vector of arboviruses such as dengue, chikungunya and Zika. Mutations in the voltage gated sodium channel (Na_V), known as *kdr*, are one of the principal mechanisms related to resistance to pyrethroids, the class of insecticide most employed worldwide inside and around residences. Our results increase our knowledge on insecticide resistance evolution in one of the main arboviral mosquito vectors of major global diseases.

C. Virus-Vector Interactions

1. Vector Competence of *Ae. albopictus* from the Northeastern US for Chikungunya, Dengue, and Zika Viruses

(Andrea Gloria-Soria, Philip Armstrong, Doug Brackney, Angela Bransfield in collaboration with Alex Ciota, Sean Bialosuknia, Anne Payne, Laura Kramer)

The Asian tiger mosquito (*Aedes albopictus*) is an invasive mosquito species that has spread to over 50 countries during the last 40 years including the U.S. The first U.S. population was discovered in Houston, TX in 1985 and it has since expanded its range in the eastern U.S. with established populations as far north as NY, CT, and MA. *Aedes albopictus* has been shown to be a competent vector of 23 arboviruses in the laboratory and serves as a secondary vector of chikungunya, dengue, and Zika viruses in the tropics. Previous studies indicate that vector competence is population- and virus-dependent but there are no comprehensive vector competence studies with local *Ae. albopictus* populations from the northeastern U.S. using isolates of invasive arboviruses. Accordingly, we compared vector competence of northern *Ae. albopictus* populations for low-passage strains of chikungunya, dengue, and Zika viruses. We find that local *Ae. albopictus* populations are susceptible to all three viruses and capable of transmission. Variation in competence was observed for CHIKV and ZIKA, driven by the virus strains and mosquito population, while competence was homogeneous for DENV-2. These results suggest that under optimal circumstances, *Ae. albopictus* could start an epidemic and emphasize the importance of maintaining an extensive mosquito surveillance and vector control program to prevent *Ae. albopictus* from establishing and expanding its geographic range.



Impact: A clearer understanding of the vector competence of *Ae. albopictus* populations for invasive arboviruses can elucidate actual public health risk for disease outbreaks.

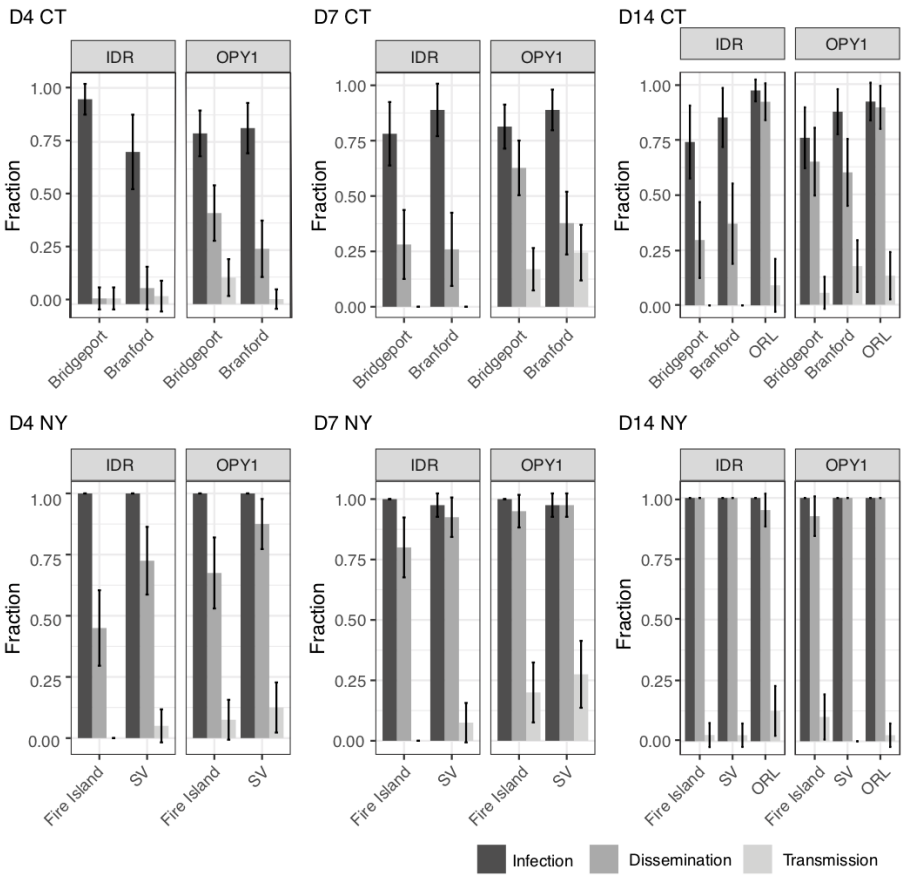
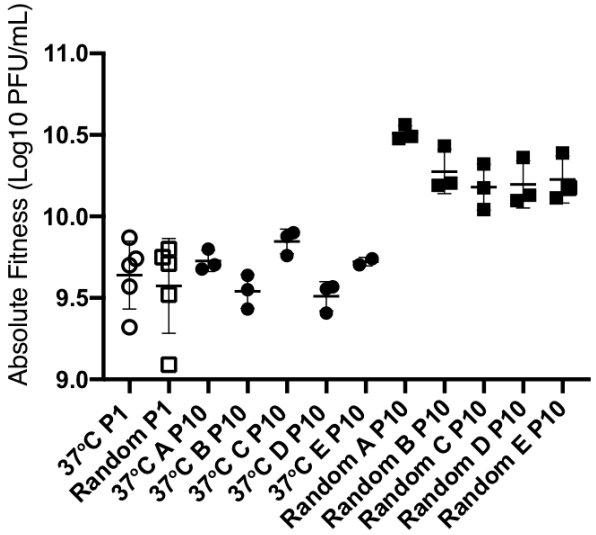


Figure: Chikungunya virus (CHIKV) infection, dissemination, and transmission rates of *Aedes albopictus* populations from Connecticut (CT: Bridgeport and Branford) and New York (NY: Fire Island and Spring Valley) at days 4, 7, and 14 pi. Percentages shown are based on the total number of mosquitoes tested. The virus strain used for the challenge is indicated in the top of each panel (IDR: IDR140025461, OPY1: LR2006OPY1). Error bars represent 95% CI. *Ae. aegypti* (ORL) control is shown.

2. Effects of prior evolutionary history on RNA virus evolution
(Andrea Gloria-Soria in collaboration with Paul E. Turner (Yale) and Barry W. Alto (FMEL))

It is unclear how historical adaptation versus maladaptation in a prior environment affects population evolvability in a novel habitat. Prior work showed that vesicular stomatitis virus (VSV) populations evolved at Constant 37ºC improved in cellular infection at both 29ºC and 37ºC; in contrast, those evolved under Random changing temperatures between 29ºC and 37ºC failed to improve. Here we tested whether prior evolution affected the rate of adaptation at the thermal-niche edge: 40ºC. After 40 virus generations in the new environment, we observed that Random populations showed greater adaptability. Deep sequencing revealed that most of the newly evolved mutations were *de novo*. Also, two novel evolved mutations in the VSV glycoprotein and replicase genes tended to co-occur in the populations previously evolved at Constant 37ºC, whereas this parallelism was not seen in populations with prior Random-temperature evolution. These results suggest that prior adaptation under Constant versus Random temperatures constrained the mutation landscape that could improve fitness in the novel 40ºC environment, perhaps owing to differing epistatic effects of new mutations entering genetic architectures that earlier diverged. We concluded that RNA viruses maladapted to their previous environment could 'leapfrog' over counterparts of higher fitness, to achieve faster adaptability in a novel environment. This work was published on *Ecol. Evol*. 2020; 00: 1-11.



Evolved fitness of VSV lineages after 10 passages at 40ºC on BHK cells. Fitness measured via plaque assay as viral growth after 24h at 40ºC. Circles are the 37ºC lineages and squares the Random lineages. Each symbol indicates the mean fitness of a single virus lineage. For each treatment, boxplots show the mean and 95% CI. Fitness of the ancestral strains under the same conditions are indicated by outlined symbols, evolved populations by filled symbols. The Random treatment group evolved higher grand mean fitness than the 37ºC group.

Impact: This project allows us to understand how biological populations adapt to new environmental challenges, and determining whether theory accurately predicts how current performance relates to future evolution. We showed that virus population adaptation and maladaptation in a selective environment was consequential for fitness improvements in a novel environment. These results inform predictions of RNA virus emergence, which pose important and difficult challenges in biomedicine and public health.

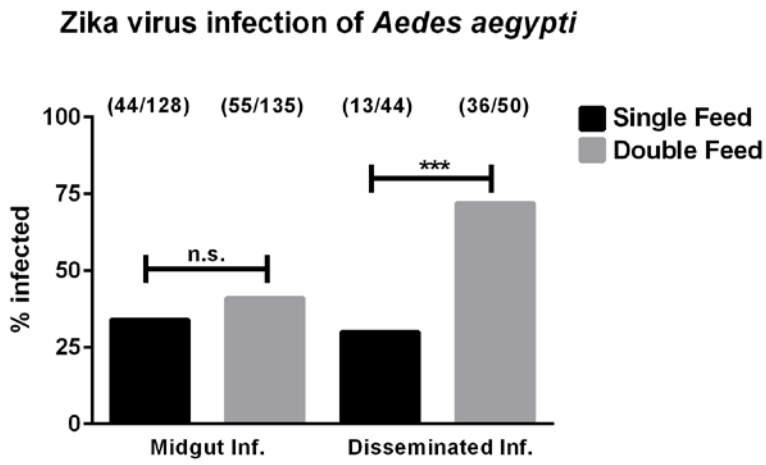
3. The Role of RNA Interference in Arbovirus Diversification
(Doug Brackney, Philip Armstrong)

Arthropod-borne RNA viruses exist within hosts as heterogeneous populations of viral variants and, as a result, possess great genetic plasticity. Understanding the micro-evolutionary forces shaping these viruses can provide insights into how they emerge, adapt, and persist in new and changing ecological niches. Our previous studies have demonstrated that the innate immune pathway of arthropods, RNA interference

(RNAi), serves as one of these micro-evolutionary forces and can directly impact the diversity of virus populations. However, because of other forces such as genetic drift and genetic bottlenecks, it is unclear the true role of RNAi in arbovirus diversification. We are currently performing a series of experiments to address this specifically. Using viruses which over-express RNAi agonists, we will be able to quantify RNAi-mediated diversification. In addition to the canonical RNAi pathway, recent work has demonstrated that arbovirus sequences can be integrated into the mosquito genome and that these sequences can serve as templates for RNAi-mediated targeting of viral genomes. Our work will be to further quantify the contributions of this non-canonical RNAi based defense mechanism in virus diversification. Ultimately this line of research will provide mechanistic insights into arbovirus evolution and epidemic potential.

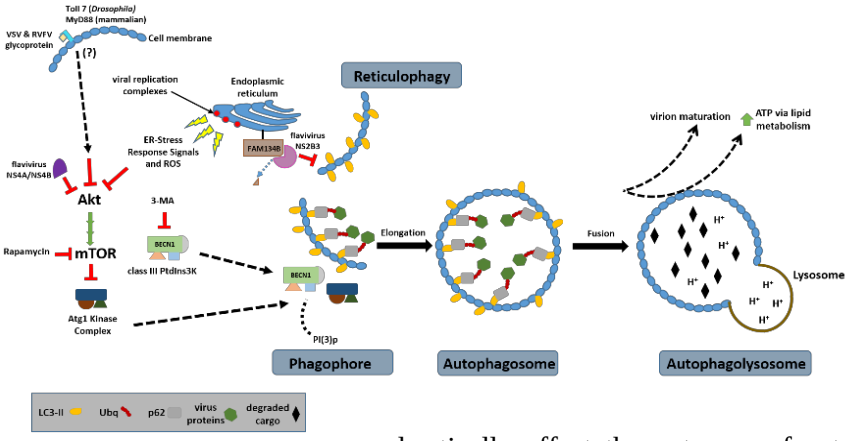
4. Factors influencing vector competence
(Dr. Doug Brackney, Dr. Philip Armstrong, Ms. Angela Bransfield)

The emergence and re-emergence of arthropod-borne viruses (arboviruses) over the last 40 years constitutes a continued and significant public health threat. Determining the relative risk for transmission is typically assessed in the laboratory by performing vector competence studies. Vector competence is the ability of an arthropod vector (e.g., mosquitoes) to become infected with a pathogen, permit replication and ultimately transmit the pathogen to a naïve vertebrate host. This can be determined by providing the local vector populations with an infectious bloodmeal containing the pathogen of interest (e.g., Zika virus). Subsequently, individual mosquitoes are assayed at varying time points post-bloodmeal to determine if the gut became infected, if the virus was able to escape the gut and enter the hemolyph (i.e., the open circulatory system), and to determine if the pathogen is being transmitted in the saliva. This basic procedure has been utilized for the better part of a century; however, for some species such as *Aedes aegypti* mosquitoes, it doesn't take into consideration the natural habits of the mosquito. For instance, it is well documented that *Ae. aegypti* mosquitoes take a bloodmeal every two to three days in the wild. Therefore, we have recently begun studying the effects that multiple feeding episodes may have on the vector competence of *Ae. aegypti* and *Ae. albopictus* to Zika virus, dengue virus and chikungunya virus. Surprisingly, we have found that non-infectious bloodmeals provided after the initial infectious bloodmeal significantly enhanced the rates in which the virus is able to escape the gut and infect the salivary glands. These paradigm shifting findings will change how risk assessments of vector-borne disease outbreaks are determined and help explain the explosive epidemic potential of viruses transmitted by mosquitoes.



5. The Role of Autophagy During Arthropod-borne Virus Infection of Mosquitoes
(Dr. Doug Brackney and Ms. Maria Correa)

Autophagy can be induced in metazoans by developmental stimuli or in response to various types of stress such as starvation, hypoxia, or microbial infection. During normal growth conditions, autophagy maintains cellular homeostasis by degrading unwanted or damaged organelles and protein aggregates. In times of cellular stress, autophagy catabolizes these cellular components, generating a pool of energy and macromolecules that maintain essential cellular processes until normal growth conditions return. Because this is a highly complex process requiring the reorganization of intracellular membranes and numerous signaling pathways, perturbations in normal activity, at any of these stages, can drastically affect the outcome of autophagic events. Not surprisingly, many viruses either directly modulate or indirectly alter many of these pathways and/or processes important in regulating autophagy. To date, our understanding of virus-host autophagy interactions has been limited to mammalian systems, yet arthropod-borne viruses (arboviruses) require both a vertebrate host and invertebrate vector for maintenance in nature. It is currently unknown if or how the autophagy pathway of vectors interacts with viruses. Our contribution here is expected to result in a detailed understanding of these events. The significance of these studies is that they will contribute to our understanding of virus-vector interactions. This is important because identifying cellular components/pathways essential to virus replication has the potential to be exploited for the development of novel control strategies.



III. TICK MANAGEMENT AND EPIDEMIOLOGY OF TICK-BORNE DISEASES

A. Tick Management

1. Evaluating the Effectiveness of an Integrated Tick Management Approach on Multiple Pathogen Infection in *Ixodes scapularis* Questing Nymphs and Larvae Parasitizing White-footed Mice
(Eliza Little, Scott Williams, Kirby C. Stafford III, Megan Linske, and Goudarz Molaei)

We investigated the effectiveness of integrated tick management (ITM) approaches in reducing the burden of infection with *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum* in *Ixodes scapularis*. We found a 52% reduction in encountering a questing nymph in the *Metarhizium anisopliae* (Met52) and fipronil rodent bait box treatment combination as well as a 51% reduction in the combined white-tailed deer (*Odocoileus virginianus*) removal, Met52, and fipronil rodent bait box treatment compared to the control treatment. The Met52 and fipronil rodent bait box treatment combination reduced the encounter potential with a questing nymph infected with any pathogen by 53%. Compared to the control treatment, the odds of collecting a parasitizing *I. scapularis* infected with any pathogen from a white-footed mouse (*Peromyscus leucopus*) was reduced by 90% in the combined deer removal, Met52, and fipronil rodent bait box treatment and by 93% in the Met52 and fipronil rodent bait box treatment combination. Our study highlights the utility of these ITM measures in reducing both the abundance of juvenile *I. scapularis* and infection with the aforementioned pathogens.

	Control	Deer	Deer Met52 BaitBox	Met52 BaitBox
Unique properties	12	8	5	13
Property visits	241	165	93	239
Area sampled (m^2)	21,721	15,451	9,517	24,240
Questing nymphs retained	80	55	20	51
Nymphs per 1000 m^2	3.68	3.56	2.10	2.10
Infected (%)	32 (40%)	26 (47%)	7 (35%)	18 (35%)
Density of infected nymphs (1000 m^2)	1.47	1.67	0.74	0.74
*Borrelia burgdorferi**	24	15	3	12
Babesia microti	9	13	5	8
Anaplasma phagocytophilum	5	1	1	2
B. burgdorferi and *B. microti*	3	3	2	3
B. burgdorferi and *A. phagocytophilum*	2	0	0	1
A. phagocytophilum and *B. microti*	1	0	0	0

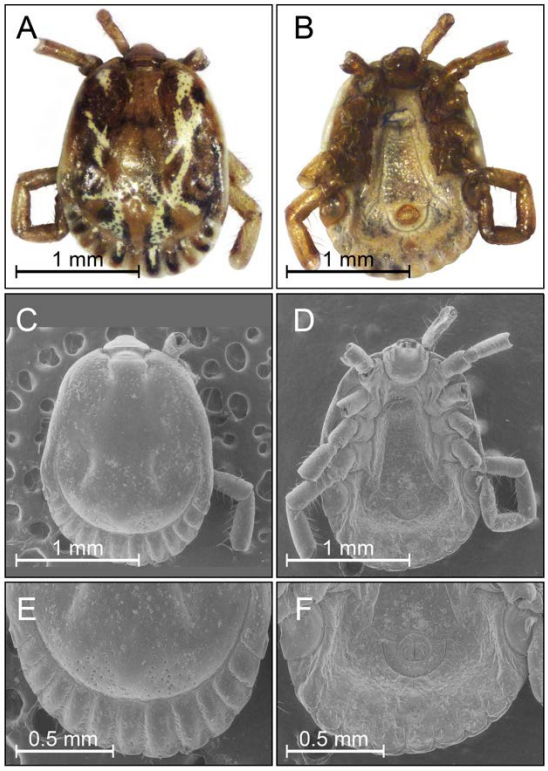
By treatment category, the total number of properties, visits, area sampled, questing *Ixodes scapularis* nymphs collected, density of questing nymphs, total infected overall, density of infected nymphs, total infected with *Borrelia burgdorferi*, *Babesia microti*, *Anaplasma phagocytophilum*, and co-infections.

Impact: The preponderance of *I. scapularis* and associated diseases, most importantly Lyme disease, babesiosis, and anaplasmosis, and predicted changes in the abundance and diversity of tick species and tick-borne pathogens as results of a warming climate and other environmental changes highlights the importance of utilizing and incorporating a variety of compatible and innovative tools for tick control that could be adjusted under different circumstances. The rather limited number of questing *I. scapularis* nymphs infected/coinfected with *B. microti* and/or *A. phagocytophilum* in our study precludes us from making a conclusion on the effects of treatments on these pathogens. Nonetheless, our study shows the effectiveness of an integrated intervention in controlling nymphal *I. scapularis* and reducing the encounter potential with a questing nymph infected with pathogens.

B. Epidemiology of Tick-Borne Diseases

1. Enduring Challenge of Invasive Ticks: Introduction of *Amblyomma Oblongoguttatum* (Acari: Ixodidae) Into the United States on A Human Traveler Returning from Central America
(Goudarz Molaei, James W. Mertins, Kirby C. Stafford III)

Introduction of exotic tick vectors of bacteria, protozoa, viruses, and filarial parasites into the United States has accelerated in recent years, primarily due to globalization, increased frequency of travel, and a rise in legal and illegal animal trades. We herein report introduction of a live specimen of *Amblyomma oblongoguttatum* on a human into the United States from Central America, and we review four previous similar incidents. This tick species occurs widely in the neotropics, from western and southern Mexico, southwards through Central America, to the northern half of South America. It is a potential vector of bacterial agents of spotted fever group rickettsioses, raising concern that *A. oblongoguttatum* ticks, if they became established in this country, might also be able to carry pathogens of human and veterinary concern.

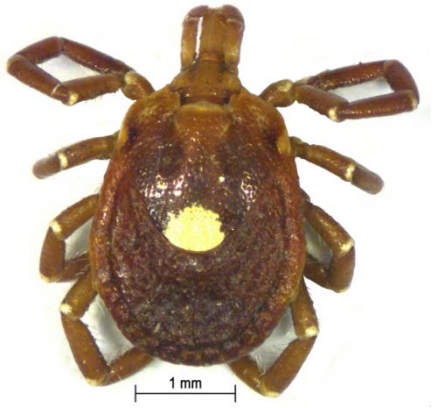


Light microscopy (LM) and scanning electron microscopy (SEM) images of the male *Amblyomma oblongoguttatum.* LM images: (**A**) dorsal aspect, (**B**) ventral aspect; SEM images: (**C**) dorsal aspect, (**D**) ventral aspect, (**E**) dorsal close-up of festoons, and **(F)** ventral close-up of anal groove.

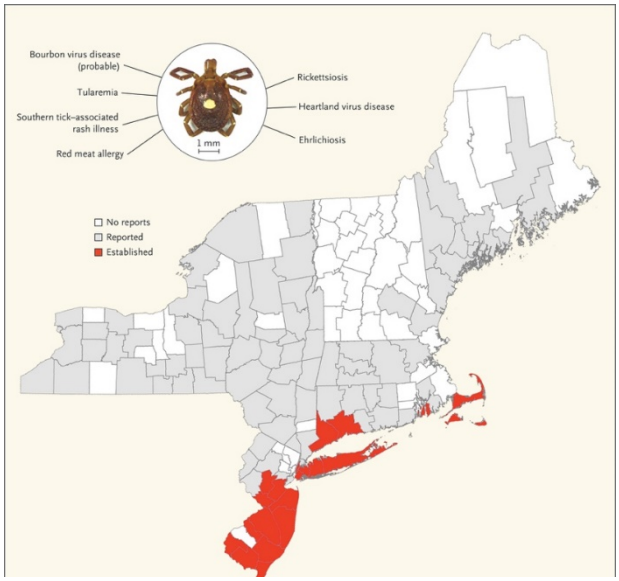
Impact: The importation of exotic tick species, as represented by yet another specimen of an *Amblyomma* sp., continues to signify a challenge and risk to human and animal health in the U.S., although this risk is not limited to the U.S. The potential is high for exotic ticks capable of transmitting pathogens of human and veterinary concern to become established in new areas with suitable environmental conditions and available hosts. Proper surveillance, interception, and identification of exotic, potentially invasive ticks are vital to protecting human and veterinary health. Rigorous governmental inspections of imported livestock and pet animals at ports of entry and educating human travelers and medical practitioners about the risks should be part of an overall national tick program. The capacity to test these ticks for presence of exotic pathogens and evaluate their vector competency for local tick-borne pathogens would be another important element of any program. A heightened awareness of health risks associated with exotic ticks and their potential as vectors for disease agents is needed.

2. <u>Range Expansion of the Lone Star Tick: Another Public Health Concern in Connecticut and throughout the Northeastern United States</u>
(Goudarz Molaei, Eliza Little, Kirby Stafford)

The lone star tick, *Amblyomma americanum*, is an aggressive southeastern United States species whose range has reportedly been steadily expanding northward. The number of *A. americanum* specimens submitted to the Connecticut Agricultural Experiment Station Tick Testing Laboratory (CAES-TTL) increased by 58% from the period of 1996-2006 (n = 488) to 2007-2017 (n = 773), mainly from Fairfield County in the southwestern corner of the state.



Previously limited to the southeastern U.S., lone star ticks have been detected in areas of the northeastern U.S. with no previous record of activity including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, and Rhode Island. Established populations of this tick species have now been documented across most of southern New Jersey, Long Island, Fairfield, and New Haven Counties in Connecticut, coastal Rhode Island, and on Cape Cod and the Islands. Established populations of lone star ticks were discovered in Fairfield and New Haven Counties in 2018 and 2019, respectively, and further establishment in New Haven County was documented on June 17, 2020. As an aggressive human biter with highly irritating bites, the lone star tick has been associated with several human diseases and medical conditions including tularemia, ehrlichiosis, rickettsiosis, Heartland virus disease, southern tick-associated rash illness, red meat allergy and likely the newly identified Bourbon virus disease. We are investigating range expansion of this tick species in Connecticut and its potential for pathogen transmission.



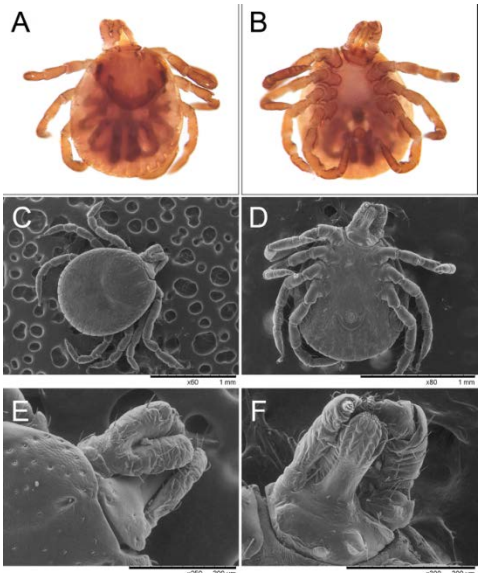
Current Populations of Lone Star Ticks (*Amblyomma americanum*) in the Northeastern United States.

Impact: Rising global temperatures, ecologic changes, reforestation, and increases in commerce and travel are important underlying factors influencing the rate and extent of range expansion for ticks and associated disease-causing pathogens. It is anticipated that warming temperatures associated with climate change may lead to the continued geographic range expansion and abundance of the lone star tick, increasing its importance as an emerging threat to humans, domesticated animals, and wildlife.

3. Investigating Morphological Anomalies in *Ixodes scapularis*, *Amblyomma americanum*, and *Dermacentor variabilis*, the three Main Tick Vectors of Human Pathogens in the United States

(Goudarz Molaei and Eliza Little)

Reports of morphological abnormalities in ticks, especially in *Ixodes scapularis*, *Amblyomma americanum*, and *Dermacentor variabilis*, as the three main vectors of human pathogens in the United States, are exceedingly rare. Only within the past few years have morphological abnormalities in *I. scapularis* ticks been documented in the upper Midwestern and Northeastern United States. While recent reports of morphological anomalies may simply reflect a new research interest, these abnormalities in ticks may also be on the rise. Studies suggests ticks with exoskeletal anomalies may have greater infections with disease agents and may also have more multiple simultaneous pathogen infections than morphologically normal ticks. We are investigating morphological anomalies in ticks and have already identified and reported 3 cases: the first was a dwarf tick in 2015, the second a nine-legged tick reported in 2017, and the third an adult female seven-legged *I. scapularis*, which we believe is the first report of this type of morphological abnormality in this important tick species. In continuation of our studies on morphological abnormalities, we herein describe a case of morphological anomalies in *Amblyomma americanum*, a medically important species associated with several human diseases and medical conditions. Based on morphological characters using dichotomous morphological keys, high resolution light microscopy, and scanning electron microscopy imaging, the tick was identified as an *Am. americanum* nymph exhibiting various morphological anomalies including ectromely associate with asymmetry, olygomely (lack) of the fourth left leg, and schizomely (bifurcation of palpus) on the right side. We believe this is the first report of the presence of several spontaneous anomalies in one *Am. americanum* specimen. Morphological identity of the specimen was corroborated by DNA sequencing of the mitochondrial 16S region.



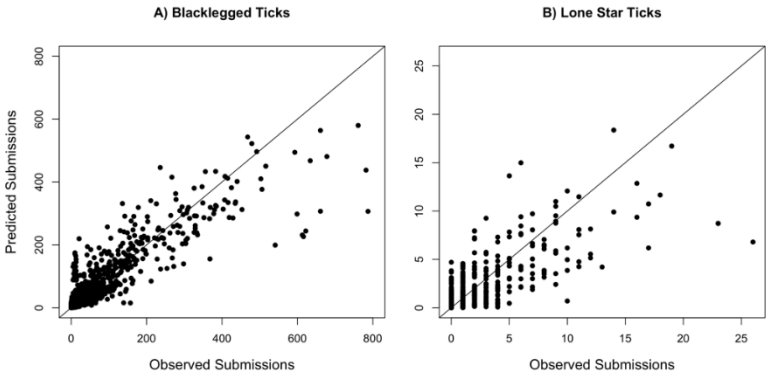
Dissecting light microscopy images, A, dorsal and B, ventral; and scanning electron micrographs, C, dorsal, D, ventral, E, dorsal view of capitulum, F, ventral view of capitulum of the seven-legged and three palpi in *Amblyomma americanum*.

Impact: Given the difficulties in species identification of tick specimens with morphological abnormalities and potential implications in pathogen transmission, further investigations of teratologies in ticks are needed. Accurate morphological identification of tick specimens is also important for understanding of species abundance and diversity, as well as determining which specimens require examination for the evidence of infection. Furthermore, descriptions of morphological anomalies in the literature will help further our collective understanding of the cause(s) and implications of morphological anomalies in ticks.

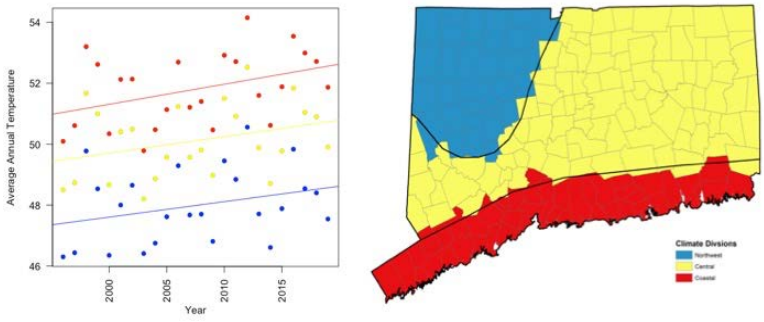
4. Climatic and Environmental Determinants of the Spatial Distribution and Abundance of Disease Vectors Blacklegged tick, *Ixodes scapularis*, and Lone Star tick, *Amblyomma americanum*

(Goudarz Molaei, Eliza Little, Kirby Stafford III)

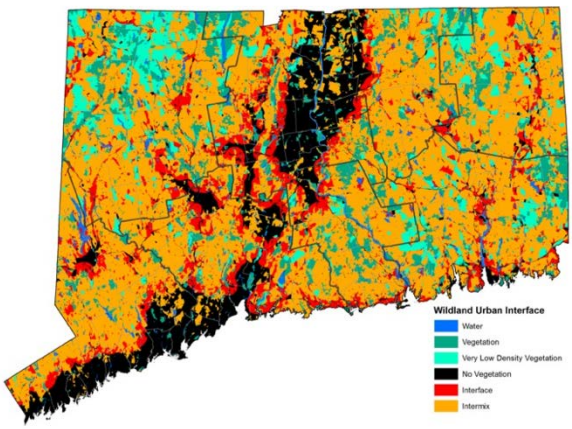
Ticks and tick-borne diseases are increasingly becoming a major public health and veterinary concern. Two key tick vectors are the blacklegged tick (Ixodes scapularis) and lone star tick (*Amblyomma americanum*). Understanding the ecological conditions underpinning vector populations is critical to making effective recommendations that reduce tick-borne disease risk. Here we developed spatially explicit statistical models using ecological principles to link extensive tick surveillance to mean annual temperature and the Wildland-Urban Interface. We found that the submission rate of blacklegged ticks, endemic in Connecticut, is not associated with temperature while the submission rate of lone star ticks, a species recently reported to be established in Connecticut, was positively associated with temperature. We linked land use metrics from the Wildland-Urban Interface with blacklegged and lone star tick submission rates. Blacklegged tick submission rates were higher in towns with a higher proportion of land classified as intermix, areas where houses and vegetation mix. Lone star tick submission rates were higher in towns with a lower proportion of very low-density vegetation and higher mean annual temperature.



A) Observed versus predicted blacklegged tick submissions to the CAES-TTL (Spearman's rank correlation coefficient is 0.9), and B) observed versus predicted lone star tick submissions to the CAES-TTL (Spearman's rank correlation coefficient is 0.8).



Climate divisions in Connecticut. Annual mean temperature plotted over time for each climate division. Colors of dots correspond to each climate division (e.g., blue dots represent the northwest climate division).



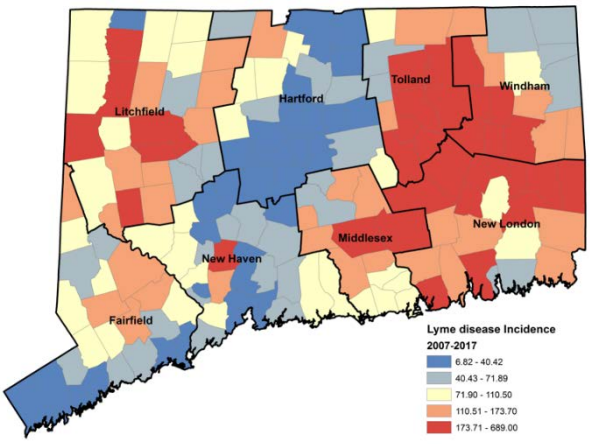
Wildland Urban Interface (WUI) classes used in analysis.

Impact: With undisrupted, uncoordinated land use development and continued, unabated climate change the abundance of ticks and incidence of tick-borne diseases will continue to increase in the northeastern U.S. Efforts to coordinate land use development and mitigate climate change are necessary measures to reduce these risks.

D. Passive Tick Surveillance and Testing Program for Assessing Human Health Risk with Tick-borne Diseases

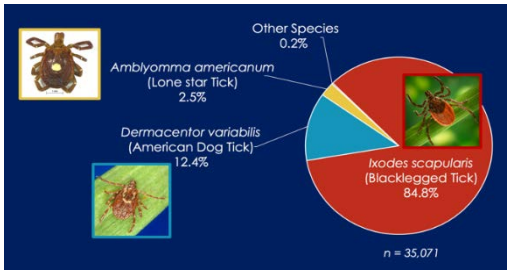
(Goudarz Molaei assisted by Noelle Khalil and Sara Bonello)

Ticks and tick-borne diseases are increasingly becoming a major public health concern. In the United States, the number of reported cases of tick-borne diseases has more than doubled between 2004 and 2016, and according to the Centers for Disease Control and Prevention (CDC), over 80% of the nationally notifiable vector-borne disease cases are transmitted by ticks. Lyme disease (LD) is the most commonly reported vector-borne disease in the United States and affects an estimated 329,000 people annually and can cause severe damage to joints and the nervous system. Connecticut is among the 14 states from which nearly 95% of LD cases in the United States are reported, and it had the 7th highest incidence per 100,000 population (n = 1859, number of confirmed and probable cases) in 2018.



Lyme Disease Incidence in Connecticut, 2007-2017.

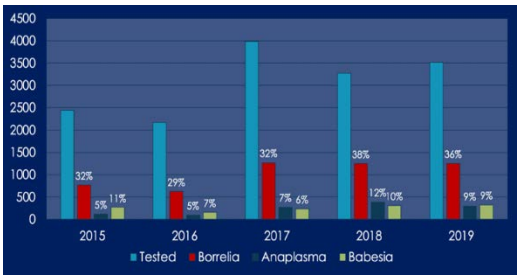
The CAES Tick Testing Program was established in 1990. Each year, an average of 3,000 ticks are submitted for testing. However, in recent years, the number of submissions has substantially increased. In 2019, the CAES Tick Testing Laboratory received a total of 4,661 ticks. In the past, testing was limited to *Borrelia burgdorferi*, the LD agent, but in view of increasing human cases of tick-related illnesses in the state, testing has been expanded to include *Anaplasma phagocytophilum*, the causative agent of human granulocytic anaplasmosis, and *Babesia microti*, the causative agent of babesiosis. Of the total of 4,661 ticks submitted by Connecticut residents, health departments and/or physicians' offices, 3,760 (80.8%) were identified as *I. scapularis* (blacklegged tick), 749 (16.1%) as *Dermacentor variabilis* (American dog tick), 145 (3.1%) *Amblyomma americanum* (lone star tick), and 7 (0.2%) a few other species. Of the 3,517 engorged nymph and adult *I. scapularis* examined, 35.7% tested positive for LD; 9.4% for babesiosis; and 8.6% for anaplasmosis. Coinfections with *B. burgdorferi* and *B. microti* were identified in 5.1%; *B. burgdorferi* and *A. phagocytophilum* in 4.5%; *B. microti* and *A. phagocytophilum* in 1.2%; and with all three pathogens/parasites in 0.9%.



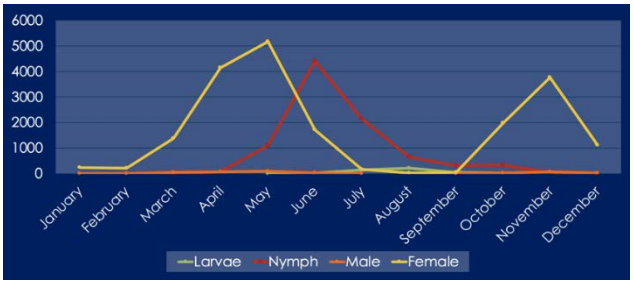
Tick Species Abundance and Composition in Connecticut, 2010-2019.

Ixodes scapularis Infection with *Borrelia burgdorferi* in Connecticut, 2010-2019.

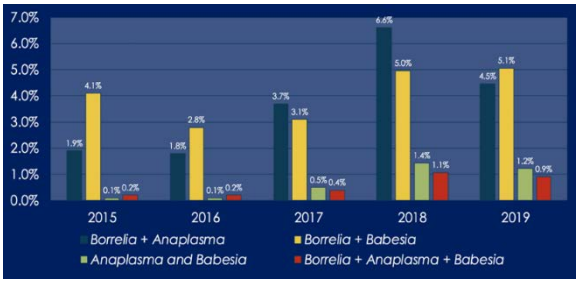
Impact: As a passive surveillance, testing human-biting ticks provides important spatial and temporal information on infection rate and the risk of human infection with tick-borne pathogens including, *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, and *Babesia microti*, the causative agents of Lyme disease, human granulocytic anaplasmosis, and babesiosis, respectively, in Connecticut. Tick testing results generated by this passive surveillance, in conjunction with other lines of evidence, can also be used to make important decision as to whether treatment is required.



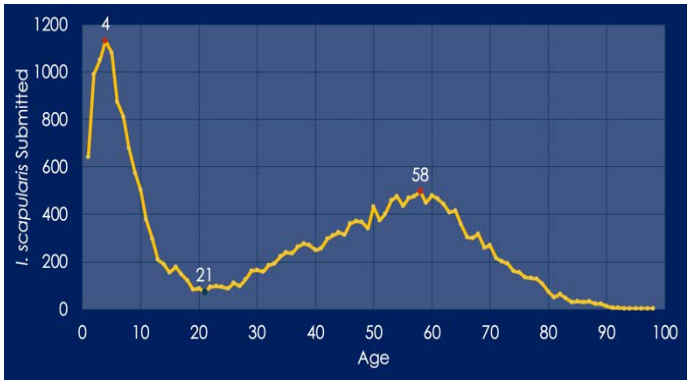
Ixodes scapularis Infection Rate with *Borrelia*, *Anaplasma*, and *Babesia* in Connecticut, 2015-2019.



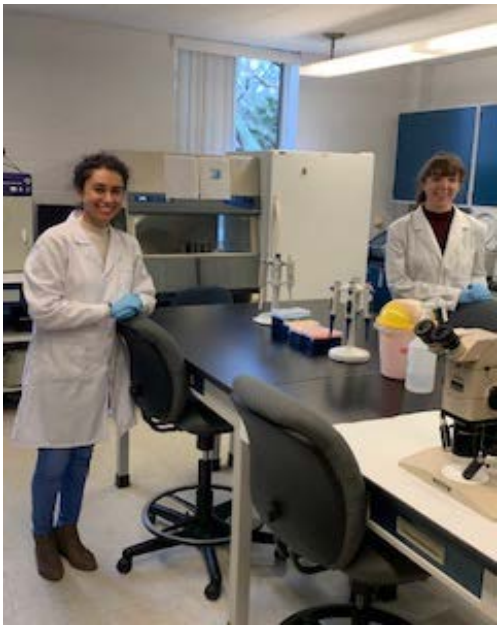
Nymph and Adult *Ixodes scapularis* Submissions by Month, in Connecticut, 2008-2018.



Ixodes scapularis Co-infection with *Borrelia*, *Anaplasma*, and *Babesia* 2015-2019.



Age Groups of Connecticut Residents Bitten by Blacklegged Tick, 2010-2019.



CAES Tick Testing Laboratory Staff Noelle Khalil (left), Sarah Bonello (right).

E. Active Tick Surveillance Program to Assess Public Health Risk for Tick-borne Pathogens
(Doug Brackney, Kirby Stafford, Scott Williams, Megan Linske, and Duncan Cozens)

The increasing prevalence of Lyme disease (LD) and the emergence of other human tick-associated diseases in the United States have become major public health concerns. To gain a better understanding of the risk associated with these diseases we have initiated a statewide tick surveillance program in order to determine the distribution and abundance of the black-legged tick as well as the prevalence of not only Lyme disease but also babesiosis, anaplasmosis, and Powassan virus encephalitis. Further details on this program are given in the Entomology Department section.

IV. ENVIRONMENTAL MICROBIOLOGY

A. Employing Experimental Systems to Characterize Wetland Responses to Disturbance
(Blaire Steven)

Our overarching objective is to better understand how interactions between plant community composition and water quality alter freshwater wetland carbon fluxes. We conducted a wetland mesocosm experiment to investigate how plant traits of three common wetland plants (*Typha latifolia, Phragmites australis, Spartina pectinata*) and three water quality impairments (i.e., sea salt, road salt, N-enrichment) interact to alter carbon gas flux and sediment microbial community composition (Figure 1). We found aboveground biomass to be positively correlated with CO_2 uptake and CH_4 emissions across species. We further showed that salt addition reduced biomass production relative to fresh-water controls, and thus reduce CO_2 uptake and CH_4 emissions. Our data clearly show that different perturbations affect the productivity of wetland ecosystems. We are currently employing a wetland marsh organ experiment to test the effects of sea level rise on the wetland plants and microbes. Our initial observations suggest that the increased salt-water intrusion has minor but significant effects on plant activity and microbial populations.

Figure 1. A) Wetland mesocosms at the University of Connecticut campus. Perturbations consist of nitrogen, road salt, and sea salt additions. B) Marsh organ experiment. The pipes are set up to alter the relative position of the plants in reference to the tide. In this way we can test how increased tidal inundation (as will happen with sea level rise) affects the plant and microbial communities.

B. Characterizing the Development of the Apple Flower Microbiome in the Presence of the Fire Blight Pathogen *Erwinia amylovora* (Blaire Steven, Zhouqi Cui, and Quan Zeng)

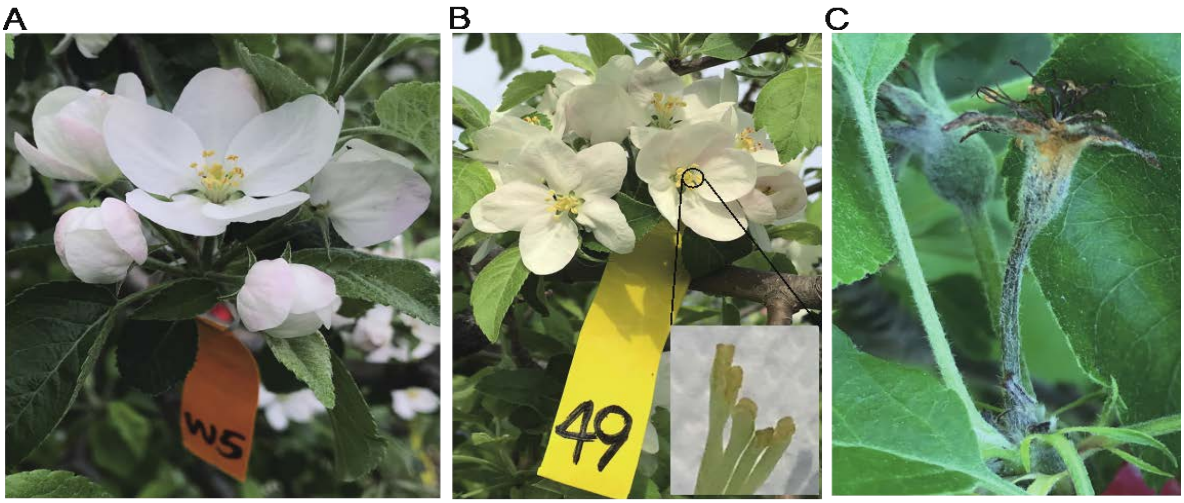


Figure 2. A) Flower clusters were individually tagged and sprayed with target organisms. B). Stigmas (inset diagram) were collected from individual flowers to measure the presence of the inoculated bacteria, while the remaining flowers were left to determine disease development. C). A flower with symptoms of fire blight.

Fire blight, caused by the bacterial pathogen *Erwinia amylovora*, is one of the most devastating diseases of apples and pears. We are studying how the apple flower microbiome develops in the presence of the flowers were sprayed with *E. amylovora* and assessed for microbiome composition (Figure 2). *E. amylovora* was identified on all of the flowers, however several flowers showed lower pathogen counts, which was also associated with the presence of unique taxa. We are currently screening isolates from these taxa for an ability to inhibit fire blight. These data show that certain bacteria have the potential to influence the development, progression, and severity of fire blight. We have found disease reduction of up to 45%. We hope that by understanding interactions in the microbiome we can design even more effective biocontrols.

C. Mosquito Species Recruit an Overlapping Set of Bacteria from the Environment
(Blaire Steven, Doug Brackney, Josephine Hyde)

The presence of a host associated microbiota or the "microbiome" (the collection of bacteria living on or in animals) is a commonality shared among most animals including mosquitoes. Yet, there are significant knowledge gaps concerning how these bacteria are acquired from the environment. We have recently developed a method to remove the bacteria from mosquito larvae and recolonize them. When bacteria were removed from three species of mosquitoes; *Aedes aegypti*, *Aedes albopictus,* and *Ochlerotatus triseriatus* and they were exposed to the same water source, they recruited an overlapping set of bacteria from the water (Figure 3). This suggests that particular bacteria are especially adept at colonizing mosquito hosts. We are in the process of characterizing these bacteria to gain a sense of what constitutes a successful mosquito colonizing species.

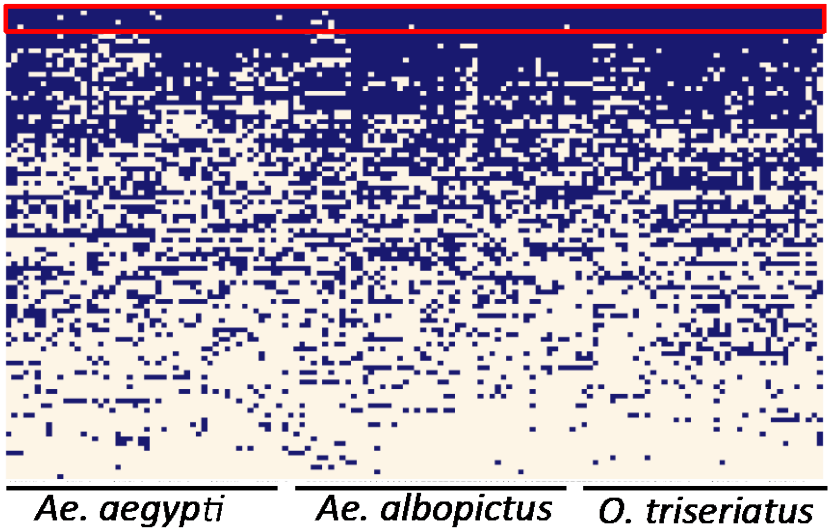
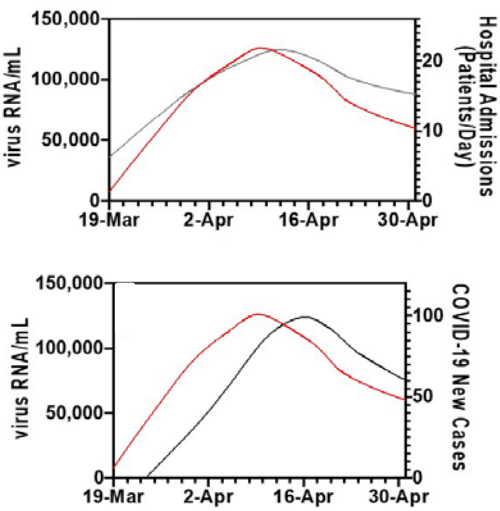


Figure 3. Presence absence heat map of bacterial species identified in three species of mosquitoes. Each row is a bacterial species and columns are individual mosquitoes. The blue color indicates bacterial presence. The red box shows 4 bacterial species that were identified in > 90% of individual mosquitoes.

D. Environmental Surveillance of SARS-CoV-2

1. Community level surveillance of SARS CoV-2 activity.
(Doug Brackney and Yale Collaborators)

The most common metric followed to track the progression of the COVID-19 epidemic within communities is derived from testing symptomatic cases and evaluating the number of positive tests over time. However, tracking positive tests is a lagging indicator for the epidemic progression. Testing is largely prompted by symptoms, which may take up to five days to present, and individuals can shed virus prior to exhibiting symptoms. There is a pressing need for additional methods for early sentinel surveillance and real-time estimations of community disease burden so that public health authorities may modulate and plan epidemic responses accordingly. SARS-CoV-2 RNA is present in the stool of COVID-19 patients and has recently been documented in raw wastewater. Thus, monitoring raw wastewater (sewage) within a community's collection system can potentially provide information on the prevalence and dynamics of infection for entire populations.



To test this, we initiated a surveillance program in New Haven county that monitors SARS-CoV-2 RNA in primary sewage sludge to see if such data was useful as an indicator of community-wide SARS-CoV-2 activity. Thus far, we have found that SARS-CoV-2 RNA concentrations in sewage sludge were a leading indicator of community outbreak dynamics over hospitalization and compiled COVID-19 testing data. SARS-CoV-2 RNA concentrations led hospital admissions by 3 days and COVID-19 cases by 7 days.

2. SARS-CoV-2 Diagnostics
(Doug Brackney and Yale Collaborators)

Table 10: Limit of detection of SalivaDirect

Proteinase K					
Proteinase K	*RT-qPCR kit*	*RT-qPCR instrument*	*LOD*	*Positive replicates*	*Mean Ct value (SD)*
Thermo	NEB Luna	Bio-Rad CFX96	6 copies/µL	100% (20/20)	36.7 (1.0)
NEB	NEB Luna	Bio-Rad CFX96	6 copies/µL	100% (20/20)	35.6 (0.4)
AmericanBio	NEB Luna	Bio-Rad CFX96	6 copies/µL	100% (20/20)	35.5 (0.4)
RT-qPCR kit					
Proteinase K	*RT-qPCR kit*	*RT-qPCR instrument*	*LOD*	*Positive replicates*	*Mean Ct value (SD*
Thermo	Bio-Rad Reliance	Bio-Rad CFX96	6 copies/µL	100% (20/20)	36.4 (0.6)
Thermo	Thermo TaqPath	Bio-Rad CFX96	12 copies/µL	100% (20/20)	35.9 (1.2)
RT-qPCR instrument					
Proteinase K	*RT-qPCR kit*	*RT-qPCR instrument*	*LOD*	*Positive replicates*	*Mean Ct value (SD*
Thermo	Thermo TaqPath	ABI 7500 Fast	12 copies/µL	95% (19/20)	36.8 (1.2)
Thermo	Thermo TaqPath	ABI 7500 Fast Dx	6 copies/µL	95% (19/20)	32.4 (0.9)

Table 12: Qualitative outcome of parallel testing of paired nasopharyngeal swabs and saliva with SalivaDirect and the ThermoFisher Scientific TaqPath COVID-19 kit.

		TaqPath RT-PCR COVID-19 Nasopharyngeal swab	
		Positive	Negative
SalivaDirect Saliva	Positive	32	**3***
	Negative	2	30
Total		34	33

Positive agreement = 94.1% (32/34)
Negative agreement = 90.9% (30/33)

** Paired saliva tested positive with SalivaDirect and TaqPath RT-PCR COVID-19 kit*

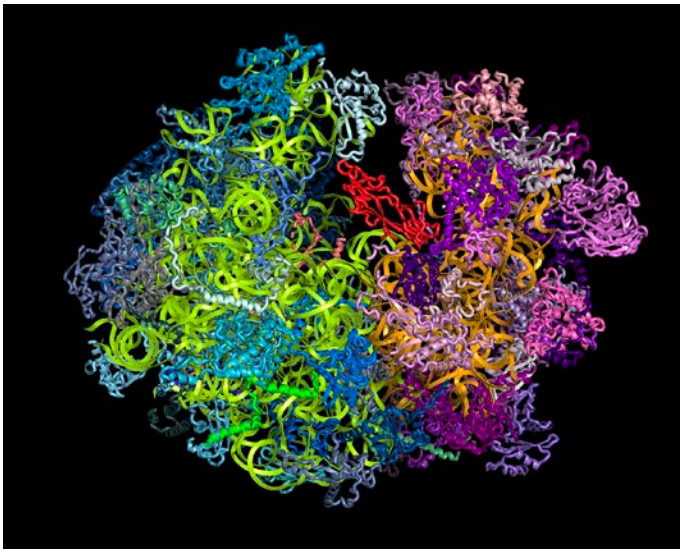
The scale and speed with which SARS-CoV-2 swept across the country left many public health departments scrambling to implement accurate and timely diagnostics protocols. With few FDA approved diagnostic tests and procedures available most diagnostic facilities were forced to adhere to strict protocols with specific reagents and equipment. Consequently, there were and still are shortages for many of these reagents. In addition, the approved sampling method, nasopharyngeal swabs (NP swabs), was moderately invasive and only ~70% accurate in large part due to variation in sampling technique.

To address these problems, researchers at CAES have partnered with scientists at Yale University to develop a more universally acceptable diagnostic protocol combined with a non-invasive and uniform sampling method. Thus far we have found that saliva is just as good or better than NP swabs when it comes to identifying infected individuals. Further, saliva can be used directly with the diagnostic test thereby eliminating the need for reagents and equipment associated with performing RNA extractions, a central step of the initial FDA approved diagnostic strategy. The SalivaDirect test further reduces costs by combining all three of the genetic markers into a single assay reducing assay costs by 66%. Because the initial test was certified for only specific reagents and machines the SalivaDirect protocol has been validated across a number of reagents and machines. If implemented, this will reduce strain on the production of specific reagents resulting in more manufacturers being able to provide needed expertise and resources during the current pandemic. Lastly, we have also been testing the suitability of using the SalivaDirect assay on pooled saliva samples. Such improvements on testing would significantly improve testing capabilities as society and schools begin to re-open. The initial results are promising as we continue to optimize the protocol. The assay is currently being prepared for submission to the FDA for Emergency Use Authorization.

E. The Microsporidia

1. Three-dimensional structure of the Microsporidial ribosome.
(Charles R. Vossbrinck)

Dr. Vossbrinck, along with Jonas Barandun at the University of Umea, Umea, Sweden, and his colleagues, have published the three-dimensional structure of the ribosome from the microsporidial parasite *Vairimorpha necatrix*. We have discovered a "dormancy" factor that may be shutting down protein synthesis or protecting the ribosome from external factors during its spore stage. Microsporidia are devastating parasites of the world's two most important domesticated insects, honey bees and silkworms. We have submitted a grant proposal to the USDA in an effort find antibiotic (anti-microsporidial) compounds that can be fed to the bees to allow them to stop this parasite from killing them and thus destroying beehives. We propose to take a two-pronged approach. First to test compounds in the lab to see if they block ribosome function and second to make three-dimensional models of the ribosome using a computer to see if there is a compound that is likely to block the ribosome's active site and test those compounds. In either case we propose to test the compounds on honey bees in the field.



The three-dimensional structure of the microsporidial ribosome showing the various proteins and RNAs in different colors. The dormancy factor is in the middle of the structure in red.

Spores of *Vairimorpha necatrix*, our model species, a close relative of the highly pathogenic honey bee microsporidian *Vairimorpha ceranae*.

2. A new species of microsporidia infecting the spotted winged fruit fly *Drosophila suzuki*.
(Charles R. Vossbrinck and colleagues)

Working with a student, Sarah Biganski and scientists from the Institute for Biological Control at the Federal Research Centre for Cultivated Plants at the Julius Kuehn Institute in Darmstadt, Germany, we have discovered and are describing a new species of microsporidia. This species of parasite is of particular interest as a biological control agent because it infects the very harmful fruit fly *Drosophila suzukii*. This small fly has now invaded much of the United States, including all regions of Connecticut and can be found in the fruits of raspberries, blueberries, figs, cherries, blackberries as well as many wild or native fruits such as yew, wineberry, and chokecherry. This recently discovered microsporidial parasite has potential for infecting and controlling this destructive spotted winged fruit fly.

3. The Asian honey bee, *Apis cerana*, in China.
(Charles R. Vossbrinck and Jinshan Xu)

In cooperation with colleagues in China, we have completed a population analysis of the Asian honey bee, *Apis cerana*, in that country. What we, in Connecticut, refer to as the honey bee, *Apis mellifera*, is a species brought over from Europe by the pioneers. There were no honey bees in North America prior to that time. In Asia, there is a separate species of honey bee, *Apis cerana*, used on honey production in China and elsewhere. We have compared honey bees from various locations and have identified several genes that are responsible for helping the Asian honey bee to adapt to different conditions of temperature and humidity. We are starting to understand the evolutionary adaptations honey bees have evolved to cope with these various conditions at the genomic level.

A comparison of the Asian honey bee, *Apis cerana* (Left) and the European honey bee, *Apis mellifera* (Right), which we culture for honey in Connecticut. The Asian honey bee is smaller, less hairy, slenderer, and faster in flight.

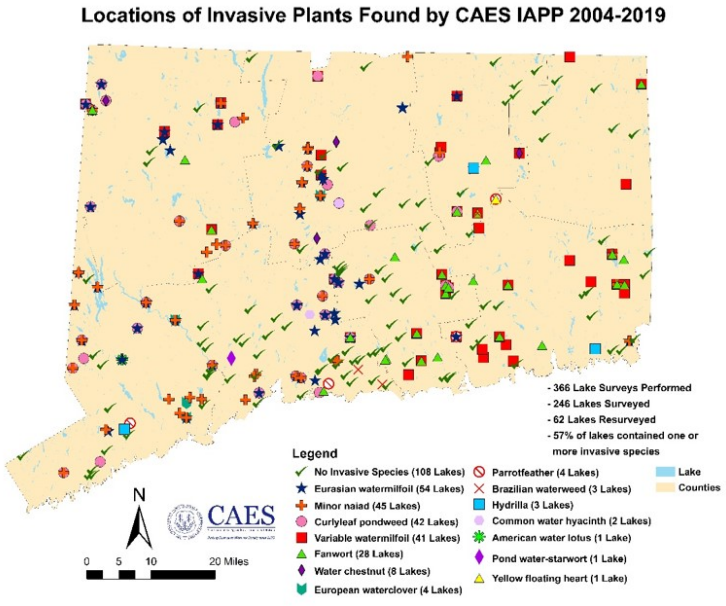
V. INVASIVE AQUATIC PLANT PROGRAM

(Gregory Bugbee and Summer Stebbins)

We are quantifying the locations of invasive aquatic plants in Connecticut's lakes and ponds, determining their effects on native plant communities, establishing baseline data to track their spread and providing information that is critical for management strategies.

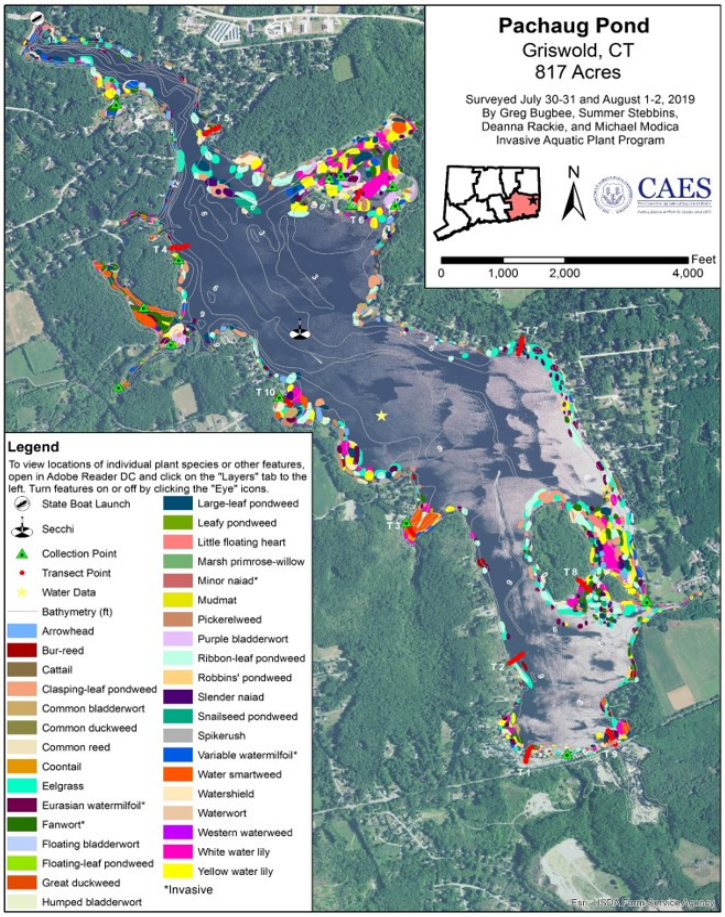
A. Surveillance and Monitoring

Since 2004, the Connecticut Agricultural Experiment Station Invasive Aquatic Plant Program (CAES IAPP) has completed 366 aquatic vegetation surveys of 246 Connecticut lakes and ponds. A total of 62 waterbodies have been resurveyed to determine how invasive plants are changing the quality of lakes and the effectiveness of management practices over time. In fiscal year 2019-2020, Gregory Bugbee and staff mapped the aquatic vegetation in three new and nine previously surveyed waterbodies. Lake Candlewood, Connecticut's largest lake, was surveyed for the 11th consecutive year to determine the effects of deep and shallow winter drawdown and recently introduced grass carp *(Ctenopharyngodon idella)* on Eurasian watermilfoil (*Myriophyllum spicatum*), minor



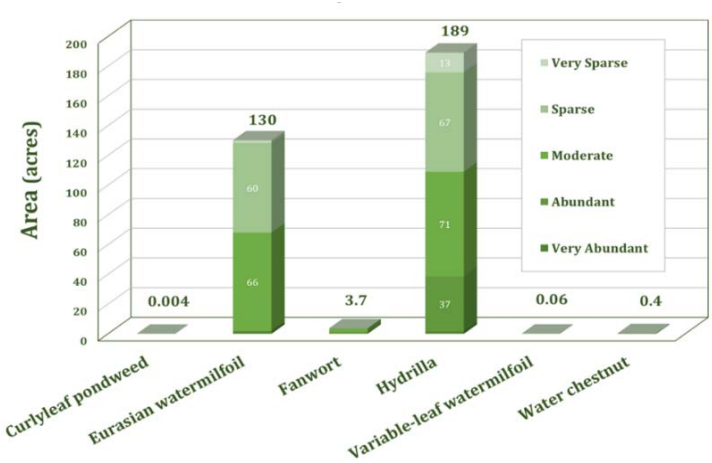
Locations of invasive plants in Connecticut's lakes and ponds as found in CAES IAPP surveys from 2004-2019.

naiad (*Najas minor*), and curlyleaf pondweed (*Potamogeton crispus*). Nearby Squantz Pond was also surveyed. We established transects in each waterbody using global positioning systems to quantify changes in native and invasive aquatic species abundance and distribution. We collected water samples and analyzed them for pH, temperature, dissolved oxygen, clarity, alkalinity, conductivity, and phosphorus. This data, along with watershed information, is being used to investigate the factors that influence the susceptibility of waterbodies to individual invasive species. We archived dry specimens of all plant species in the CAES herbarium for future reference. We designed our Invasive Aquatic Plant Program to utilize the latest digital technology to rapidly and comprehensively report our findings to the public. Lake survey maps and other data are published online (http://www.portal.ct.gov/caes-iapp). Nearly 60 percent of the waterbodies contained one or more invasive plant species and some lakes contained as many as four invasive plant species.



Aquatic vegetation survey of Pachaug Pond 2019.

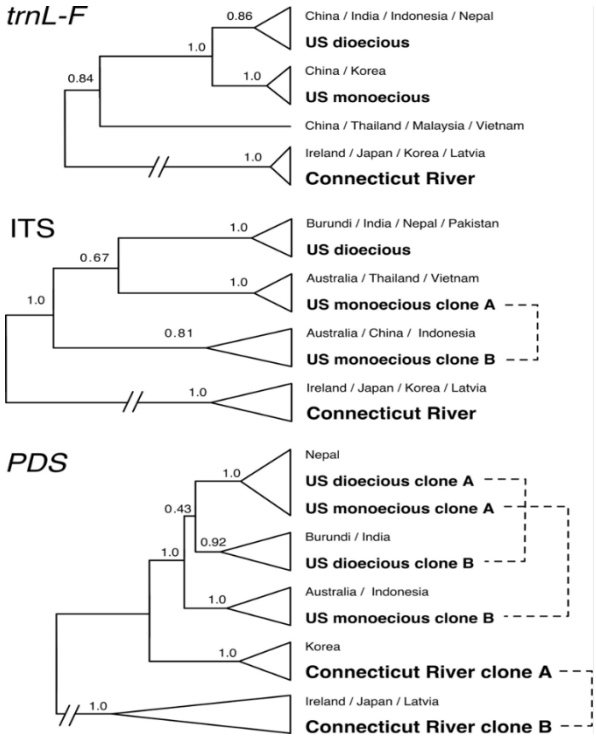
The most common invasive plants are Eurasian watermilfoil, variable watermilfoil (*Myriophyllum heterophyllum)*, minor naiad, curlyleaf pondweed, and fanwort *(Cabomba caroliniana*). Less common are water hyacinth (*Eichhornia crassipes*), water shamrock (*Marsilea quadrifolia*), hydrilla (*Hydrilla verticillata*), and water chestnut (*Trapa natans*). Our 2009 survey of Fence Rock Lake in Guilford discovered Connecticut's first infestation of Brazilian waterweed (*Egeria densa*) and our resurveys in 2010, 2011, 2012, and 2013 found the population expanding. We have since found Brazilian waterweed in Lower Moodus Reservoir (East Haddam), Staffordville Reservoir (Stafford Springs), and Mono Pond (Coventry). We tested the efficacy of a CT DEEP approved herbicide in Fence Rock Lake and eliminated the plant. We have surveyed Pachaug Pond from 2017 - 2019 to document changes in aquatic vegetation over time. In the early spring of 2018, the level of Pachaug Pond was lowered 1-2 m and then raised to normal by summer. Our surveys found similar occurrence and species richness of aquatic plants between



Acreages of invasive aquatic plants in the southern portion of the Connecticut River.

the three years, but the abundance had decreased throughout the center of the lake. These results suggest early spring lake drawdowns may be an alternative to the typical winter drawdowns.

Hydrilla is a destructive invasive aquatic plant in many southern states. Following reports of the plant occurring in the Connecticut River, a task force led by the CAES IAPP was formed. Comprising over 30 experts from throughout the northeast, the task force performed preliminary surveillance of the river from central Vermont to southern Connecticut in 2018. Hydrilla was not found in New Hampshire or Vermont and the first sightings were just north of the Massachusetts/Connecticut border. Travelling south, *Hydrilla* became common, creating large dense stands between Hartford and East Haddam.



Connecticut River *Hydrilla* is genetically unique from other strains.

The *Hydrilla* found in the river is more robust than seen elsewhere in Connecticut. CAES IAPP in collaboration with the University of Wisconsin-Whitewater, performed genetic tests on the Connecticut River *Hydrilla* and found it to be a different strain than previously found in North America. This could mean the plant has an enhanced ability to spread, harm aquatic ecosystems and resist current control practices. Movement of the CT River *Hydrilla* to lakes and ponds via fragments on trailered boats and wildfowl is of utmost concern. In 2019 CAES IAPP was commissioned to survey the river from Haddam to Long Island Sound. Results found extensive areas of hydrilla, Eurasian watermilfoil and lesser areas of other invasive species. We will survey the remainder of the CT portion of the river in 2020 and begin investigating hydrilla management options.

B. Control Technologies

The goals of this objective are 1) to research novel means of control that minimize herbicide usage and protect native vegetation and 2) to investigate non-chemical management options such as winter water level drawdown.

CAES IAPP led treatment of variable watermilfoil in Bashan Lake with ProCellaCOR.

1. <u>Herbicides.</u>

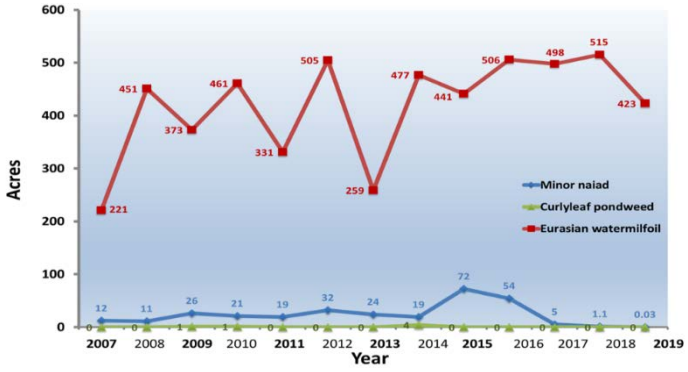
Novel methods of chemical control with herbicides can rapidly remove invasive plants and begin to restore native plant communities to aquatic ecosystems.

Bashan Lake – East Haddam, CT. We are in the 18th year of research involving the use of spot applications of herbicides to control variable watermilfoil in Bashan Lake. We had largely restored the lake to preinfestation conditions prior to lowering the lake for

dam repairs in 2014. Surveys of Bashan Lake in 2018 found a regrowth of variable watermilfoil and a number of areas where phragmites (*Phragmites australis*) had become established. A new herbicide called ProCellaCOR was registered in 2018 for use on variable watermilfoil. In collaboration with the Bashan Lake Association, the Town of East Haddam, SePro Corp., and Solitude Lake Management Inc., a targeted application of the new product was administered to variable watermilfoil in late September. Control attributed to the ProCellaCOR treatment was excellent in all sites except for the south cove where most of the variable watermilfoil was unaffected. These areas were retreated in June 2020.

2. Winter water level drawdown and grass carp.

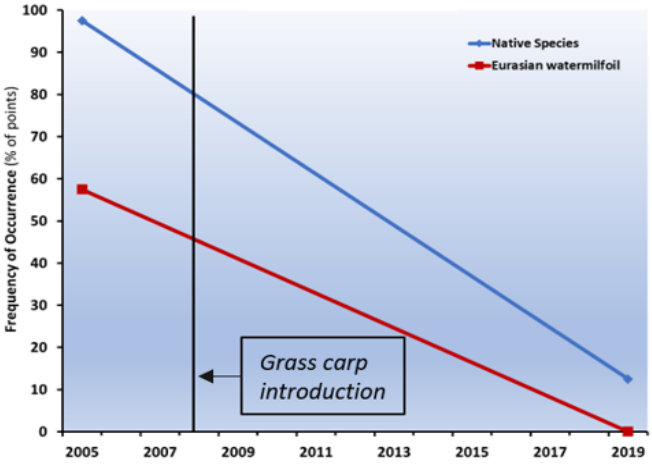
Candlewood Lake - Brookfield, New Fairfield, New Milford, Sherman, CT. Candlewood Lake's aquatic plant community is dominated by Eurasian watermilfoil. Winter water level drawdown has been used for decades to manage the plant. In 2015 and 2017, a total of nearly 10,000 sterile plant-eating grass carp were introduced to provide additional control. Using state-of-the-art geospatial technology, we have documented the success of the drawdowns each year since 2007 and have begun to determine the effects of the grass carp. The surface coverage of milfoil shows a negative relationship to drawdown depth. Eurasian water milfoil reductions attributable to the grass carp appear to be substantial in many shallow coves and less so in most of the lake. As the grass carp get larger and consume more vegetation this would be expected to change. Both Taunton Lake in Newtown and Lake Waubeeka in Danbury have received grass carp introductions. CAES IAPP surveillance has found over time excessive plant reduction is possible.



The effects of winter drawdown depth on the acreage of Eurasian watermilfoil in Candlewood Lake (deep drawdown years in bold).

3. Benthic barriers.

Lake Quonnipaug - Guilford, Bashan Lake - East Haddam, and Lake Beseck - Middlefield. Benthic barriers are blankets designed to be placed over nuisance vegetation in lakes and ponds. They provide an alternative to herbicides and are thought to control vegetation by blocking the light aquatic plants need to grow. Benthic barriers are not new; they are typically placed over weed beds early in the growing season and removed in the fall. Recently, marketers of benthic barriers have claimed that their products need only be placed over weeds for a few weeks and then moved to another location or removed. To test this practice, we collaborated with the Towns of Guilford and Middlefield and placed benthic barriers at the Lake Quonnipaug and Lake Beseck public beaches. The beaches had problems with Eurasian watermilfoil and other invasive and native aquatic plants. We placed the benthic barriers in April and removed them within two months. The



The effects of grass carp on aquatic vegetation in Lake Waubeeka, Danbury.

results are promising with little vegetative regrowth throughout the summer. We are also testing the use of benthic barriers to control a pioneer infestation of fanwort in Bashan Lake. Further tests are needed to determine why these barriers provide impressive weed control even when they are used for short periods of time.

C. Outreach

We strive to disseminate all information from our program to the public in a timely fashion and educate stakeholders in the identification, prevention, and management of invasive aquatic species. We make every effort to engage citizens, lake associations, and other stakeholders. CAES IAPP scientists have organized several workshops on the identification of invasive aquatic plants. We also have given presentations to professional organizations such as the Northeast Aquatic Plant Management Society, the Northeast Aquatic Nuisance Species Panel, and the Connecticut Federation of Lakes. In addition, CAES IAPP staff members speak to numerous lake associations, town meetings, and student groups such as the Connecticut Envirothon. We have made our information freely and readily available via our website. Included are digitized interactive lake maps, our herbarium, and publications (http://www.portal.ct.gov/caes-iapp).

Invasive aquatic plant workshop at the 2020 high school Envirothon.

Talk on lawn care during drought presented via tele-conference provided by the New Canaan Public Library.

Our invasive aquatic plant control and outreach efforts have resulted in the protection of lakes and provided scientifically proven methods for use by others. Our workshops have trained hundreds of citizens to recognize and report new infestations in order to prevent future problems and the associated control expenditures.

VI. SOIL TESTING LABORATORY
(Gregory Bugbee)

Testing soil samples for fertility and suggesting methods for growing better plants are provided for citizens of Connecticut. At the laboratory in New Haven, 6,457 samples were tested and approximately 1,500 related inquiries were answered.

The soil testing services and recommendations made by the Connecticut Agricultural Experiment Station reduce unnecessary fertilizer treatments to lawns and nursery stock throughout the state. This provides direct economic and environmental benefit to the suburban community by reducing nitrogen runoff into soil and water.

DEPARTMENT OF FORESTRY AND HORTICULTURE

Connecticut's landscape is a quilt of forests, farms, towns, and cities. Scientists in the Department of Forestry and Horticulture are studying the factors that influence both forest and farm productivity, including how trees respond to novel pests and a changing climate, innovative forest management practices, the effect of the growing deer population on natural and managed landscapes, and novel specialty crops.

The value of the forest to Connecticut is much more than the timber and other forest products. First and foremost, forests protect watersheds, aquifers and groundwater supplies that provide the bulk of our clean drinking water. Trees also provide air pollution control, acting as giant filters to remove dust, particulates, and some airborne chemicals. In addition, trees cool our environment in the summer by recycling water and reflecting sunlight. Forests contribute to the character of Connecticut and add to our enjoyment throughout the year.

Deer Herbivory Exclosure Study
(Drs. Scott C. Williams, Megan Linske, and Jeffrey Ward assisted by Mr. Michael R. Short and Joseph P. Barsky)

One method to study the impact of deer on natural ecosystems is to compare growth rates and species diversity of vegetation protected from white-tailed deer (*Odocoileus virginianus*) herbivory to unprotected plots. Drs. Scott Williams and Megan Linske are collecting vegetation data within deer exclosures and adjacent control plots in collaboration with the Metropolitan District Commission (MDC) and the Wildlife Division of the Connecticut Department of Energy and Environmental Protection (DEEP). Deer exclosures prevent deer from accessing vegetation within. Growth rates and species diversity of enclosed vegetation are compared with that of an adjacent control plot, where deer have access to vegetation. Plots have been sampled for woody and herbaceous plants for the past several years. Preliminary data analyses indicate that herbaceous cover within exclosures is greater than control plots. Density of tree seedlings at least two feet tall is twice as high within exclosures compared to control plots. All locations were sampled in late summer 2019 and will be resampled 2020. An additional deer fence was erected on Nepaug Reservoir to investigate impacts to different silvicultural treatments in the presence and absence of deer browsing. Results from this study will reveal plant species composition and growth rates in the absence of browsing deer.

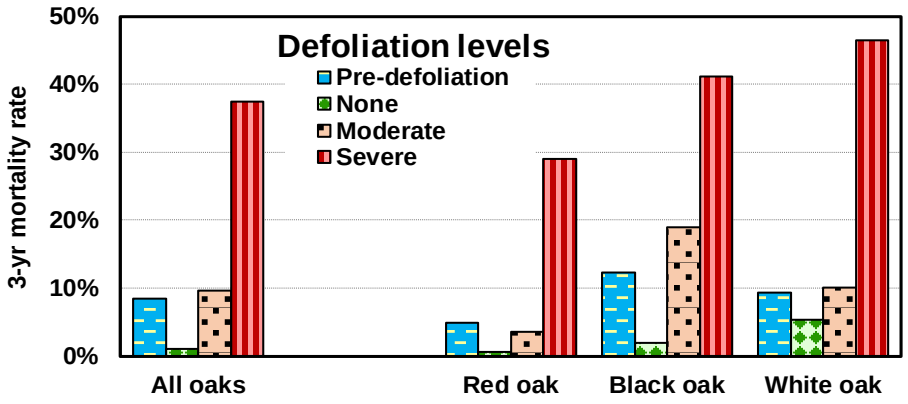
Drs. Scott Williams and Megan Linske and technician Michael Short sampling oak regeneration in a control plot adjacent to a deer exclosure in a recent clearcut, Barkhamsted, CT.

Impact: Overabundant herds of white-tailed deer negatively affect forest regeneration by repeated herbivory. This in turn will negatively affect the future of the timber industry and other wildlife populations in Connecticut. CT DEEP and MDC are using these data to scientifically justify and document the results of their deer management program to limit overbrowsing of vegetation by white-tailed deer to ensure forest regeneration to protect the drinking water supply of greater Hartford. The Metropolitan District Commission will use these data to monitor similar impacts by overabundant deer but as it relates to water quality in terms of minimizing erosion and siltation into surface drinking water bodies.

Impact of multi-year defoliation on oak mortality
(Dr. Jeffrey S. Ward assisted by Mr. Joseph P. Barsky)

Repeated episodes of multi-year defoliations of oak-hickory forests in southern New England during the 1960s-1980s caused widespread regional oak mortality. Populations of the primary defoliator, European gypsy moth (*Lymantria dispar* L.), collapsed with the unanticipated appearance of gypsy moth fungus (*Entomophaga maimaiga*) in 1989 and multi-year defoliations did not occur for decades. The lack of multi-year or widespread outbreaks between 1989-2015 lulled many natural resource managers into believing that multi-year defoliations would no longer occur. However, the fungus did not activate during the exceptionally dry late springs from 2015-2018 and gypsy moth populations exploded.

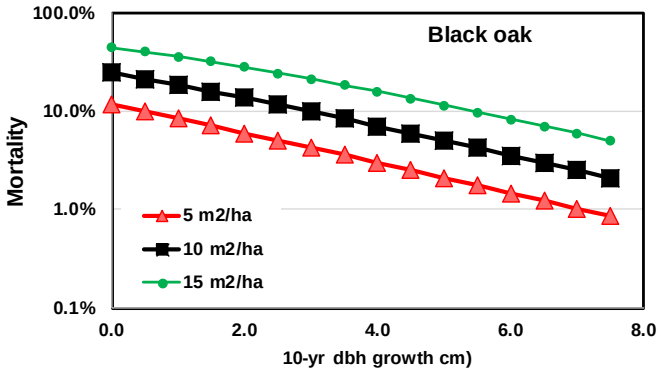
In 2018, Dr. Jeffrey Ward began a study to assess the impact of the return of multi-year defoliations. Because both the spatial and temporal occurrence of multi-year regional defoliation events are unpredictable, we examined the impacts of defoliation on stand level mortality and individual tree mortality and diameter growth using twenty-seven pre-existing study areas located in Connecticut and eastern Rhode Island. Trees had been monitored since at least 2004, 11 years before the latest outbreaks. Typical of most southern New England forests, all study areas were second-growth forests that originated in the early 1900s following a century or more of pasture, cultivation, and/or repeated cutting for charcoal and other wood products. Upper canopies were predominately upland oaks with admixtures of white pine (*Pinus strobus* L.)/black birch (*Betula lenta* L.) on drier sites and red maple (*Acer rubrum* L.)/American beech (*Fagus grandifolia* Ehrh.)/northern hardwoods on more mesic sites. With the possible exception of a few smaller trees, the 3046 oaks included in this study were survivors of several periods of regionwide defoliations between 1961-1982.



Stand level mortality varied among oak species, but consistently increased with increasing defoliation intensity.

Mortality rates were converted to 3-year values to allow direct comparisons of pre- and post-defoliation values. An arcsine transformation of mortality rates was completed to improve normality prior to analyses. Stand mortality was examined using linear mixed model regression with TREAT (managed, unmanaged), DEFOL (none, moderate, severe), and TREAT × DEFOL interaction as fixed factors and study area as the random effect. Pre-defoliation stand level oak mortality averaged 2% and did not differ between stands that had been managed and unmanaged, nor among stands with subsequent no-low, moderate (single year or less than 50% defoliation), and severe defoliations (two or more years of 50% defoliation). We were not able to separate the effects of drought and defoliation on mortality as all sites experienced droughts, some with defoliation, but no sites had defoliation concurrent with normal precipitation. Our study found that drought by itself was not associated with elevated oak mortality levels. Post-defoliation mortality did not differ between managed and unmanaged stands, but was much higher in severely defoliated stands (32%) than in stands with moderate (4%) or low-no defoliation (1%). On plots with severe defoliation, post-defoliation mortality rates were lowest for northern red oak (29%), higher for black oak (41%), and slightly higher again for white oak (46%).

Arsine transformed 3-year mortality rates were also using for examining factors influencing individual tree mortality. Analysis of each oak species was completed using logistic regression with DBH (initial stem diameter) or GROW (pre-defoliation diameter growth); along with categorical factors TREAT and CP (pre-defoliation canopy position) and continuous independent variables DEN (pre-defoliation oak stand density) and BA (pre-defoliation oak stand basal area). The selected models were parsimonious with the lowest Akaike's Information Criterion (AICc). Logistic regression indicated management had no effect on individual tree mortality, and unlike most earlier studies, mortality did not differ by canopy position.



Mortality rates of black oak on moderately defoliated plots increased with stand biomass while decreasing for faster growing trees.

Alenka Mora measuring diameter on an oak tree.

On plots with light to no defoliation, models with only either initial diameter (northern red oak) or pre-defoliation diameter growth (black oak, white oak) were superior to models with canopy class, treatment, initial oak stand density, or initial oak stand basal area. Mortality decreased with increasing diameter and pre-defoliation diameter growth. On plots that had moderate defoliation, post-defoliation mortality rates ranged from 4% for northern red oak, to 10% for white oak, to 19% for black oak. Mortality decreased with increasing diameter and pre-defoliation diameter growth for all three species. The best post-defoliation mortality model for northern red oak included only pre-defoliation diameter growth. For both black and white oak, the best model had both diameter growth and initial oak stand basal area. For a given diameter growth rate, black oak mortality was lower for trees in the upper canopy and higher on plots with greater oak stand basal area. One clear, and disturbing, difference between our study and earlier research was that increased vigor did not necessarily increase survival on severely defoliated stands. We found mortality was lower for faster growing trees on unmanaged, but not managed plots.

Impact: Forest managers should anticipate that oaks that had survived earlier multi-year defoliations may have high mortality rates in future multi-year events. While speculative, this research suggests that some of the differences between earlier and recent defoliation episodes in the relative importance of various tree and stand characteristics for predicting mortality is tree age. With a few exceptions, the oaks we measured were survivors of the defoliations in the 1960s and later. Hence, they were thirty-five years older and larger than the last major outbreak in 1981.

Potential of nanoparticles as urban tree care agents
(Dr. Susanna Keriö)

Maintaining a healthy forest canopy cover in urban areas is critical for public health, habitability of urban areas, and biodiversity. Climate change is predicted to amplify the abiotic and biotic tree stress, thus resulting in increased mortality. These impacts are especially strong in cities and arboricultural environments where conditions are often suboptimal to support healthy tree growth. Due to their relatively high stress tolerance, apples are among the most planted ornamental urban trees in Connecticut, and nationally they have high value for food production. Despite their relatively high stress tolerance, apples are not immune to the impacts of climate change. In the context of the unpredictable future, research that dissects the mechanisms of tree stress tolerance, and develops tools for tree species restoration and tree care, is of high priority. Nanoparticles have gained a lot of interest for their potential as antimicrobial agents and fertilizers. However, their potential for tree care has not been extensively studied. As part of her new research program focusing on urban tree stress responses, Dr. Susanna Keriö has initiated a pilot study to explore the impact of metallic nanoparticles on apple stress levels. In collaboration with CAES scientists, the project will monitor nutrient allocation in leaves, gene expression, chlorophyll, ecophysiological responses, and the foliar fungal community in response to nanoparticle application (Figure 1). The project will provide information on the usability of nanoparticles as tree care agents in urban settings, gardens, and orchards, and whether the nanoparticles can be used to enhance tree stress tolerance without adverse effects on the foliar fungal community.

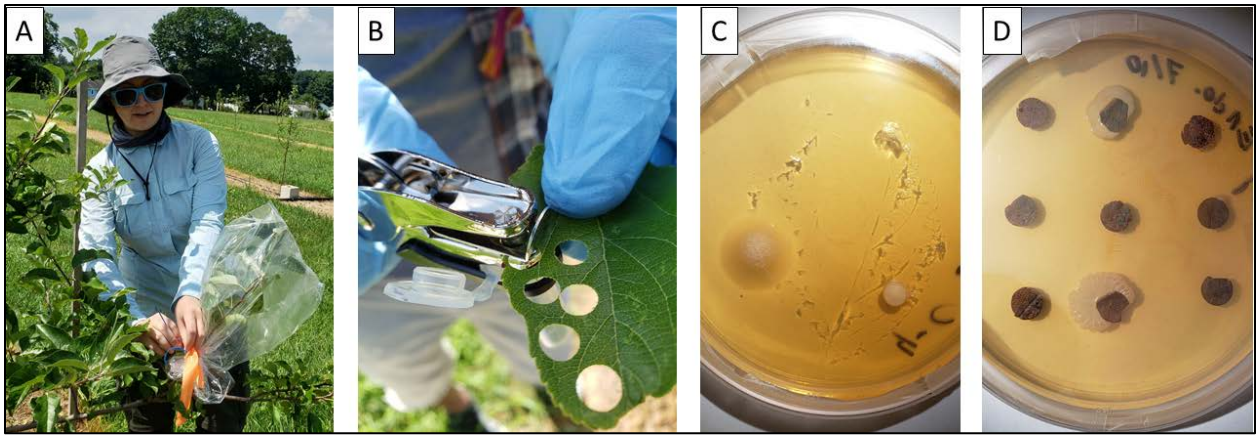


Figure 1. Dr. Susanna Keriö initiated a research project to study the impact of metallic nanoparticles on tree stress responses and the foliar fungal community. A) The nanoparticles were applied on apple tree branches and the branches sealed in plastic bags to promote assimilation of the nanoparticles in the leaves. B) Leaf samples were collected to analyze the foliar fungal community, gene expression, chlorophyll, and stress responses. C) Epiphytic fungi growing from the top (left) and the bottom (right) of apple leaves. D) Endophytic fungi growing from surface sterilized leaf samples.

New Crops Program
(Dr. Abigail A. Maynard)

Investigation of new crops is essential to provide new opportunities for farmers during a time of changing agriculture in Connecticut. Today, about 11,000 acres on 733 farms in Connecticut are devoted to vegetable production with a cash value of 30.2 million dollars. This compares to 19.1 million dollars from 582 farms in 2002. Seventy-nine percent of these farms are less than 100 acres in size; sixty-three percent are less than 50 acres in size. With numerous small farms, there is a need for growers to find a diversity of high value niche crops. In addition, small farm sizes in Connecticut have resulted in marketing shifts from wholesale contracts with local supermarkets to direct retail sales. Approximately 560 farms offer direct sales through roadside stands and sales rooms, where a variety of fruit, vegetables, nursery stock, and Christmas trees are offered. About 16 of these are open all year. Nearly 20% of these farms offer pick-your-own fruit and vegetables to reduce the cost of harvest labor. These savings are passed on to the consumer.

The development of a network of farmers' markets in Connecticut's major urban centers and densely populated suburbs is an important segment of direct sales of vegetables to consumers. All produce sold at farmers' markets must be "Connecticut Grown." Farm fresh produce is offered at reasonable prices to urbanites who cannot travel to the farms. Niche crops valued by diverse ethnic groups are generally sold at these markets. According to the Connecticut Department of Agriculture, there were 120 farmers' markets in 2019, attended by over 300 farmers compared to 87 markets in 2007, a 38% increase.

As the popularity of farmers' markets in Connecticut have surged, so too has the need for growers to find a diversity of high value niche crops. Consumers used to a wide variety of fruits and vegetables in large supermarkets are seeking a greater diversity of ethnic and specialty crops at farmers' markets and roadside stands. A recent survey of vegetable growers by The Connecticut Agricultural Experiment Station showed that over 70 vegetable crops are currently being grown in Connecticut. The Connecticut Agricultural Experiment Station has been investigating specialty crops to provide new opportunities for Connecticut's farmers since 1982. Over 50 fruits and vegetables have been studied resulting in over 50 publications. Results have been, and continue to be, communicated to growers at meetings and farm visits. Some of the crops studied in the New Crops Program include globe artichoke, Belgian endive, radicchio, heirloom

tomatoes, sweet potatoes, specialty melons, okra, and tomatillos. Research included cultivar trials and experiments to determine the best cultural methods for growing each specific crop in Connecticut. Crops that were chosen have a high market value and an existing or expanding market that would readily accommodate these commodities.

Sweet Potato Trials: A 1998 Connecticut Department of Agriculture survey noted that sweet potato is one of the most popular specialty vegetables. In addition, it is very nutritious, with high values of beta carotene (vitamin A) and vitamin C. North Carolina and Louisiana are the leading US producers where they are grown in hilled soil, but we have found that they can easily be grown in Connecticut. Since they have a long growing season and thrive in warm soil, they have always been grown in the Northeast with black plastic mulch. However, black plastic mulch and hilling the soil increases both the labor and the cost per acre of producing the crop. In 2019, Dr. Maynard evaluated the effect of different cultural treatments on the yield and quality of sweet potatoes. There were 4 treatments: black plastic/flat soil, black plastic/hilled soil, no mulch/flat soil, and no mulch/hilled soil.

Impact: The highest yields were from plots amended with black plastic mulch (8.2 lbs/plant) compared to bare soil plots (5.8 lbs/plant). By growing sweet potatoes on black plastic instead of on bare soil, the grower can produce over 34,848 more pounds/acre. At a retail price of $0.99/lb, the grower can gross almost $34,500 per acre by utilizing black plastic. Hilled plots averaged 7.1 lbs/plant compared to 6.9 lbs/plant from flat soil plots. Thus, hilling the soil is not necessary to produce optimum yields. The long-term benefits of growing sweet potatoes include additional revenue for farmers and providing a product that has growing consumer demand. In addition, there may be health benefits for those who consume sweet potatoes. About 43% of vegetable growers in Connecticut grow sweet potatoes.

Butternut Squash Trials: Winter squash varieties such as butternut, buttercup, acorn, and Hubbard have long been favorite fall crops for vegetable growers who operate roadside stands and attend farmers markets. An Experiment Station survey of vegetable growers found that 93% grow winter squash with butternut squash the most popular. Consumers often purchase by the bushel because they store well and can be eaten well into the winter months. Most squash varieties are long-vined and discourage home growers with limited space. New cultivars have been developed that produce fruit on shorter vines, allowing closer spacing. In 2018, Dr. Maynard evaluated the yield and quality of 5 semi bush butternut squash varieties and 5 traditional long vined varieties at Lockwood Farm and Windsor.

Impact: Ultra (long-vined) averaged the highest yields (26.0 lbs/plant) followed by Atlas (semi bush) (25.4 lbs/plant). Cultivar selection can dramatically increase yields and grower profits. By growing the cultivar

Atlas (25.4 lbs/plant) instead of another semi bush cultivar Butternut 1744 (12.3 lbs/plant), the grower can produce over 63,000 more pounds per acre of butternut squash. At a retail price of $0.59/pound, the grower can gross over $37,000 more per acre by growing Atlas. For long vined varieties, by growing Ultra (26.0 lbs/plant) instead of Butternut 23 (13.6 lbs/plant), the grower can produce over 60,000 more pounds per acre of butternut squash. At a retail price of $0.59/pound, the grower can gross over $35,000 more per acre by growing Ultra. The long-term benefits of growing butternut squash include providing a product that has growing consumer demand and additional revenue for growers who attend farmers' markets or have their own roadside stands. Butternut squash is an especially important product for growers in the fall after a frost when other vegetables are not available.

Heirloom tomato trials. In 2012, tomatoes were the most popular vegetable crop grown in Connecticut with 631 farms growing the fruit. According to an Experiment Station survey, 78% tomato growers grow heirloom tomatoes. A strong market for heirloom tomatoes has developed because home gardeners and consumers seek tomatoes with excellent flavor in a variety of colors, shapes, and sizes. Consumers perceive that heirlooms taste better and have thinner skins than hybridized tomatoes. In addition, heirloom tomatoes demand a higher price on the marketplace. Heirloom tomatoes provide an excellent opportunity for local growers, despite several production problems. Most heirloom tomatoes have little disease resistance. In addition, because their skin is tender, heirloom varieties may crack easily. Earlier variety trials were conducted on heirloom tomatoes 2004-2006 and 2007-2009 in which a total of 57 varieties were evaluated. A 2018 catalog from Totally Tomatoes lists 138 different heirlooms. In 2019, Dr. Maynard evaluated the yield, quality, and disease resistance of 10 (previously not tested at CAES) heirloom tomato varieties at Lockwood Farm and at Windsor.

***Impact**:* German Head had the highest yields (38.6 lbs/plant) followed by Brandywine Orange (37.9 lbs/plant), Orange Oxheart (37.5 lbs/plant), and Striped German (35.2 lbs/plant). Giant Oxheart (33.4 lbs/plant) also produced consistently excellent quality fruit. Cultivar selection can dramatically increase yields and grower profits. By growing German Head (38.6 lbs/plant) instead of Vintage Wine (23.3 lbs/plant, the grower can produce 15 more pounds for each heirloom tomato plant. At a retail price of $3.49/pound, the grower can gross over $52 more per plant by growing German Head instead of Vintage Wine. Comparing heirloom tomatoes with conventional tomatoes, the average total yield of the two research plots (150 plants/plot) was 4,556 lbs or a retail value of $15,001. The same yield of the same number of conventional tomatoes would have a retail value of $9,158 ($2.01/pound). The long-term benefits of growing heirloom tomatoes include providing a product that has growing consumer demand and additional revenue for growers who attend farmers' markets or have their own roadside stands.

Pawpaw Trials: Pawpaws are shrubby trees that are native to the temperate woodlands of the eastern United States. The American Indian is credited with spreading pawpaws across the eastern U.S. to eastern Kansas and Texas, and from the Great Lakes almost to the Gulf. They are woodland understory plants that need shade to protect the seedlings but once established prefer full sun. They produce maroon, upside-down flowers which are self-incompatible, requiring cross pollination from another unrelated pawpaw tree. They are not pollinated by bees but by flies and beetles. The pawpaw is the largest edible fruit native to America. Individual fruits weigh 5 to 16 ounces and are 3 to 6 inches in length. The tasty fruit has a smooth, custard texture. In this trial, 4 cultivars of pawpaws were planted in 2002. Since 2013, annual yields have been recorded from each tree.

Impact: Thus far, the cultivars Rebecca's Gold and Overleese have averaged the highest yields (74 and 53 fruit/tree, respectively) with Sunflower producing the largest fruit (8.5 oz/fruit). Pawpaws are an ideal fruit for Connecticut growers who attend farmers' markets or have their own roadside stands as they are very delicate and difficult to ship long distances. The long-term benefits of growing pawpaws include an additional unique product and revenue for growers.

Onion Trials: Onions are one of a few crops which can be marketed for several months after harvest. In this way, growers can sell onions in the fall and winter when most other vegetables are not available. In addition, onions are a good CSA crop in that they can be included in the farm offering every week. There are currently 76 CSA's in Connecticut. Twenty-five years ago, Experiment Station trials evaluated 35 varieties of Spanish and storage onions for yield, quality, and storage longevity. Only 3 of those varieties are still available. In 2019, Dr. Maynard evaluated the yield, quality, and disease resistance of 10 (previously not tested at CAES) storage onions varieties at Lockwood Farm and at Windsor. In addition, onions from each variety were placed in storage after harvest and evaluated monthly for seven months for their storage longevity.

Impact: Ailsa Craig (12 lbs/10 ft row) and Patterson (11 lbs/10 ft row) averaged the highest yields with Blush (8 lbs/10 ft row) averaging the highest yields of the red varieties. Cultivar selection can dramatically increase yields and grower profits. By growing the cultivar Ailsa Craig (12 lbs/10 ft row) instead of another yellow cultivar Zoey (4 lbs/10 ft row), the grower can triple the yields, producing over 23,000 more pounds per acre of yellow onions. At a retail price of $0.75/pound, the grower can gross over $17,000 more per acre by growing Ailsa Craig. For red onions, by growing Blush (8 lbs/10 ft row) instead of Cabernet (4 lbs/10 ft row), the grower can double the yields, producing almost 12,000 more pounds per acre of red onions. At a retail price of $0.75/pound, the grower can gross almost $9,000 more per acre by growing Blush. Patterson was the best cultivar in terms of longevity with 89% still sound after 7 months. The long-term benefit of growing onions include additional revenue for growers who attend farmers' markets or have their own roadside stands especially important product in the fall, winter, and spring when other vegetables are not available.

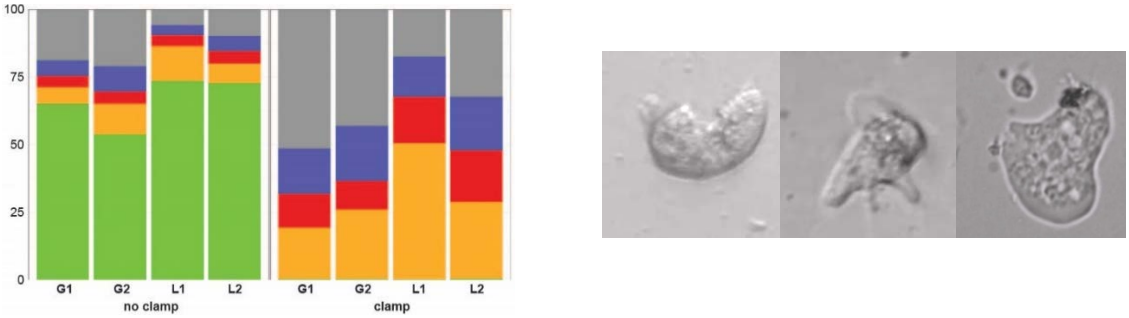
DEPARTMENT OF PLANT PATHOLOGY AND ECOLOGY

The Department of Plant Pathology and Ecology is led by Chief Scientist Dr. Wade Elmer and has seven research scientists that are supported by two full-time technicians. The Plant Disease Information Office serves as the Department Flag Ship serving the citizenry and agricultural industries of Connecticut and provides vital support to other Connecticut state agencies and CAES departments. The department maintains active cutting-edge research programs that address important disease problems caused by bacterial, fungal, and viral pathogens of crops important to Connecticut while also addressing national and international issues.

RESEARCH ACTIVITIES

The Roles of Protists in Shaping Microbiomes and Plant health.

Dr. Lindsay Triplett and Dr. Blaire Steven, along with collaborators at the University of Connecticut, initiated a USDA-funded project in 2019 to understand the functional roles of protists in shaping bacterial communities of plant roots. Protists are single-celled organisms that feed on bacteria in the soil, and some protists can greatly enhance plant growth by releasing nitrogen or feeding on harmful bacteria. A major accomplishment this year was the development of a new method to enable the large-scale genetic profiling of protists, fungi, and microscopic worms and insects attached to the plant. The method will allow researchers to block sequencing of the plant tissue that normally overwhelms the sample, so that other types of organisms can be deeply profiled. This discovery was led by postdoctoral researcher Dr. Stephen Taerum. In addition, the team isolated over 100 protists from the roots of corn grown at Lockwood and Griswold research farms. In the coming year, these resources will be used to profile the complex food webs occurring at the plant-soil interface, and understand how certain protists affect crop health.



On the left, the genetic profile of corn root microorganisms without (no clamp) and with (clamp) a CAES-developed sequencing method is shown. Green is the proportion of corn sequences, and fungi, animals, and protists and unclassified are shown in yellow, red, purple, and gray respectively. The sequencing method greatly increases the number of microorganisms that can be detected. On the right, images of three types of protists that were isolated from Lockwood Farm.

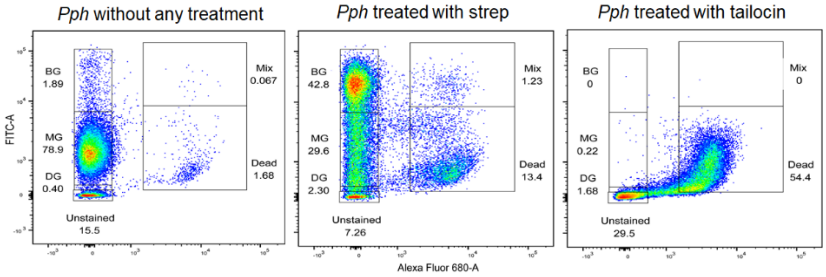
Impact: Plant-associated microbes have a strong influence on the sustainability of crops and ecosystems, and the market for beneficial microbial products has surpassed $2 billion. However, the roles of protists among these microbes are still poorly understood. This study will help us understand which protists are most beneficial to plants and why, which could lead to new protist-based strategies for crop enhancement.

Characterization of stress-tolerant physiological states of plant pathogenic bacteria.

Antimicrobial treatments often leave behind a small population of survivor bacteria, and this is hypothesized to arise from a portion of the population that is in a state of dormancy. Dr. Lindsay Triplett,

along with collaborators at the Pennsylvania State University, initiated a USDA-funded project in 2019 to understand the physiological and genetic basis of this survival state, and to determine whether it impacts the effectiveness of biological control treatments. In this year, work led by postdoctoral researcher Dr. Ravikumar Patel found that survivors of antibiotic treatment are efficiently killed by a biocontrol protein, and vice-versa, showing that combination treatment could be very promising to stop the cycle of disease. He also showed that survivors of each control treatment have a distinct physiological state, which may explain why they can only be killed by a certain treatment. These discoveries can help us understand how bacteria can survive control treatments and give us new tools to study survival genes.

Impact: Antibiotic and biological control treatments are important tools to fight crop disease. Understanding why some bacteria survive exposure to these treatments can help us design ways to make disease control methods more effective at a lower cost.



By analyzing pathogen populations after bactericidal treatment, CAES researchers are discovering what makes some cells more likely to survive and start new infections.

The contribution of toxin-antitoxin systems to bacterial plant disease

Toxin-antitoxin systems are genetic modules that are thought to help human bacterial pathogens survive antibiotic treatments. With collaborators at Penn State, Drs. Lindsay Triplett and Ravikumar Patel have helped discover that a single potential toxin-antitoxin system helps confer stress survival to the bean pathogen *Pseudomonas syringae* pv. *phaseolicola*. Seven spontaneous variant strains were selected that generated a high proportion of antibiotic survivors, and all had mutations in this system. Preliminary data confirmed that expression of the hypothesized toxin suppressed the growth of bacteria. The next year's experiments will confirm the role of the TA system in stress survival during plant disease, and search for the mode of action of the toxin.

Impact: Toxin-antitoxin systems are thought to play a major role in bacterial survival of antibiotics and survival in the host, making it difficult to eradicate disease in an area. Discovering which ones are important will tell us which ones to target for disease control strategies, and which ones could be used to improve biocontrol strains for improved survival.

Nanoparticle effects on Chrysanthemum Wilt: An approach to incorporate undergraduate training into original field research

In summer 2019, Dr. Lindsay Triplett and collaborators at Southern Connecticut State University completed the third year of a USDA-funded project to train the next generation of the agricultural workforce through undergraduate research experiences. As part of this project, thirty undergraduate students have participated in a group research project aimed at determining the effect of nanoparticle treatments on a fungal wilt disease of Chrysanthemums. Students participated in plot design, planting, pathogen inoculation, rating

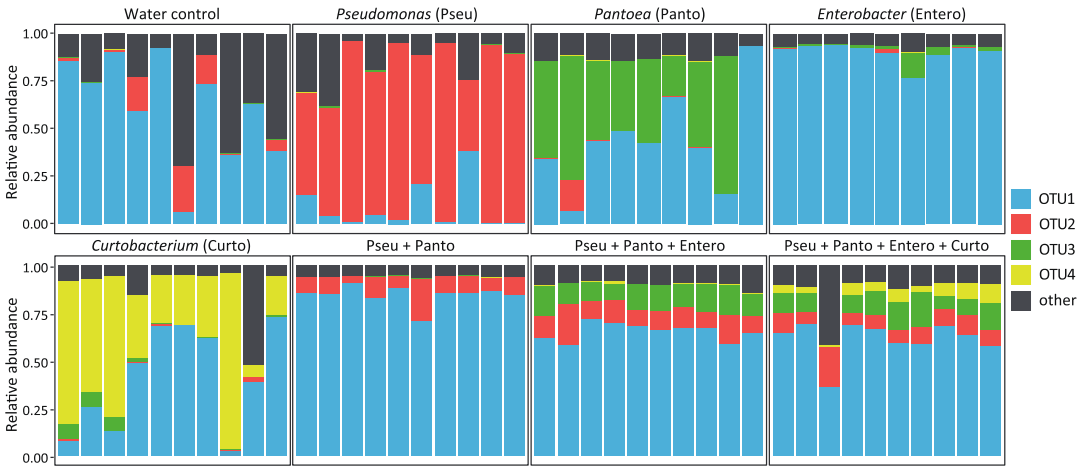
disease, and analyzing data. The project was prepared along with Dr. Wade Elmer and maintained by Mr. Peter Thiel and farm staff.

Impact: Although field research skills are strongly needed on the job market, there are currently few opportunities nationwide for undergraduate training in agricultural research. This project has exposed 30 undergraduate students to participation in a complete field project and has generated educational curricula to help educators and students. Second, fungal wilt is a significant problem of Chrysanthemum, which represents a $124 million market in the United States. Nanoparticles may represent a more environmentally sustainable alternative for control of root diseases than the current treatment, fungicidal root drenches.

Dr. Wade Elmer (L) shows college students how to inoculate potting media with fungal spores as part of their group research project.

Manipulation of the apple stigma microbiome reduces the occurrence of fire blight disease

Flowers are important reproductive organs of Angiosperms. Flowers secrete nutrient rich exudates that support the growth of an assemblage of microorganisms, including both beneficial and pathogenic members, most of which belong to the phylum Proteobacteria. Given the potential role of the microbiome in plant health, manipulating the microbiome to promote growth of beneficial members holds promise in controlling plant diseases. In this study we inoculated four different bacterial strains that were originally isolated from flowers, alone or in mixtures of increasing complexity, onto apple flowers during bloom. We tested if such treatments would influence fire blight occurrence, a disease caused by a bacterium *Erwinia amylovora,* and if we could detect a shift in the structure of the microbiome due to the treatments. We show that various inoculations did influence the occurrence of fire blight, although the level of disease suppression was dependent upon specific bacterial strains. Furthermore, treatments using different strains or strain mixtures resulted in largely unique microbiome structures, with increased representation of the inoculated strains. These data support that disease suppression was due to an alteration of the stigma microbiome structure. Compared to treatments with single strains, a *Pantoea-Pseudomonas* strain mixture produced a homogeneous microbiome structure and better disease control.

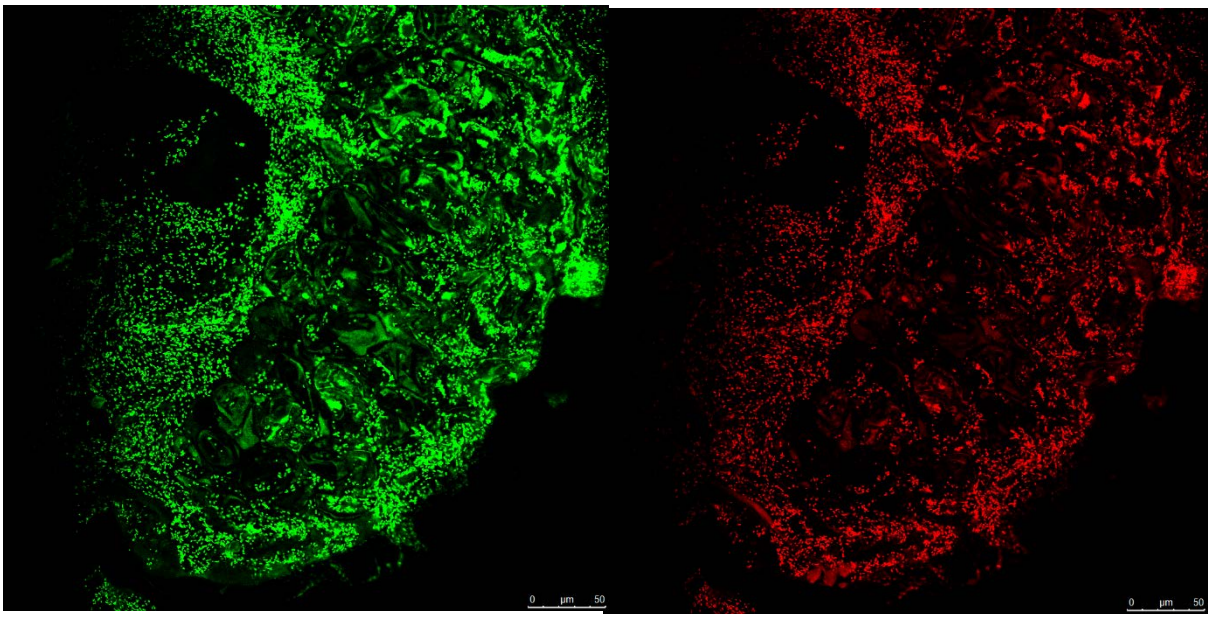


Microbiome composition upon manipulation of different microbes.

Impact: Findings from this study suggest the microbiome on the flower stigma can be manipulated through microbial inoculation. Due to flowers' short life span yet important role in plant disease infection, even a short-term influence on microbiome composition may result in significant decreases in disease susceptibility.

Expression of the type III secretion system genes in epiphytic *Erwinia amylovora* cells

Erwinia amylovora causes fire blight on rosaceous plants. An important infection pathway of fire blight is through flowers, during which the pathogen transits from an epiphytic colonization on stigma and hypanthium surfaces to endophytic (intercellular) infection at the hypanthium. The type III secretion system (T3SS) is an important virulence factor in *E. amylovora.* Although the role of T3SS during the endophytic infection is well characterized, its expression during the epiphytic colonization and role for the subsequent infection is less understood. Here, we investigated the expression of T3SS in epiphytic *E. amylovora* on stigma and hypanthium of apple flowers, under different relative humidities (RH). On stigma, T3SS was expressed in a high percentage of cells, and its expression promotes epiphytic growth of *E. amylovora*. On hypanthium however, the T3SS expression percentage is not only much lower than that on stigma, but also not correlated with the epiphytic growth, although is essential for infection. Compared to *E. amylovora* cells constantly grown on hypanthium surface, cells that first grown on stigma surface before flushed down to the hypanthium displayed a higher expression of T3SS on hypanthium surface. Furthermore, cells pre-cultured on stigma before inoculated on hypanthium caused more infections than when inoculum was from cells pre-cultured in a T3SS-repressive medium, suggesting that having the T3SS induced during the epiphytic colonization may be beneficial for the subsequent infection. Finally, the epiphytic expression of T3SS is influenced by RH. Higher percentage of stigmatic *E. amylovora* cells expressed T3SS under high RH than under low RH.



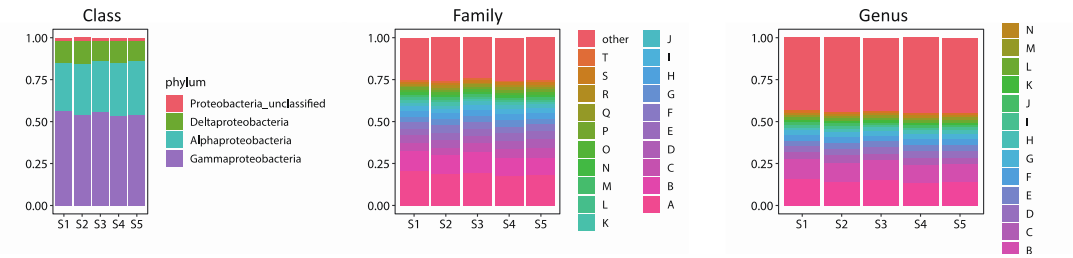
Confocal microscopy images examining *E. amylovora* (green) with virulence genes turned on (red) on stigma of apple flowers.

Impact: Findings from this study suggest that plant pathogen's epiphytic stage of colonization plays an important role in the later endophytic stage of infection. It not only helps the pathogen to build up a large population, but also helps the pathogen to prime up the virulence, which was ignored in previous research. It also showed that virulence genes are up-regulated in humid conditions, which provides the genetic basis of why plants get sick more easily in wet weather than in dry weather.

Characterization of interspecies communication of rhizosphere bacteria

Rhizosphere bacteria play an important role in plant development and growth. Most current studies characterizing plant rhizosphere focused on the description of community structure and understanding the succession. Knowing that many species coexist in such environment prompt the question how bacteria communicate with each other, especially across species. Such communication may be important for the microbiome interaction, assembly, and for plant fitness.

The most prevalent, well-studied mode of communication in bacteria is quorum sensing (QS). Bacteria synthesize and secrete the QS signaling molecules into the environment, and when the concentration of such molecules reaches to a threshold, they bind to a QS receptor and activate downstream gene expression. Known phenotypes controlled by QS include degradation of organic matters, production of antimicrobial metabolites, and virulence. However, most previous studies of QS focused on bacterial communication within a single species. There is a significant knowledge gap into what extent bacteria communicate among different species with the help of QS, and the outcome of such communication to plant fitness and health. Here we used a combined method of metagenomics and metatranscriptomics and perform such investigation in rhizosphere of soybean (*Glycine max*), an important biofuel crop.



Composition of the rhizosphere microbiome upon treatment of various QS molecules.

***Impact*:** We characterized the quorum sensing molecule treatment's effect to bacterial community structures and identified a panel of quorum sensing synthases and receptors through the metagenomics approach. These findings suggest the interspecies communication in soil rhizosphere do exist. We are currently performing further investigation in understanding transcriptomic responses of the QS treatments.

Apple and *Erwinia amylovora* Transporters of 6-thioguanine - a Fire Blight disease-associated toxic nucleobase derivative

Dr. Schultes is studying *Erwinia amylovora*, the causal agent of a devastating disease of apples and pears called fire blight. Fire blight can cause large losses in apple and pear production and is a major disease for commercial farmers. As part of the disease process *E. amylovora* produces and excretes 6-thioguanine (6TG), a toxic derivative of the nucleobase guanine. 6TG is toxic to other microorganisms and is believed to aid *E. amylovora* in securing valuable space on apple flowers and in infected developing fruit by thwarting growth of competing microorganisms. In addition, 6TG is known to affect the viability of plant cell cultures and may also be toxic to cells *in planta*. Our laboratory investigates plant and bacterial membrane localized transport proteins that move 6TG. We are characterizing an Apple Nucleobase Cation symporter 1 transporter, one of several nucleobase transporters that is known to transport guanine in other plant species. In addition, we characterize the role that a Nucleobase Cation Symporter 2 guanine-hypoxanthine permease (GhxP) from *E. amylovora* has in disease establishment and influx of 6TG. In our previous work we have determined the function of the *E. amylovora* uracil transporter, adenine transporter and xanthine transporter through heterologous complementation in *E. coli* strains deficient for endogenous nucleobase transporters. We have also generated specific gene deletion-insertion mutations in the *E.* amylovora genes encoding for the adenine, uracil and xanthine transporters.

The Apple (*Malus domestica*) NCS1 transporter, MdNCS1, was cloned into a bacterial expression vector and introduced into *E. coli* lines that are deficient in specific nucleobase transport, either in guanine-hypoxanthine, adenine, uracil or xanthine transport. These strains were then monitored for their ability to import radiolabeled guanine, hypoxanthine, adenine, uracil, or xanthine. Our results show that MdNCS1 is an adenine and guanine transporter and that MdNCS1 binds 6TG with high affinity. Growth studies also show that *E. coli* strain lacking the endogenous guanine transporter (Δ*ghxP*) but harboring MdNCS1 grow poorly in the presence of 6TG, compared to same *E. coli* strain without MdNCS1 (Figure 1). These results show that MdNCS1 can import 6TG and are the first example of a specific plant transporter moving 6TG.

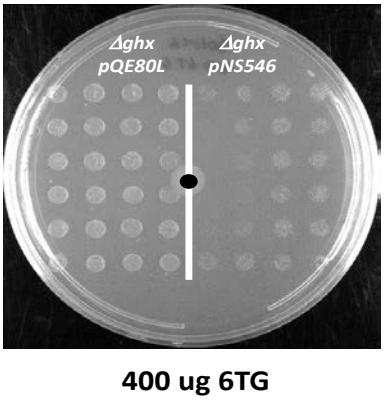
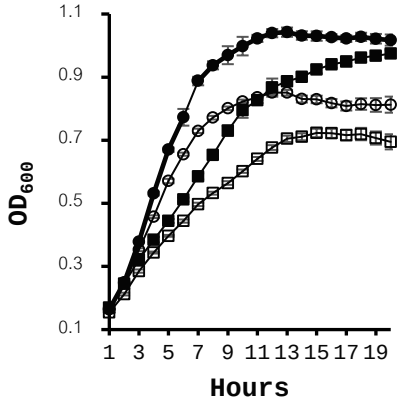


Figure 1. Normal growth of *E. coli* Δ*ghxP* with no *MdNCS1* (pQE80L left side) or with *MdNCS1* (pNS546 right side) showing a zone of growth inhibition of 400 µg 6TG diffusing in a gradient from the central application spot.



We have also characterized the *E. amylovora* Nucleobase Cation Symporter 2 guanine-hypoxanthine transporter (EaGhxP) using the same *E. coli* nucleobase transporter deficient strains. Our results show that the EaGhxP transports guanine and hypoxanthine and binds xanthine. The *E. coli* (Δ*ghxP*) strain harboring EaGhxP also grows poorly in the presence of 6TG, indicating import of 6TG. Biochemical characterization reveals that EaGhxP has a high affinity for 6TG K_i of 3.7 µM. *E. amylovora* lines that contain extra copies of EaGhxP display similar heightened sensitivity to growth on 6TG (Figure 2).

Figure 2. Growth of *E. amylovora* Ea1189 on 6TG *E. amylovora* Ea1189/pQE80L [●or ○] or *E. amylovora* Ea1189/pAS104 [■ or □] was grown in liquid culture with 0 µg/ml 6TG [● or ■] or 200 µg/ml 6TG [○ or □] for 20 hours and OD600 measurement recorded.

This result is counterintuitive in that EaGhxP, an influx transporter, can move 6TG back into *E. amylovora* cells, raising questions regarding the role of 6TG in the disease process. In addition, we generated an *E. amylovora* strain that lacks the endogenous EaGhxP gene, *Ea*Δ*ghxP::Cam*^{r} and determined its role in virulence using immature apple and pear fruitlet growth assays. Pathogenicity tests using immature pear and apple fruitlets reveals that the *E. amylovora* strain carrying a deletion of the guanine hypoxanthine transporter gene (Δ*ghxP*) can still cause disease symptoms once inoculated into immature pears (Figure 3A) and in immature apples (Figure 3C) and that quantitation of the bacterial growth in immature fruits over time shows no difference between the wildtype and Δ*ghxP* strains for both pears (Figure 3B) and apples (Figure 3D).

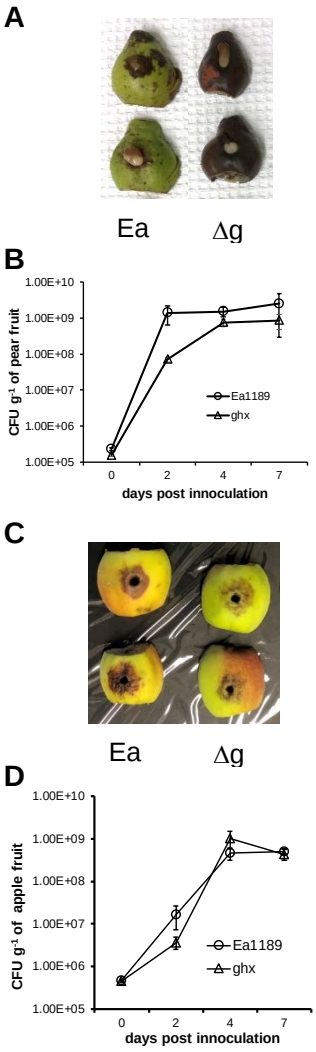


Figure 3. Virulence of WT and *E. amylovora* Δ*ghxP*. Virulence tests A, symptoms on immature pear fruits seven days post inoculation with buffer *Ea 1189* (Ea1189) or *Ea*Δ*ghxP::Cam*^{r} (ΔghxP); B, graph of bacterial count (CFU/g fruit) in pear fruits at 0, 2, 4, and 7 days post inoculation with days 2 showing significant differences with p values at 0.05; C, symptoms on immature apple fruits seven days post inoculation labeled as above; D, graph of bacterial count (CFU/g fruit) in apple at 0, 2, 4, and 7 days post inoculation. Error bars indicate standard error of the mean.

Impact: Comprehending how *Erwinia amylovora* utilizes the nucleobases and the derivative – 6 thio-guanine – in disease establishment will contribute to devising new strategies for fire blight control. The research is conducted by Dr. Neil Schultes and a colleague Dr. George Mourad at the Dept. of Biology at Indiana University - Purdue University, Ft. Wayne, IN.

Forest Health Monitoring

Oak Wilt

Due to the proximity of occurrences of oak wilt in New York state – on Long Island, and in Brooklyn – Dr. Marra has assumed responsibility for monitoring the state of Connecticut for oak wilt, a devastating vascular wilt disease caused by the ascomycete fungus, *Bretziella fagacearum*. Symptoms of the disease can be easily confused with other biotic and abiotic factors that also result in crown dieback, and therefore proper and complete diagnosis of oak wilt must be completed in the laboratory, using both traditional culturing methods as well as DNA extraction and PCR. This devastating disease typically kills oaks in the red oak group (red oak, scarlet oak, black oak, pin oak, bear oak, in Connecticut) within a single season, and spreads rapidly via root grafts as well as vectoring by native sap beetles. To gain a more thorough understanding of the disease and its diagnosis, in August 2019, Dr. Marra attended and participated in a diagnostics workshop hosted in Minnesota by the US Forest Service and the University of Minnesota.

Figure 1. Left, a red oak, infected with oak wilt, in a forest in a Minneapolis suburb. Right, red oak foliage showing characteristic symptoms of oak wilt. R. Marra, both photographs, August 2019.

Given the proximity of recent oak wilt findings in New York state, Dr. Marra has given several presentations on oak wilt to landscape and tree-care professionals, as well as to Master Gardener classes, in order to educate the public on symptoms to be on the lookout for, and to contact CAES and Dr. Marra should these symptoms be seen.

Impact: Oak wilt is a devastating disease that threatens Connecticut's abundant red oak stock, including red oak, black oak, pin oak, scarlet oak, and bear oak. Based on the trajectory of outbreaks in neighboring New York state, the disease is most likely to turn up in residential areas, which makes scouting and surveys futile. We are therefore dependent on the informed vigilance of tree care professionals, which includes arborists, tree wardens, and other landscape managers. Also essential is the ability of the CAES staff to act

quickly in diagnosing and confirming the presence of the fungus, and communicating this to the state's DEEP, which will be responsible for developing a response protocol.

Beech Leaf Disease

Beech leaf disease (BLD), caused by the foliar nematode, *Litylenchus crenatae mccannii*, was first identified, by Dr. Marra, in Connecticut in 2019 on American beech (*Fagus grandifolia*) in lower Fairfield County, but was not seen elsewhere in the state in 2019. This year, 2020, Dr. Marra and seasonal research assistant Cora Ottaviani have identified BLD in additional parts of Fairfield County, as well as in New Haven, Middlesex, and New London Counties; to date, the disease has not been seen in Litchfield, Hartford, Tolland, or Windham Counties. The disease, first identified in 2012 in Ohio, and subsequently in western regions of PA and NY, as well as in Ontario, Canada, can kill young trees within seven years of detection. BLD has also been documented in RI and MA. BLD has been found on both American and European beech (*F. sylvatica*) in North America, including on European beech in Plymouth and Lexington, MA.

In partnership with other affected states in the northeast (OH, NY, PA, WV, MD), Dr. Marra is participating in a region-wide program, funded by the US Forest Service, to monitor the development and spread of BLD, through the installation and monitoring of ten long-term plots in various parts of the state. Dr. Marra is also educating stakeholders, including landscape and tree-care professionals, on BLD.

Dr. Marra has joined forces with researchers in OH, NY, the USDA-ARS, and Ontario, Canada, to form a Beech Leaf Disease Working Group, with each researcher applying their area of expertise to addressing this disease. Dr. Marra's approach will be to use population genetic methods to test hypotheses on paths of movement of the nematode, to gain insights on how the disease spreads at both local and regional scales. To do this, Dr. Marra will be developing microsatellite markers, based on proven success in this area with the fungal pathogens *Neonectria ditissima* and *Fusarium palustre*.

The characteristic foliar symptoms of BLD (Figure 2), darkening and hypertrophy in interveinal bands of leaves, appear immediately upon leaf-out. However, at this stage in early spring, and until late June or early July, only nematode eggs are present in symptomatic tissue, and neither juvenile nor adult nematodes will be found. To permit early season confirmation of the presence of the nematode, Dr. Marra has developed a rapid PCR diagnostic test that targets a 682 bp portion of the mitochondrial cytochrome oxidase subunit 1 gene (CO-I), permitting identification of the presence of eggs from DNA extracted in a rapid extraction procedure starting with < 20 mg of leaf tissue (approximately one hole-punch leaf disc (5 mm diam). In testing this method, Dr. Marra has also demonstrated the random and patchy distribution of eggs within symptomatic interveinal bands (Figure 3).

Figure 2. Beech Leaf Disease is characterized by a darkening of interveinal bands, best seen by viewing foliage from below with lighting from above.

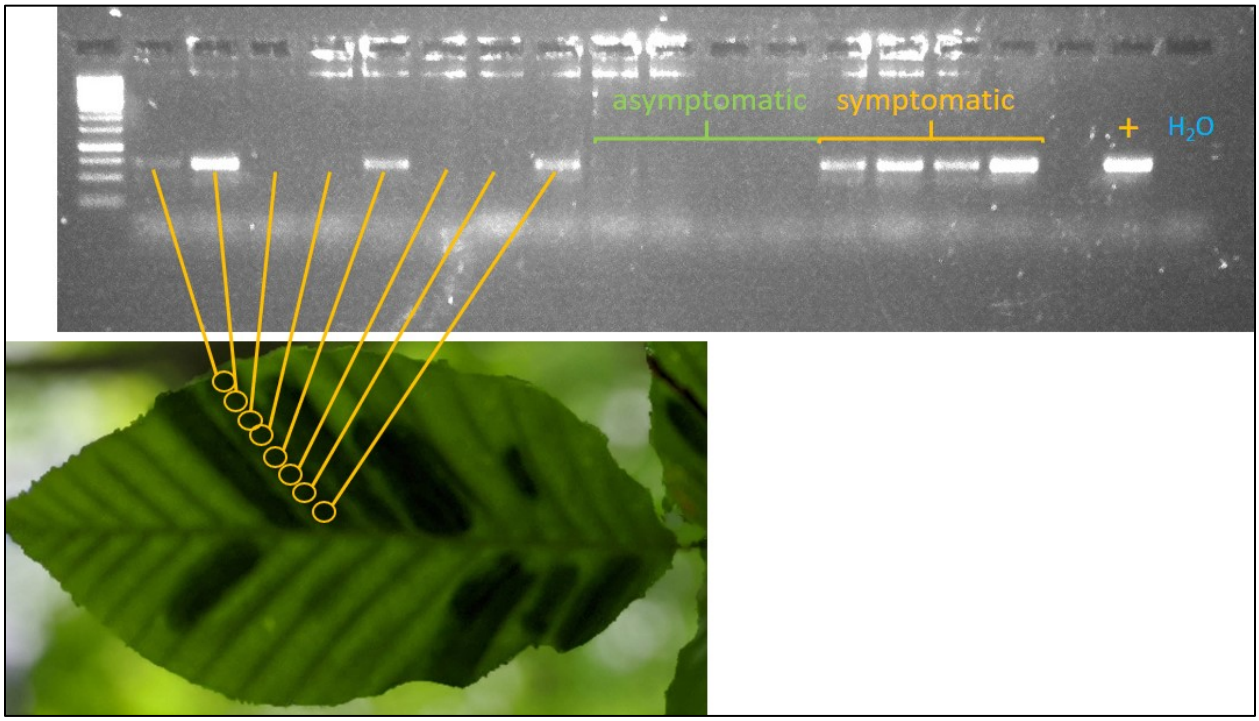


Figure 3. PCR amplification of a 682 bp portion of the BLD *Litylenchus crenatae mccannii* mitochondrial CO-I gene from early-season symptomatic leaf tissue in which no juvenile or adult nematodes are found, demonstrating the presence of only nematode eggs. The eight amplifications in lanes 2-9 were from DNA extracted from serially isolated 5-mm discs of leaf tissue, demonstrating that eggs are not homogeneously distributed. The eight amplifications in lanes 10-17 were from DNA extracted from 100 mg leaf tissue, demonstrating the absence of Lcm DNA in asymptomatic tissue in late spring.

Impact: Given the unexpectedly rapid manner in which BLD has established itself in Connecticut's forested landscapes, particularly along the shoreline, it is essential that CAES take a proactive role in tracking the spread of the disease, and participating in research on better understanding the modes of spread, about which little is currently known, and potential management strategies.

Genetic Variation and Dispersal Dynamics in *Fusarium palustre*, Associated with Sudden Vegetation Dieback in salt marshes of eastern United States

Dr. Marra's research on *Fusarium palustre*, the fungal pathogen of *Spartina alterniflora* (described previously by Drs. Elmer and Marra) made significant progress again this past year. Because of the unique nature of *F. palustre* distribution (i.e., in isolated patches in discontinuous salt marshes), Dr. Marra is testing hypotheses about the introduction and spread of the pathogen, and relatedness among populations. A key component of wetland dieback syndrome, *F. palustre* has been shown in Dr. Marra's lab to have a surprisingly high degree of genetic diversity both within and among populations sampled from various marshes ranging from Louisiana to Maine. Amplified Fragment Length Polymorphisms (AFLP), used in an earlier study, showed a significant amount of genetic variability among a group of approximately 100 *F. palustre* isolates from North America as well as several from China, a surprising result, given the absence of an observed sexual state, and therefore no obvious mechanism for generating the observed levels of genotypic diversity. Based on this finding, and in order to study relatedness (or lack thereof) of disjunct populations, Southern Connecticut State University graduate student Alysha Auslender developed a suite of 47 microsatellite markers for *F. palustre*, all of which showed remarkably high genetic diversity among 32 isolates representing the currently known distribution of the fungus along the Eastern seaboard, ranging from Louisiana to Nova Scotia, as well as China.

These microsatellite markers, whose length polymorphisms are based on differing numbers of repeating DNA motifs, are currently being used to study population differentiation among three populations of *F. palustre*, collected by Dr. Wade Elmer from saltmarshes in Connecticut: (1) 29 isolates from West River in Guilford, collected in 2007; (2) 58 isolates from Hammonasset Beach State Park, in Madison, CT, collected in 2007; and (3) 24 isolates from Hammonasset Beach State Park (same site as in "2"), collected in 2008. All isolates were confirmed to be *F. palustre* based on morphology as well as partial sequence of the translation elongation factor 1-alpha (*tef1*) gene. Comparisons between populations "1" and "2" will test for genetic differentiation between spatially disjunct populations. Comparisons between populations "2" and "3" will test for genetic differentiation between temporally disjunct populations, an important consideration given seasonal and tidal fluctuations that are characteristic of salt marshes.

This research is ongoing. Of the 30 microsatellite loci that will be used for this study, 10 have been used thus far to genotype the 111 isolates in this study. All ten loci are polymorphic both within and among the three populations; overall the number of alleles segregating at each locus ranges from 6 to 16 (Table 1). Once the genotyping is completed, hypotheses will be tested on both geospatial and temporal population differentiation.

Table 1. Ten microsatellite loci segregating among three CT populations of *F. palustre*. Each column lists the alleles segregating within and among the populations, with their frequencies in parentheses.

cat2	cat1	tct2s	gtt2	ttg1	aac1s	aga1	tgc1	cat3	gac1
269 (64)	416 (30)	275 (54)	260 (27)	376 (37)	99 (42)	241 (17)	226 (47)	187 (45)	245 (37)
272 (26)	410 (24)	288 (11)	275 (17)	378 (28)	102 (15)	259 (14)	223 (26)	183 (13)	236 (29)
250 (11)	413 (13)	290 (11)	269 (12)	382 (23)	89 (12)	256 (13)	230 (9)	180 (13)	248 (20)
277 (3)	401 (12)	301 (10)	257 (12)	357 (10)	105 (10)	273 (12)	233 (8)	190 (12)	251 (6)
280 (3)	390 (10)	285 (9)	278 (9)	372 (3)	91 (6)	262 (9)	213 (7)	159 (10)	242 (4)
266 (1)	404 (6)	282 (6)	272 (9)	367 (2)	116 (5)	239 (8)	246 (3)	210 (4)	254 (1)
283 (1)	419 (5)	293 (4)	266 (4)		119 (5)	254 (6)	236 (2)	193 (3)	
	443 (3)	287 (2)	284 (3)		108 (4)	248 (6)	239 (2)	200 (1)	
	407 (1)	278 (2)	346 (3)		111 (3)	245 (5)	235 (1)	206 (1)	
	398 (1)	279 (1)	317 (1)		122 (2)	264 (4)			
	422 (1)		259 (1)		126 (2)	267 (4)			
	431 (1)		220 (1)		155 (1)	251 (4)			
			320 (1)		132 (1)	305 (1)			
						275 (1)			
						278 (1)			
						283 (1)			

Impact: Nothing is known about the means of dispersal of *F. palustre* from one salt marsh to the next. This is particularly intriguing given that salt marshes are typically disjunct in their distribution, and experience tidal inundation on a daily basis, suggesting the possibility that dispersal is by means of water. We currently do not know the means by which *F. palustre* generates these high levels of genetic and genotypic diversity among the sampled isolates, a conundrum given the absence of a known sexual state. Research into the epidemiology and dispersal dynamics of this fungus is critical, given the importance of salt marches as buffers against the impacts of climate change and associated sea-level rise on coastal ecology.

Neonectria Canker caused by *Neonectria ditissima*

Perennial Target Canker (also known as Neonectria canker) continues to be researched by Dr. Marra. This research focuses on the ecology and genetics of the causal agent of perennial target canker, the fungal pathogen, *Neonectria ditissima*. The goal of this research is to gain a fuller understanding of the life history, evolution, population dynamics, and host-interactions of *N. ditissima*, particularly with respect to its principle hosts, black and yellow birch (*Betula lenta* and *B. alleghaniensis*). Fundamental knowledge of the natural history of *N. ditissima* is lacking, yet is an essential component to effective management strategies. Dr. Marra has developed the field techniques and laboratory tools necessary to the study of this fungus and the disease it causes, and has used these tools and methods to examine the relationship between mating system and genetic structure.

Previously, Dr. Marra developed and used a set of 13 polymorphic microsatellite markers to study mating and genetic differentiation in *N. ditissima* from two nearly adjacent sites at West Rock Ridge State Park in New Haven, CT. This study revealed a paradoxical juxtaposition of high levels of genetic diversity alongside high levels of selfing and biparental inbreeding. The results confirm an earlier hypothesis that *N. ditissima* has a "mixed mating system" (selfing and outcrossing occurring in the same population). All observations of selfing were confirmed through the use of AFLPs.

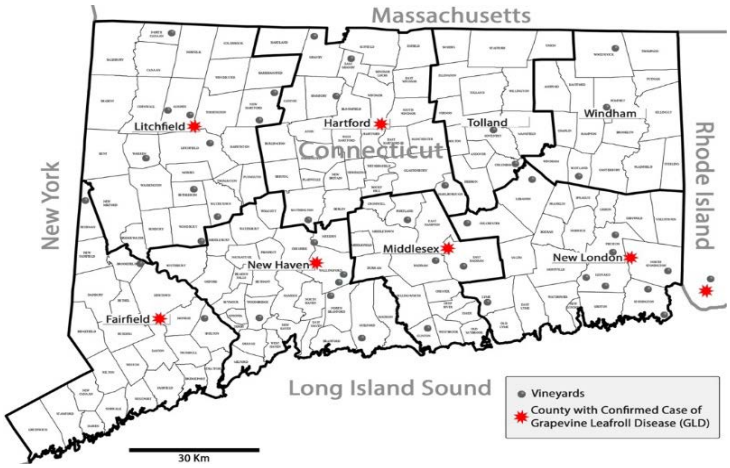
Last year, Dr. Marra generated a whole-genome sequence of a Connecticut isolate, and, working in collaboration with a graduate student, Cameron Stauder, at West Virginia University, used published whole-genome sequences of other isolates of *N. ditissima* to identify the two alleles (idiomorphs), *MAT1-1* and *MAT1-2*, of the mating-type locus (*MAT1*). Screening a collection of isolates obtained from cankers, Dr. Marra and Mr. Stauder have found that *N. ditissima* isolates have either one idiomorph or the other, never both, ruling out the possibility that self-fertilization occurs by virtue of isolates having both idiomorphs in the same haploid genome; such is the paradigm observed in other ascomycetes. Dr. Marra developed a Taqman-based real-time PCR assay to allow for quick and efficient screening of large numbers of isolates. Using this protocol, a 2019 USDA Plant Health Fellow, Olivia Rianhard, a student from Eastern Connecticut State University, assisted with the screening of numerous sets of sexual (ascospore) progeny that have previously been shown to be the result of self-fertilization by analysis at 13 microsatellite loci. Preliminary results suggested that the *MAT1* idiomorphs segregate even among ascospore progeny that appear otherwise to be the result of self-fertilization, despite the occurrence of only one or the other idiomorph in the parental genome. In order to confirm this observation, Dr. Marra, assisted by student interns from the University of New Haven, has re-isolated DNA from new cultures of these progeny arrays, taking utmost precautions in avoiding contamination during extraction. To complete this project, this year these progeny arrays will be re-assayed for *MAT* segregation.

Black birch (*Betula lenta*), with multiple *Neonectria ditissima* cankers distributed along stem. Because cankers typically only form on stems younger than ~15 years of age, lower cankers were likely initiated many years before those higher up the stem.

***Impact*:** Due to its increasing abundance in Connecticut, black birch is a tree of growing importance and concern. Although trees infected with Perennial Canker can persist for decades, the extensive scarring caused by the cankers renders them of little value for lumber or veneer. Our efforts to more fully understand the biology and natural history of *N. ditissima* is an important contribution in the fields of mycology and evolutionary biology and will contribute to the identification and utilization of control strategies. An important result of this research is that it provides empirical support for theoretical models that posit the importance of biparental inbreeding to the evolutionary stability of mixed mating.

Using Nanoparticles to Deliver dsRNA for Controlling Destructive Plant Viruses

The achievement of virus resistance in plants by the application of exogenous double-stranded RNA (dsRNA) is well documented. Essentially, dsRNA is recruited by the plant RNA silencing machinery to guide the cleavage of complementary virus RNA by a sequence-specific manner, resulting in virus infection suppression. The trouble is that the application of naked dsRNA on plant leaves provides a short-lived protection window (~ five days) against target viruses - it is quickly assimilated by the plant regulatory mechanisms and also degraded by environmental factors. Nanoparticles have emerged as a promising dsRNA delivering system that protects and gradually delivers dsRNA in plants. Drs. da Silva and Zuverza-Mena are working to develop this technology at CAES with the long-term goal of developing a novel and innovative ways to control plant virus infections. Our three specific objectives are: 1) to characterize and screen dsRNAs from tobacco plants infected with potato virus Y (PVY), 2) to evaluate commercially available nanoparticles and to synthesize and characterize nanoparticles as potential dsRNA delivering systems, and 3) to use nanoparticles to sustainably deliver those dsRNA molecules to protect tobacco plants.



Map of the State of Connecticut highlighting the location of vineyards (gray dots) and counties with confirmed cases of grapevine leafroll disease (red stars).

Impact: Tobacco is a valuable crop in Connecticut (CT) with an annual farm-gate value of ~$41 million, which is planted primarily for cigar wrapping and no blemishes are acceptable on the leaves. *Potato virus Y* (PVY) is associated with deformities on leaves of several solanaceous species, including tobacco, and it has become an endemic disease in CT and neighboring states. In 2009 alone, losses in tobacco linked to PVY infections were greater than $10 million in CT and contributed to 45% of the crop being discarded - the loss was 100% in some farms, causing growers to cease all production. The results from this research have the potential to change the way that we protect plants and to create sustainable plant virus disease control strategies that will help to mitigate crop losses due to virus diseases in CT tobacco farms.

Survey for grapevine leafroll-associated viruses in CT

Dr. Washington da Silva is leading a three-year statewide survey of the viruses that cause grapevine leafroll disease (GLD) to develop efficient management strategies to control this devastating disease in Connecticut (CT) vineyards. GLD is the most detrimental and widespread viral disease of grapes worldwide. It can cause up to $40,000 loss per hectare during a single grape growing season. There is no cure for GLD. The only management options are to plant healthy grape seedlings and to eliminate infected plants from vineyards, because of vectors that can spread the viruses from infected to healthy plants. The problem is GLD can take up to five years to develop visual symptoms and many common grape cultivars do not show GLD symptoms when infected. In this project, we join experts in plant virology, entomology, and epidemiology in a collaborative effort to identify the extent of the spread of the viruses and the insect vectors (hemipterans) capable of transmitting these viruses in Connecticut. With this information, we will then be able to raise awareness among grape growers, vineyard managers, and vintners on the detrimental effect of this devastating virus disease in grape production and quality. CAES is partnering with CT Department of Agriculture in knowledge dissemination and outreach. The long-term goal is to develop a statewide management plan that is mechanistically and economically feasible, which might then be adopted by all growers throughout the northeastern region of the United States.

***Impact*:** With the first-year survey results in hand, we are assisting growers on decision-making processes, over 50% of the samples from each of the seven vineyards visited were positive for at least one of the viruses that cause leafroll disease (Figure 1). We are providing data to growers of the percentage of the vineyards that is infected with leafroll disease and the plants tested so that growers can remove infected plants to reduce viruses' spread (Figure 2). Our new virology lab at CAES is up and running - the only plant virology lab in the New England region. It is set up with all pieces of equipment and resources needed to provide services to growers so that samples can be tested before planting to avoid introduction of grapevine virus diseases in CT vineyards. Growing grapes is an expensive venture and having information on the presence of grapevine viruses in the state, the right identification of the virus species, the presence of vectors, and percentage of virus incidence statewide, will help to maximize resources and mitigate losses. We are already able to advise growers on when to remove plants and to spray pesticides to reduce vector populations in order to reduce risks of virus spread in the vineyards. And in worse case scenarios, we will provide guidance on when it is economically practical to remove all plants and start the vineyard fresh.

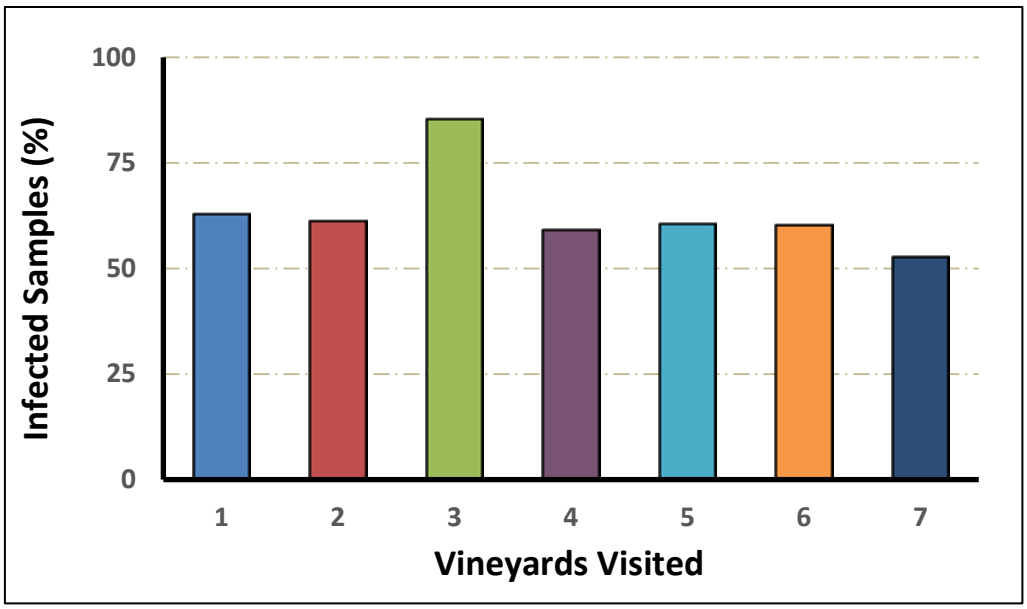


Figure 1 – Results from the first year of the survey. Over 50% of the samples from each of the seven vineyards visited were positive for at least one of the viruses that cause leafroll disease.

Figure 2 – A grape plantation, Cabernet Franc variety, from a Connecticut vineyard. Half of the grape plot tested positive for grapevine leafroll virus 1 and 3 (see enlarged photo for typical leafroll disease symptoms). The other half tested negative and we can visually see the difference between infected (right side of the plot) and non-infected plants (left side of the plot). The grower was advised to remove the entire left side of the plot to mitigate further spread of the viruses to other sections of the vineyard by insect vectors.

Using nanoparticles to deliver dsRNA for controlling destructive plant viruses

The achievement of virus resistance in plants by the application of exogenous double-stranded RNA (dsRNA) is well documented. Essentially, dsRNA is recruited by the plant RNA silencing machinery to guide the cleavage of complementary virus RNA by a sequence-specific manner, resulting in virus infection suppression. The trouble is that the application of naked dsRNA on plant leaves provides a short-lived protection window (~ five days) against target viruses - it is quickly assimilated by the plant regulatory mechanisms and also degraded by environmental factors. However, just recently nanoparticles have emerged as a promising dsRNA delivering system that protects and gradually delivers dsRNA in plants. Drs. da Silva and Zuverza-Mena are working around the clock to establish this technology at CAES with the long-term goal of helping the development of innovative ways to control plant virus infections.

Our three specific objectives are: 1) to characterize and screen dsRNAs from tobacco plants infected with potato virus Y (PVY), 2) to evaluate commercially available nanoparticles and to synthesize and characterize nanoparticles as potential dsRNA delivering systems, and 3) to use nanoparticles to sustainably deliver those dsRNA molecules to protect tobacco plants against this devastating virus.

Impact: Tobacco is a valuable crop in Connecticut (CT) with an annual farm-gate value of ~$41M, which is planted primarily for cigar wrapping and no blemishes are acceptable on the leaves. Potato virus Y (PVY) is associated with deformities on leaves of several solanaceous species, including tobacco (Figure 2), and it has become an endemic disease in CT and neighboring states. In 2009 alone, losses in tobacco linked to PVY infections were greater than $10M in CT and contributed to 45% of the crop being discarded - the loss was 100% in some farms, causing growers to cease all production. The results from this research have the potential to change the way we protect plants and to create sustainable plant virus disease control strategies that will help to mitigate crop losses due to virus diseases in CT tobacco farms. We have identified regions in the PVY genome (Figure 1), by Illumina high-throughput sequencing, likely to be efficiently targeted by RNAi silencing machinery and successfully designed dsRNA molecules (Figure 2) that protect tobacco plants against PVY infections for up to five days. We are now designing, synthetized, and testing different nanoparticles to act as nanocarriers for a sustainable delivery of dsRNAs to suppress PVY infections in tobacco plants (Figures 3 and 4).

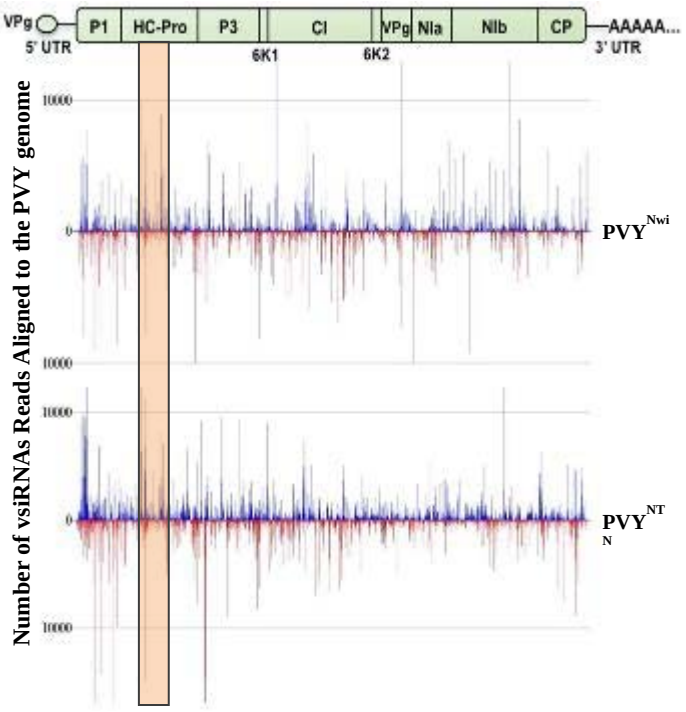


Figure 1. Graphical representation of total sense (blue bars) and antisense (red bars) vsiRNA reads aligned to PVY^{Nwi} and PVY^{NTN} genomes. The horizontal green schematic representation on top denotes the PVY genome. The orange vertical box depicts a vsiRNA hotspot region, common on both PVY strains (Nwi and NTN) genomes, detected on the helper-component (HC-Pro) cistron that was used for dsRNA synthesis.

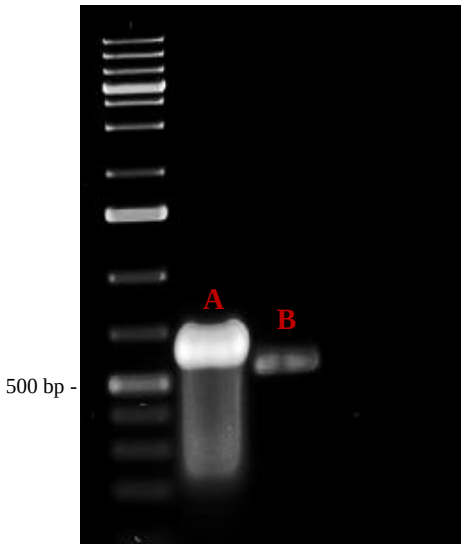


Figure 2. DsRNA synthetized from the helper-component (HC-Pro) region of PVY genome. **A,** dsRNA. **B,** PCR product (HC-Pro region) used as template for dsRNA synthesis.

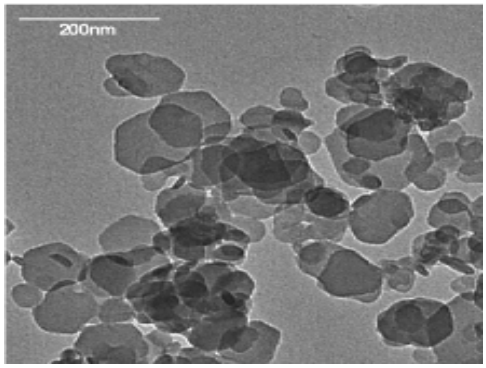


Figure 3. Transmission Electron Microscopy image of our first synthetized nanosheets at CAES. Photo by Teja Shidore.

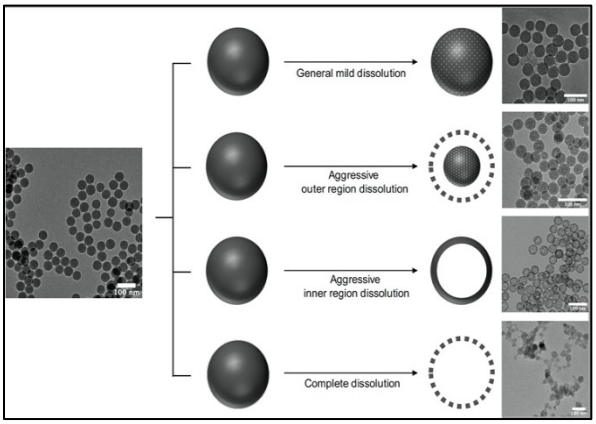


Figure 4. Spherical nanoparticles functionalized for varied dissolution behaviors for different release rate of dsRNA. Photo Courtesy of Christy L. Haynes from University of Minnesota.

Using Nanoparticles of Cu, P, and Si to Enhance Plant Health

Nanoparticles (NP) of Cu (CuO and $CuPO_3$) have shown to be effective promoters of plant health when applied foliarly. Dr. Elmer, along with Dr. White (Analytical Chemistry), have partnered with the NSF-funded Center for Sustainable Nanotechnology (CSN) to advance the use of NP of Cu, P, and Si in plant health management.

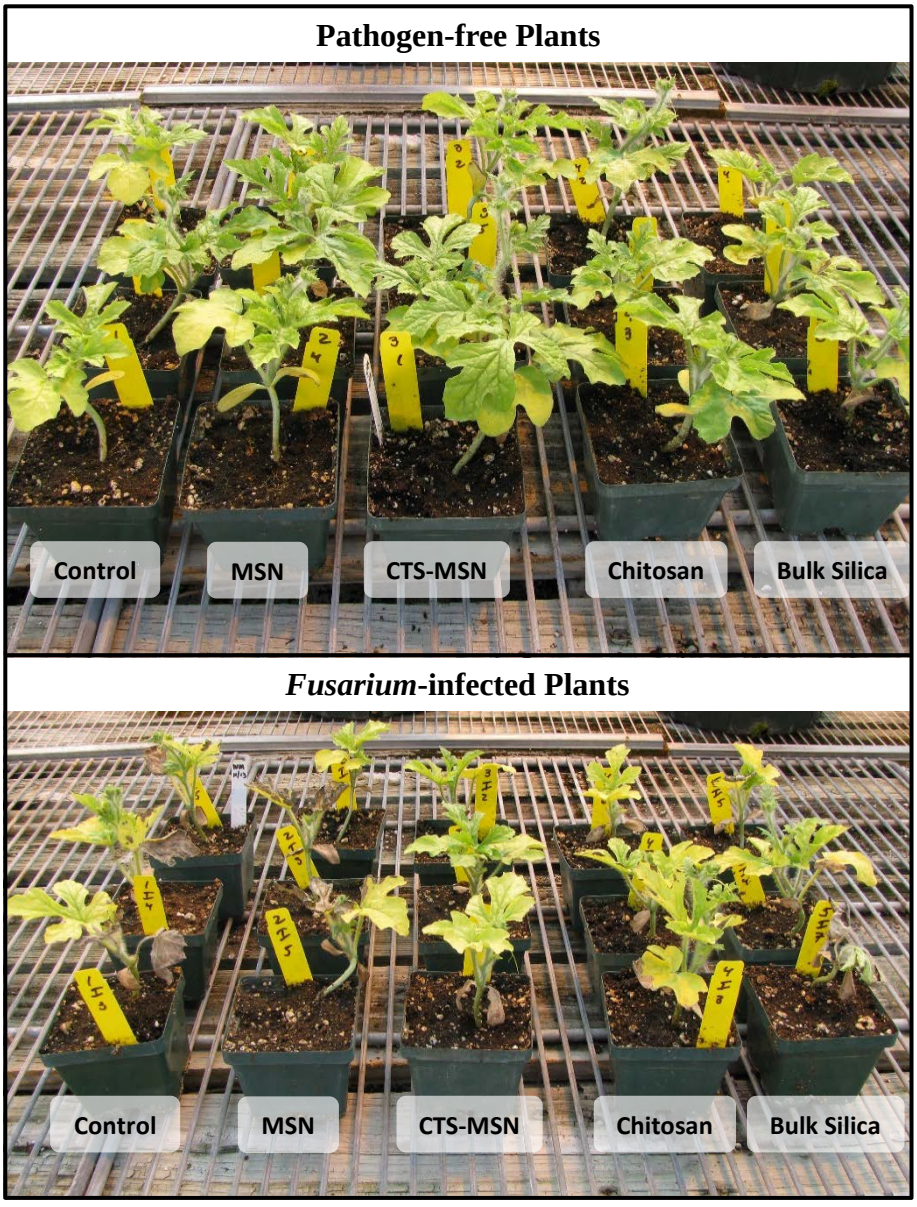
Copper plays essential roles in activating enzyme systems that are essential in host defense. For example, polyphenol oxidase is a tetramer that contains four atoms of Cu per molecule and catalyzes the oxidation of *o*-diphenols to produce antifungal *o*-quinones. These and other defense products are increased by NP of Cu. Numerous greenhouse and field trials on many vegetable and ornamental plants have been conducted. NP of Cu frequently outperform the NP of other micronutrients like B, Mn, and Zn and provide season-long protection following a single application. We have calculated on eggplant that a single application of NP CuO that costs < $20.00 per ha could generate up to $6,300 more profit per ha ($15,567 per acre) in New England. NP of Cu have also increased yields of pumpkin and cabbage and improved disease suppression of begonia, cyclamen, soybeans, tomatoes, violets, and watermelon.

Phosphorus is an element required in large amounts by plants. Considerable waste occurs each year from excessive applications of P to CT soils, which in turn, leaches into the ground water, and contaminates waterways and ultimately Long Island Sound. Biodegradable composites produced by CSN colleagues at Johns Hopkins University have been designed to slowly release P over time. Preliminary studies with tomatoes have shown that the degradable composites provided phosphorus nutrition and produced plants that did not differ from plants that received the leachable phosphate salts, but drastically reduced the amount of P that leached from the pot.

Comparison of biodegradable P composites to PP4 salts on growth of tomato.

Future studies are being designed to assess their effects on yield production. Considerable research has also been conducted using mesoporous silica nanoparticles (MSN) on Si-accumulating species like watermelon. NP MSN composites that were functionalized with Chitosan (CTS), a plant resistance inducing compound, increased seed germination, plant growth, and watermelon yield and reduced the ratings of disease severity. Studies that determine the effect of NP size found NP MSN with smaller sizes (< 30 nm) were more effective in increasing biomass and reducing disease ratings than larger size MSN (> 50 nm). When MSN composites that possess different dissolution behaviors were examined, we observed that MSN NP

composites that released the majority of Si initially as opposed to slowly were better in promoting plant health. MSN NP constructed with (3-aminopropyl) triethoxysilane (APTES) and N-[3-(Trimethoxy silyl) propyl] ethylenediamine (NPED) were superior to all other formulations.



Images of the non-inoculated plants (top) and *Fusarium*-infected plants (bottom) treated with MSN, MSN plus Chitosan, Chitosan alone, or bulk silica.

***Impact*:** These studies revealed that applications of NP of Cu, P, and Si offer an improved delivery system for applying these elements to susceptible tissues. Nanoparticles offer great promise in increasing food and fiber production without additional chemical inputs and may be the new weapon in plant disease management by enhancing plant health for nominal costs and without the cultivation of new land or application of chemical inputs.

Disease Survey

The weather conditions in the past year were rainy and less snow in the winter, cool and wet in the spring, and hot and dry in the early summer. The prolonged cool and wet spring weather conditions favored foliar diseases on woody ornamentals and fruit trees. Dr. Yonghao Li diagnosed a wide range of fungal, bacterial, viral, nematode, and abiotic diseases on trees, shrubs, herbaceous ornamentals, lawn grasses, fruits, and vegetables during the year. Cold temperatures in early May resulted in frost and freeze damage on various crops and ornamentals.

Ornamentals:

Beech leaf disease, caused by the foliar nematode *Litylenchus crenatae*, was first detected in Fairfield County in August 2019. A further distribution of the disease in New Haven and New London was reported in the early season of 2020. A severe outbreak of anthracnose along with beech leaf disease caused noticeable damage on beech leaves. Phytophthora bleeding canker remained a major disease problem on beech trees in landscapes. Dutch elm disease was reported on some hybrid elm trees. Caliciopsis canker (*Caliciopsis pinea*) was first reported in Connecticut in 2019. Several cases of pine wilt, caused by the soilborne nematode *Bursaphelenchus xylophilus*, were reported on white pine and 2-needle pines. Rainy and cool spring weather conditions resulted in epidemics of leaf spots on various trees including oak anthracnose, maple anthracnose, sycamore anthracnose, dogwood anthracnose, hornbeam anthracnose, shot hole leaf spot of cherry, Septoria leaf spot of birch, and apple scab, which caused significant distorted new growth and premature defoliation. Powdery mildew was found on many woody ornamental plants including dogwood, Japanese maple, lilac, ninebark, rose, pear, sycamore, and tulip tree. *Gymnosporangium* rust diseases were found on crabapple, pear, quince, serviceberry, hawthorn, hydrangea, rose, and cedar. Several cases of bacterial blight were reported on lilac bushes. Botryosphaeria canker was found on holly, hydrangea, rhododendron, oak, and arborvitae. Rhizosphaera needlecast and Stigmina needlecast were two major foliar diseases on spruce. Pestalotiopsis needle blight was prevalent on arborvitae, which might be associated with environmental stress and wet spring weather conditions. Phytophthora root rot was detected on hemlock, lilac, rhododendron, and Balsam fir. Significant diebacks of junipers, weeping cherry, and snowbell caused by winter injury were observed.

Beech leaf disease

Caliciopsis canker of white pine


Pine wilt

On bedding annual and perennial flowers, root rot diseases including Pythium root rot, Thielaviopsis root rot, and Rhizoctonia root rot remained major issues. Rainy and cloudy spring weather conditions favored edema on geranium. Impatiens necrotic spot virus and tomato spotted wilt virus were commonly detected on greenhouse bedding crops including annual flowers and vegetables. Bacterial leaf spot was found on greenhouse-grown salvia, lavender, poinsettia, chrysanthemum, begonia, and heuchera. Powdery mildew was problematic on beebalm, phlox, rudbeckia, and zinnia. Ascochyta blight was a major problem on groundcover vinca in nurseries and landscapes. Botrytis blight was prevalent on greenhouse-grown phlox in late winter and early spring. Bacteria leaf spot and Alternaria leaf spot were problematic on zinnia. Botrytis blight, leaf blotch, powdery mildew, and anthracnose were found on peony.

Vegetables:

Leaf mold, powdery mildew, Botrytis blight, and Fusarium wilt were found in greenhouse-grown tomato plants. Septoria leaf spot, early blight, blossom-end rot, anthracnose, and bacterial leaf spot were common diseases in garden- and field-grown tomatoes. Herbicide injury was frequently found in home vegetable gardens especially on tomatoes. On peppers, bacterial leaf spot and Phytophthora blight were problematic. Powdery mildew, Plectosporium blight, anthracnose, bacterial wilt, and bacterial angular leaf spot were major disease problems on cucurbits. Verticillium wilt and Phomopsis blight were found on eggplants. Black rot and Alternaria leaf spot were problematic on broccoli and cabbage. White rot of garlic was found in several commercial farms and home gardens.

TSWV on tomato

TSWV on pepper

Tree and Small Fruits:

Black rot, downy mildew, and anthracnose were commonly found on grapevines. Cedar-apple rust, scab, fire blight, frogeye leaf spot, Marssonina leaf blotch, and black rot were prevalent on apple trees. On pear trees, rust and Fabraea leaf spot were found. Leaf curl, powdery mildew, scab, and brown rot continued to be major diseases on peach. Black knot and winter injury caused significant dieback on cherry trees. Phomopsis canker, Botryosphaeria canker, and mummy berry were major diseases on blueberry. Dry and hot early summer weather resulted in white drupelet disorder on raspberry.

Black rot of grape

Apple scab

Turf:

Brown patch, summer patch, Pythium blight, red thread, Drechslera leaf spot, Bipolaris leaf spot, anthracnose, dollar spot, slime mold, and rust were common diseases of lawn grasses.

Dollar spot of grass

Pythium blight of grass

Weeds:
Poison ivy, Oriental bittersweet, Japanese knotweed, Asiatic dayflower, broadleaf dock, cinquefoil, Virginia creeper, horsenettle, garlic mustard, mugwort, nightshade, pigweed, spurge, Japanese stiltgrass, and sumac remained significant problems in residential properties and gardens. Running bamboo continued to be a topic of increasing public concern because it causes problems between neighbors. Crabgrass, annual bluegrass, bittercress, creeping bentgrass, chickweed, clover, ground ivy, yellow nutsedge, bedstraw, purslane, red sorrel, wild garlic, moss, and wild violets were common weed problems in turf grasses. In the spring, perennial grassy weeds such as tall fescue and dallisgrass were prevalent in lawns.

Impact: Information from disease surveys in Connecticut landscapes, greenhouses, nurseries, vegetable fields, orchards, natural woodlots, forests, and home properties each year helps to monitor and assess the impact of these problems on the overall health of plants in the state. This information also assists in detecting new diseases or in identifying potentially important emerging diseases on specific plants, which can then be monitored in the years that follow.

SERVICE ACTIVITIES

Members of the Department of Plant Pathology and Ecology are involved in a wide range of service and public outreach activities. Some of these services involve presentations, publications, displays at meetings and other outreach events, tours of facilities, and interviews, in addition to being conducted in cooperation with other state agencies.

Seed Testing: In Cooperation with the Connecticut Department of Agriculture, Bureau of Regulation and Inspection

Every year, official samples of vegetable, crop, and lawn grass seeds are collected by inspectors from the Bureau of Regulation and Inspection of the Connecticut Department of Agriculture and submitted to The Connecticut Agricultural Experiment Station, an official seed testing laboratory for Connecticut.

In 2019, 317 vegetable, 9 lawn, and 6 crop seed samples were tested for the germination and purity that are required for compliance with Connecticut Seed Law Regulations and the Federal Seed Act by following strict protocols designated by the Association of Official Seed Analysts. Three hundred tested vegetable

seed samples passed the germination test, eight of the tested seed samples failed label claims for germination, and nine samples did not have enough seed for the test. A total of six lawn grass seed mix samples were tested for purity and germination rates. The results of the tests showed that only the sample URI #2 Mix from Agway passed both purity and germination tests for all ingredients by meeting the label claims or passing the tests within acceptable tolerances, but all other samples had one or more ingredients in seed mixtures that did not meet the label claims. The eight of nine received crop seed samples were tested for purity and germination rates because the other sample did not provide label claims. Of the tested eight crop samples, all samples passed purity tests with the exception of Perennial Ryegrass and Gulf-Annual Ryegrass from Thompson & Sons Inc. In germination tests, all samples passed except for all three components in the Hay Mixture 2 Broad Brook from Crop Production Service.

Impact: Results of seed tests conducted by Station staff are reported to the Seed Control Official of the CT Department of Agriculture who has the authority to stop the sale of products that do not meet label claims or contain noxious weeds. In the short term, this program protects state residents from purchasing inferior seed and ensures that seeds comply with the Connecticut Seed Law Regulations and the Federal Seed Act. The long-term benefit of the seed testing program is to minimize the unintentional introduction of noxious weed seeds that could potentially impact crops of economic importance and the state's ecosystem.

Samples for Analytical Chemistry and the Connecticut Department of Consumer Protection
During the year, Dr. Li examined 26 samples from the Connecticut Department of Consumer Protection at the request of the Department of Analytical Chemistry at the Experiment Station.

Citizen Inquiries
Plant Disease Information Office

Dr. Li answered 3,325 inquiries about plant health from Connecticut citizens. Although the majority of inquiries were on ornamentals, trees, and shrubs (75%), other categories, such as food crops (10%) and turf grasses (3%), were also well represented. A moderate percentage of inquiries fell into the miscellaneous category (12%), which included identification of various plants, weeds, and mushrooms, and information about pesticides and their relationships to health and environmental concerns. The majority of inquiries were from commercial growers and plant care professionals (46%) and Connecticut homeowners (47%). One percent of inquiries were from cooperative extension and 6% were from health departments, news, agricultural personnel, and other. A further breakdown of inquiries showed that 16% of the questions came in by phone, 29% came in by mail, 17% came as email, and 38% were brought in person. In response to inquiries, 2,105 letters and email messages with attached files of fact sheets were sent from the PDIO. Many citizens opted to download fact sheets posted on the CAES website in lieu of letters since this gave them instant access to the information of concern.

VALLEY LABORATORY

Scientists at the Valley Laboratory conduct research on insects, diseases, mycology, integrated pest management, soil nutrition, and weeds of concern to commercial agriculture and homeowners in Connecticut. The Valley Laboratory, located in Windsor, was originally established in 1921 to conduct tobacco research. While research on tobacco continues today, the research mission has expanded to reflect the diverse agriculture present in the State. Scientists and staff also diagnose insect and plant health problems, test soils for fertility, conduct outreach to growers and homeowners by speaking to professional and community groups, host informational meetings, and assist municipalities, state agencies, and students.

Activities on the Farm

There were a total of 31 experimental plots at the Valley Laboratory Research Farm during the past year. Five Windsor-based scientists had 25 of these plots; three New Haven-based scientists were using six plots. Additional plots were maintained by the Farm Manager as rotation crops or for seed collection. Valley Laboratory scientists also conducted experiments in many plots off site, such as in growers' fields, the CAES Lockwood and Griswold farms and in State forests. Valley Laboratory Farm Manager James Preste kept the farm and equipment ready and in excellent shape. He expertly maintained the many field plots and addressed the specific needs of each scientist. He and his summer research assistants did an outstanding job maintaining the extensive ornamental garden in cooperation with the Connecticut Nursery and Landscape Association. Mr. Preste and Dr. LaMondia coordinated the Valley Laboratory effort to comply with EPA Worker Protection Standards for Agricultural Pesticides and organized and conducted safety and pesticide training sessions for the staff.

RESEARCH ACTIVITIES

Hemlock Woolly Adelgid Research

Recovery of eastern hemlocks documented after a recent extreme drought
Hemlock recovery continued in most sites in 2019-2020, 2-4 years past the extreme drought of 2015-2017. The drought-induced hemlock borer outbreaks on rocky ridgetop sites with poor soil did not expand in 2019-2020 at these marginal sites. Fourteen *S. tsugae* release sites were revisited by Dr. Cheah from winter – early summer 2020 to assess hemlock crown health two years post drought. Following a warm winter with little snow, rebound and reinvasion of HWA was recorded in 69% of sampled sites after 2 years of negligible HWA. One southeastern site in an area of droughty soils had the poorest crown conditions in 2020 with heavy needle loss and very heavy elongate hemlock scale (EHS) populations in 2019. Most other sites continued to show recovery of crown conditions. Long-term hemlock crown assessments in 2020 showed that hemlocks improved in most sites. Foliar transparencies in the majority of these older *S. tsugae* release sites were statistically similar to that in baseline sites in 2019, indicating similar rates of recovery after the extended drought of 2015-2017.

2020 hemlock recovery at 1998-2001 *S. tsugae* release sites around the state.

The emergence of HWA in 2020 following a very warm winter and the continued expansion of EHS populations

Following a very warm winter (6th warmest for Connecticut in 125 years), resurgence and/or reinvasion of HWA in some areas was noted, particularly in northeastern and southeastern Connecticut. Other patchy HWA resurgence was noted in some central areas, especially along rivers, near lakes and reservoirs and even in isolated pockets in northern forests on the border with neighboring states. Homeowner reports of HWA have also increased indicating resurgence in suburban areas in 2020. Surveys of hemlock forests

statewide continued through the fall - spring of 2019-2020. To date, 18 forest stands and 541 samples have been sampled and evaluated for hemlock recovery, HWA, and EHS infestations. Samples indicated the patchy resurgence of light to moderate HWA in a third of the sites sampled (32.6%) while 59% of sites had medium to very high levels of EHS, and these included sites east of the Connecticut River, indicating further spread.

Rebound in HWA in 2020 in some sites.

Promising results from 2017 biological control release sites

Sampling showed that 87% of the 8 new 2017 *S. tsugae* release sites had much reduced HWA levels in fall 2019. These sites had received small numbers (100-400) of ladybeetles, donated by Tree-Savers, PA in 2017, to target emerging HWA infestations. One site in southeast CT near the Rhode Island border still had heavy HWA infestations and an augmentation release of 200 was applied in June 2020. The results indicated that using small scale releases of *S. tsugae* to suppress emerging HWA infestations could be a useful strategy to manage HWA after mild winters.

Biological control of HWA in 2020

In late winter and spring of 2020, ongoing surveys of hemlock forests and detailed annual site assessments of > 20 older forest release sites also indicated HWA rebound in some sites. In 25% of sites, the resurgence was high and necessitated action for control. The adelgid appeared to efficiently exploit the lush new growth of recovering hemlocks. In response, a cooperative strategy of augmentation biological control releases of *S. tsugae* was implemented to immediately target HWA resurgence starting in late spring 2020. Dr. Cheah contacted and worked with land preserve stewards and foresters from CT DEEP, the MDC, and Steep Rock Association in Washington to implement *S. tsugae* releases in emerging hot spots of HWA in spring 2020. Beetles were purchased from Tree-Savers, PA (2,000 by CT DEEP; 700 by the MDC, 500 by Steep Rock Association) and over 3,350 were also generously donated by Tree-Savers to supplement releases. In 2020, > 6,500 *S. tsugae* were released in multiple sites around the state on state lands, public preserves, and watershed forests. Since 1995, > 185,000 *S. tsugae* have been released statewide in 37 sites, primarily on state lands and public preserves.

It is hoped that this cooperative program of biological control with *S. tsugae*, which will include homeowners, land trust preserve managers, forest managers from water companies, open space and town land managers, and more, will continue in joint statewide efforts to manage HWA and protect our eastern hemlock resource for the future.


Releasing *S. tsugae* at the Pachaug State Forest with Dan Evans and Ruby Hayes, CT DEEP, July 2020.

DEEP park manager Stephany Dummond and staff releasing *S. tsugae* at Burr Pond State Park, June 2020.

Will Hochholzer, CT DEEP, releasing *S. tsugae* at Devil's Hopyard State Park, June 2020.

Andy Hubbard, MDC forester, releasing *S. tsugae* on watershed forests of the Barkhamsted Reservoir.

Dr. Brian Hagenbuch, Exec. Director, and Rory Larson, conservation and program leader, of the Steep Rock Association, observing released *S. tsugae* on a popular trail.

Impacts:

- Documenting the continuation of the resilience, improvement, and recovery of eastern hemlocks, previously severely stressed by drought and insect pests, is important information for land and forest managers. Hemlocks, especially mature trees, can recover after serious drought after ample precipitation, even in marginal sites, following heavy winter mortality of HWA.

- Mature hemlock forests can be protected as increasingly important carbon dioxide sinks in a warming world and biological control with *S. tsugae* is an important tool.
- Long-term impacts of biological control show that eastern hemlocks can recover from HWA infestations, which is important to the multiple and diverse avian, amphibian, fish, and mammal species that are dependent on the hemlock ecosystem.
- Protection of hemlocks with HWA on state lands and public preserves for recreation can be achieved with biological control and shows that eastern hemlock can be a sustainable resource.
- Biological control offers a safe and attractive alternative to homeowners seeking to protect landscape hemlocks on private properties. This strategy minimizes the need and application of annual prophylactic chemical treatments for HWA.
- The equivalent monetary investment of the sum total of biological control releases with *S. tsugae* in Connecticut exceeds $462,500, but the intangible benefits in hemlock ecosystem services protected far exceed this estimate.

Implementation of Biological Control of Mile-a-Minute Weed in Connecticut

Mile-a-minute weed, *Persicaria perfoliata,* (MAM) originates from Asia, was first discovered in the eastern U.S. in the 1930s, and is classified as a serious invasive weed in Connecticut. Infestations have been found in 14 eastern states from North Carolina to Ohio and the first record of MAM in Connecticut was in Greenwich in 1997, later confirmed in 2000. Infestations of MAM are concentrated primarily in the southern and western regions of the state, with other large areas of infestations in Glastonbury and Sprague. More recent spread has also occurred east of the Connecticut River along the coast. New town reports in 2019 were confirmed in Haddam, Bridgeport, Beacon Falls, Shelton, and Coventry. Most reports occur via the public through the online reporting site of the Connecticut Invasive Plant Working Group (CIPWG). As of the end of 2019, 59 towns in Connecticut (35%) had confirmed reports of MAM since 2000. However, several towns have only limited reports of a few plants, which have since been removed. This rapidly growing prickly and prolific vine is an annual in its northern range but quickly forms dense thickets that overwhelm and displace native vegetation and reduces plant diversity. Areas invaded by MAM include riparian and wetland ecosystems, utility power line corridors, agricultural fields, roadsides, gardens, and recreational open space.

The introduced weevil, *Rhinoncomimus latipes* (Coleoptera: Curculionidae), imported from central China, has been successfully reared and released for biological control of this invasive species in the Mid-Atlantic and southern New England states. This project has been a 9-year collaboration between Dr. Cheah and Donna Ellis, Senior Extension Educator (retired) at the University of Connecticut and funded by USDA APHIS PPQ, in cooperation with the New Jersey Department of Agriculture Phillip Alampi Beneficial Insect Laboratory, who have reared and provided the majority of weevils to cooperating states. Many volunteers and cooperators from the private sector, NGOs, state, town, and federal officials have worked in cooperation to implement MAM biological control and helped in monitoring impacts at the release sites. As Donna Ellis retired in February 2019, Dr. Cheah coordinated and implemented the final year of the MAM biological control program in 2019-2020, during which 4,000 weevils were released in the new towns of Old Lyme and Durham, and also in Fairfield and on Calf Island, part of the Stewart B. McKinney National Wildlife Refuge. To date, > 60,000 weevils have been released in 27 towns at 45 major sites over the 10-year program to mitigate the spread of MAM.

Annual assessments have shown that the weevil is now well established and adapted to Connecticut's climate and is dispersing widely to impact MAM in non-release areas, although the extent of impacts such as seed reduction are still unclear and appear to vary with sites. Funding for releases through APHIS PPQ has now ended, but weevils are still feeding and reproducing and increasing their populations on MAM throughout the state. Monitoring in 2019 showed the weevils' continued presence at all sites and higher

weevil activity and damage in more sites than in 2018. The growing season of 2019 had more normal precipitation levels, which appeared to be more favorable for weevil activity. Weevils continued to spread and disperse over many miles from original release sites in a variety of different habitats and can be readily found in non-release locations, feeding and reproducing on MAM.

Inspecting MAM in New Milford with Carrie Davis (Weantinoge Land Trust) and Kathleen Nelson (Mad Gardeners) September 2019.

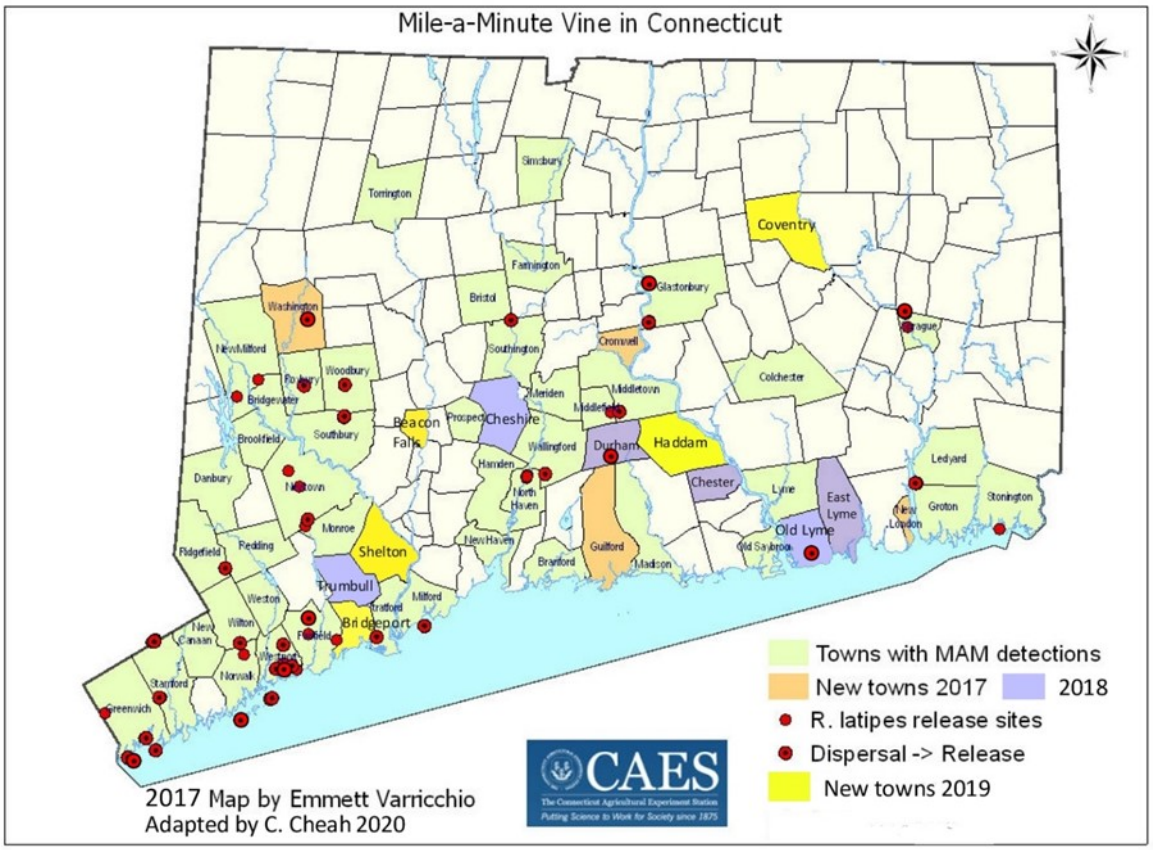
Augmenting weevils on Sheffield Island Stewart B. McKinney National Wildlife Refuge with Kris Vagos and staff August 2019.

Newly emerged weevils on MAM in September 2019.

Heavy feeding damage by weevils on MAM in September 2019.

***Impacts*:**

- Establishment of *Rhinoncomimus latipes* for MAM control is another important tool for control that has been implemented throughout the MAM range in the state.
- Biological control of MAM will hopefully reduce the need for chemical control, especially in watershed areas, utility corridors, agricultural lands, bird refuges, and recreational open space.
- Biological control has the potential to be combined with other cultural methods such as mowing and selective volunteer hand-pulling if areas are set aside for weevil establishment. Monitoring has shown weevil survival even where herbicides have been applied and that may also mean that chemical control may be integrated with biological control.
- The total number of weevils released through this program is equivalent to > $90,000 investment to combat MAM in Connecticut.



Map showing *Rhinoncomimus latipes* release sites in MAM towns 2009-2019.

Insect Management

New efforts were started by Dr. Richard Cowles to assist Christmas tree growers to find effective strategies to manage armored scale pests. Current standard practices, developed previously from his work, involve a basal bark spray application of dinotefuran, a systemic insecticide. This insecticide then kills developing scales as they feed, while not presenting toxic residues on the exterior of the foliage. Although this has been effective on many farms, the extreme population size of armored scales in some fields (estimated to be on the order of 10^{10} scales per acre) and the haplodiploid genetic system of scales practically guarantees the rapid evolution of insecticide resistance. Dr. Cowles' multi-pronged approach is investigating three strategies: (1) testing selective insecticides as alternatives to dinotefuran to selectively target scales, (2) growing *Euonymus japonica* as banker plants for euonymus scale, whose natural enemies are expected to also feed on scales affecting Christmas trees, and (3) prospecting for insect pathogenic fungi (in collaboration with Dr. DeWei Li) to test for their potential to be used as biopesticides.

Cryptomeria scales damage Christmas trees by causing a yellow spot to appear on the needle where feeding has taken place. A previously undescribed fungal disease of cryptomeria scale is shown in the image on the left, whereas a less-commonly observed parasitic wasp, probably an *Aphytis* spp., has parasitized a high proportion of scales on one farm in CT. Environmentally sound methods for managing the scale insect will encourage biological control provided by these naturally occurring beneficial organisms.

Honey Bee Health

Funding from the CT Department of Agriculture Specialty Crops Block grant program supported a two-year project (ended in 2019) between Dr. Cowles and the CT State Bee Inspector, Mark Creighton, for genetic improvement of honey bees. It resulted in finding two queen bees in spring 2020 with good colony survival, gentle behavior, varroa resistance, and honey hoarding traits. A cooperating queen producer, Mark Czerczak, has grafted larvae to rear queens from the best of the two colonies, to share with the CT Queen Breeders' Association. If this line of bees is successful with volunteer beekeepers testing this line, then additional queens will be shared or sold to other local beekeepers wishing to requeen their hives to improve hygienic traits. Another aspect of improving honey bee health is to enhance the quantity and quality of bee forage. Two projects involve efforts to grow and evaluate bee forage, one is supported by a Feed-A-Bee grant and consists of replicated plots at Lockwood Farm. The other is a SARE-supported project to establish high-yielding honey crops within Christmas tree plantations, conducted in collaboration with Dr. Jatinder Aulakh, to determine the most effective herbicides to use in initial establishment of these plants. The herbicide flumioxazin was less injurious and more effective for establishment of most of the honey plants than was imazapic. *Mentha arvensis* (wild mint) and *Melissa officinalis* (lemon balm) appear to be easier to establish than most of the other species tested.

Christmas Tree Disease Management

Application of sulfur to reduce soil pH to 4 enhances the establishment and growth of firs native to the eastern U.S. grown as Christmas trees, and may delay infection of susceptible trees to *Phytophthora* organisms that cause root rot. One hypothesis for improved tree growth with more acid soil is that *Phytophthora* spp. are less tolerant of acid soils than are the fir tree hosts, allowing the trees to grow quickly enough to compensate for some loss of roots to disease, but alternative hypotheses need to be tested. In collaboration with Dr. Blaire Steven, we are investigating the rhizosphere soil microbiome for trees in adjacent plots with soil pH ~5 vs. 6, to see whether the microbial community greatly differs in association with low vs. higher pH, and testing soil bacteria from these two conditions to determine whether there is a greater proportion of bacteria with the ability to inhibit Phytophthora from the soils with the lower pH.

A series of three follow-up experiments established in spring of 2019 were supported by a grant from the Christmas Tree Promotion Board, to determine whether bare-root transplants significantly benefit from the addition of controlled-release fertilizer, as evident from their improved color. Bare root transplants of

balsam, Canaan fir, Fraser fir, Douglas-fir, and two species of spruce were darker green and had significantly greater leader growth when planted with 13 g of controlled-release nursery fertilizer incorporated into the soil around the roots. Trees were examined in 2020 to determine whether greater soil fertility translated into greater risk of bud abortion or tree mortality. There was a statistically insignificant increase in bud mortality in Canaan fir among transplants treated with higher quantities of fertilizer at the time of planting.

Impacts:

- The Connecticut Queen Breeders' Association has locally selected queen bees that they can share or sell to interested beekeepers.
- Christmas tree growers are implementing use of sulfur to improve the health of their true firs.

Weed Science

Ornamental Nursery Trials

Weed control in ornamental plantings is very challenging. The tolerance of ornamental plants to herbicides varies with genotype, species, and variety. Dr. Aulakh has conducted multiple ornamental plant safety and weed control efficacy trials in 2019 on ornamental species including goldenrod, iris, purple coneflower, sunflower, vincas, and Christmas trees.

The 2019 ornamental plant safety trials identified many newer and safer chemical weed control options for purple coneflower, sunflower, and goldenrod. Two applications spaced 6 weeks apart of Pendulum 2G up to 600 lb/ac were found safe on goldenrod. A single application of Pendulum 2G up to 600 lb/ac or two applications up to 300 lb/ac at 6-week intervals were safe on purple coneflower. For sunflower, two applications spaced 6 weeks apart of Pendulum 2G at 150 lb/ac were safe whereas only temporary stunting injury was seen at 300 lb/ac.

Pendulum 2G herbicide safety trials in goldenrod and common sunflower at the Valley Laboratory in Windsor, CT in 2019.

Impact:

- The results will help the herbicide manufacturers in extending herbicide labels for use in tested tolerant crops.

Christmas Tree Weed Management Trials:

Indaziflam is a relatively newer addition to the Christmas tree preemergence weed control products. It is an alkylazine herbicide that controls a broad spectrum of annual grasses and broadleaf weeds by interfering with cellulose biosynthesis pathways in susceptible weed species. The current indaziflam (Marengo®) label lists only a limited number of Christmas trees species. Dr. Aulakh is evaluating tolerance to indaziflam in container- and field-grown balsam fir, Canaan fir, Colorado blue spruce, Douglas-fir, eastern hemlock, eastern white pine, Fraser fir, Nordmann fir, Norway spruce, and Turkish fir to over-the-top application of indaziflam (Marengo®) up to 36 fl oz/ac.

Figure 1. Indaziflam safety research trial in balsam fir at Kogut's tree farm in Somers, CT.

Findings: The 2019 research trials revealed high tolerance in balsam fir, Canaan fir, Colorado blue spruce, Douglas-fir, Fraser fir, Nordmann fir, and Turkish fir to over-the-top application of indaziflam (Marengo®) up to 15 fl. oz/ac. No phyto injury (chlorosis, necrosis, or stunting) was observed in any of the species.

***Impact*:** Many weeds are either tolerant or have evolved resistance to the conventional herbicides belonging to PS-II inhibitor (atrazine, simazine, hexazinone, etc.) and ALS-inhibitor (sulfometuron-methyl), mitotic inhibitors (pendimethalin, Surflan, Treflan, etc.) groups. Indaziflam will also serve to mitigate the risk of evolution of herbicide resistance in weeds by providing a novel mode-of-action to Christmas tree producers. Results from this research have been shared with the Christmas tree growers via an article in *The Real Tree Line* magazine of the Connecticut Christmas Tree Growers Association.

Palmer Amaranth Herbicide Resistance Screening

Palmer amaranth (*Amaranthus palmeri* S. Wats.) is the latest member of the pigweed family in Connecticut. According to a recent weed survey across the US, Palmer amaranth has been ranked as the most problematic weed in several annual and perennial production systems. In the United States, Palmer amaranth is resistant

to many herbicides. In fact, a population was found resistant to at least 5 different herbicide modes-of-action in Arkansas and Kansas. Greenhouse experiments are being conducted at the Valley Laboratory in Windsor to test Palmer amaranth's response to atrazine, chlorimuron, glyphosate, halosulfuron, imazaquin, and several other herbicides.

Palmer amaranth control failure with glyphosate (left, nontreated control; right, 3,360 g glyphosate ae ha^{-1}). Palmer amaranth was treated at the 3-inch height.

Palmer amaranth control failure with ALS-inhibitor herbicides (left, nontreated control; center and right, sulfometuron and chlorimuron herbicides, respectively). Palmer amaranth was treated at the 3-inch height.

Findings:

Research trials in 2019 were conducted under the most unfavorable weather conditions; incessant rains coincided with the treatment application timings. Data have been collected on various response variables. Research will be continued in 2021 and results shared with the stakeholders as early as spring 2022.

Connecticut farmers and the general public have already been made aware via electronic and print media of Palmer amaranth's presence in Connecticut. Additionally, a virtual barn exhibit will be conducted on

Palmer amaranth identification at CAES's annual Plant Science Day on August 5, 2020. Greenhouse dose response studies revealed high levels of herbicide resistance in the newly discovered CT population of Palmer amaranth. This population was resistant to glyphosate up to 4 times and ALS-inhibitor herbicide, imazaquin, up to 16 times the labeled rates to control sensitive Palmer amaranth biotypes. A low level of resistance to atrazine up to 2,240 g ai ha^{-1} was also observed in the CT population. However, this population was effectively controlled with herbicides such as 2,4-D, dicamba, glufosinate, lactofen, oxyfluorfen, and mesotrione, which have different modes-of-action than glyphosate and ALS-inhibitor herbicides.

Preventing Freeze Injury in Peaches and Nectarines

Peaches and nectarines are very susceptible to freeze injury during late winter and early spring months as the buds begin to swell and mature into blossoms. In 2016, over 95% of Connecticut's peach and nectarine crops were lost due to early spring freeze injury. Application of salicylic acid and methyl jasmonate at the bud swell and green tip stages has been reported to consistently delay blooming up to 8 days, increase flowering up to 128%, increase fruit yield by 2 folds. Therefore, field research has been initiated in 2019 at peach and nectarine farms in Cheshire, Ellington, and Windsor in CT to investigate the potential of repeated exogenous applications of these phytohormones at early and late bud swell stages for preventing freeze injury via artificially prolonged bud dormancy.

A peach research site at the Valley Laboratory in Windsor, CT.

Impact:

- Fruit and vegetable growers in Connecticut have effective herbicide options for controlling in different production systems.

Mycology Research

Dr. DeWei Li conducts research on fungal taxonomy, indoor molds of human health concern, fungal succession on water-damaged building materials, and infiltration of fungi from outdoors into residences.

Intercropping Wine-cap Mushrooms in Christmas Trees

A new three-year project started from January 2019 to develop a new intercrop, wine-cap mushroom for Christmas tree farms using woodchip mulch between rows of Christmas trees in Connecticut. The project has dual purposes: 1) develop a new cash crop, wine-cap mushroom for Christmas tree farms; 2) the woodchip mulch will improve root health by controlling weeds and thus preventing damage from herbicides, maintaining cool, moist soil conditions, suppressing injurious root pathogenic nematodes, and adding organic matter into the soils. Four experimental plots have been set up at the Valley Laboratory, Humming Grove Farm and at Jones Family Farm. The cultivation was conducted at all locations, the Valley Lab, Humming Grove Farm and Jones Family Farm. The wine-cap mushrooms have been successfully cultivated at all field plots in the three locations in early fall 2019 and in spring 2020.

Wine cap mushrooms

Impact:

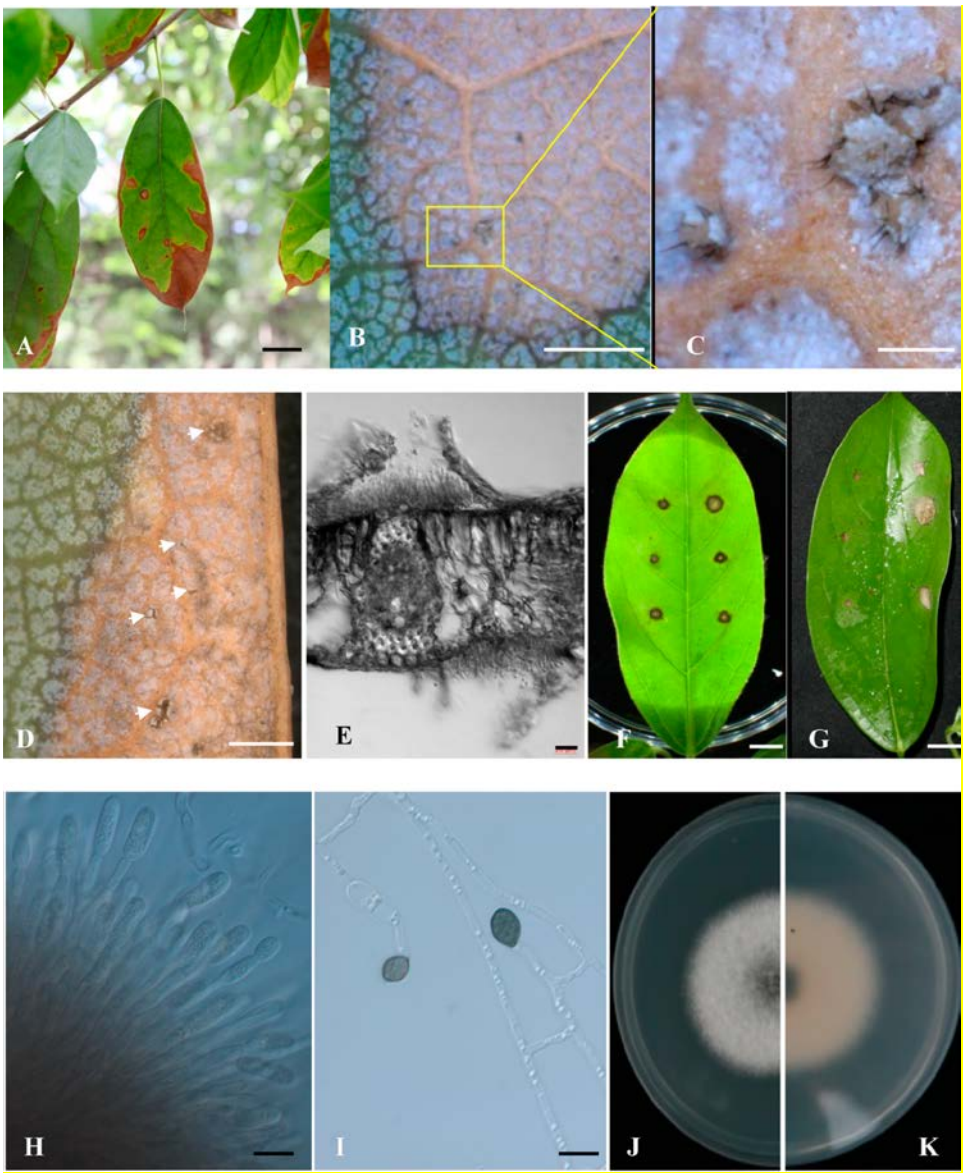
- Wine Cap Mushroom (*Stropharia rugoso-annulata*) is an edible gourmet mushroom. The result of this study will help Christmas tree farmers to develop a new product - wine cap mushrooms while controlling weeds between trees. Fresh wine cap mushrooms have been sold at $5.00/pound. Grocery stores and farmers' markets are potential venues for this produce. The new crop will increase their profit in the future.

Study of New Plant Diseases

A number of newly emerged diseases were studied, including Huechera root rot, a new disease for *Plectosphaerella cucumerina*, leaf blotch on *Acer coriaceifolium* caused by *Colletotrichum gloeosporioides* s.s. (see Figure), and brown apical necrosis of walnut caused by *Fusarium avenaceum*. This results from a collaboration between several plant pathologists/scientists at CAES and in China.

Impact:

- These new diseases of ornamental plants are causing severe damage to the ornamental plants and the landscape. Determination and characterization of these pathogens is imperative for disease management and future studies to fully understand the diseases for finding solutions to these diseases.



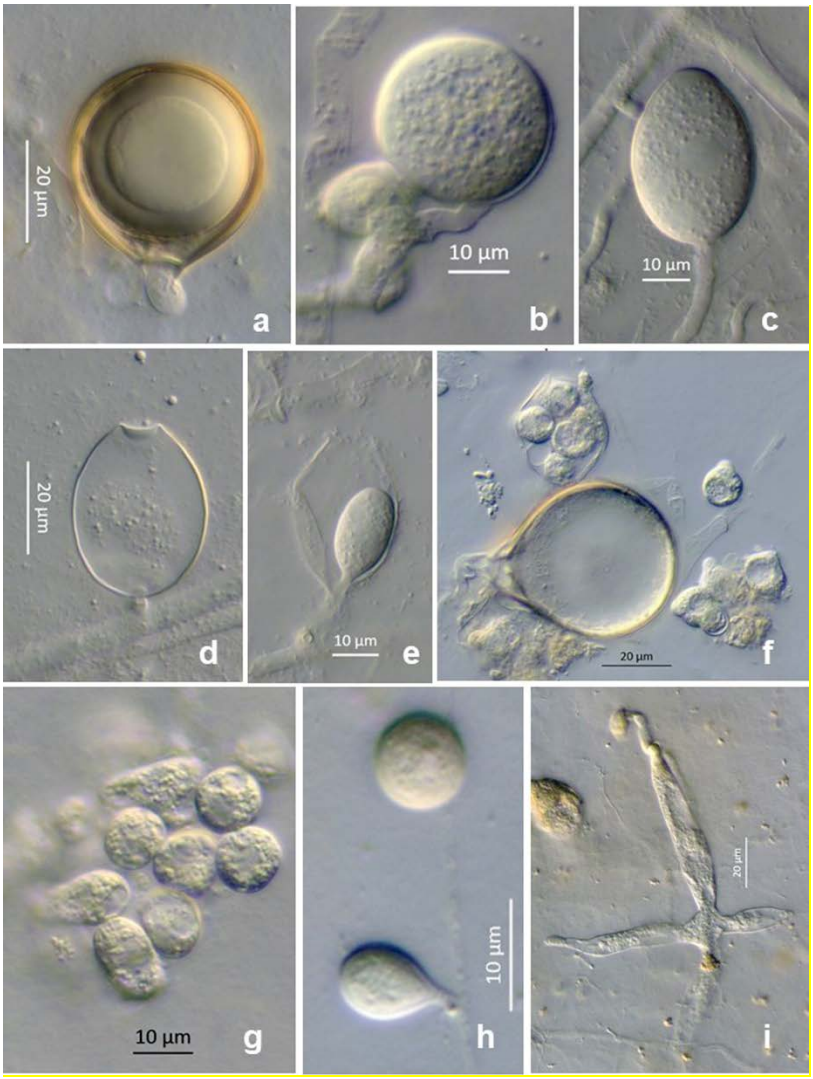
Symptoms of leaf blotch disease on *Acer coriaceifolium* and morphological characters of conidiophores, conidia, appressoria and colony of QS2-1-1. A. Diseased leaves in nature, bar = 2 cm. B-C. Conidial masses and setae on the lesion of infected leaf developed in nature; bar of B = 1 mm, bar of C = 100 µm. D. Conidial masses and setae on a lesion of on the edge of an infected leaf in nature (Arrows indicate conidial masses), bar = 0.5 mm. E. Acervuli on the adaxial and abaxial surfaces of infected leaf developed in nature, bar = 20 µm. F-G. Symptoms on leaf of *A. coriaceifolium* 5 days after inoculated with mycelial plugs and spore suspension of QS2-1-1, bars = 1 cm. H. Conidiophores and conidia of QS2-1-1, bar =10 µm. I. Appressoria of QS2-1-1, bar =10 µm. J-K. Culture of QS2-1-1 on PDA from above and below 5 days after plating.

Fungal Taxonomic Study

This collaborative study with Dr. Neil Schultes and mycologists from several countries: Brazil, Canada, Cuba, China, Mexico, has led to discovery of two new genera, *Natonodosa* and *Morganjonesia* and two new fungal species: *Phytophthora abietivora* and *Natonodosa speciosa.* These new species and genera have been published in three papers. *Phytophthora abietivora* (see Figure) causes a new root rot disease on Christmas trees in Connecticut.

Impact:

- Discovering and describing new fungal species provide very important information to fungal diversity in the world and for the studies, such as pest control, biological resources, fungal ecology and fungal biology. I dentification of plant pathogen, which causes significant loss of farmers, is an important service to local economy, agriculture, and CT farmers. These studies need to identify fungi. The newly described species supplement new information to fungal diversity, resources and conservation and utilization.



Phytophthora abietivora. a. Oogonium and oospore. b. Immature oogonium and antheridium. c. Sporangium, d. Empty sporangium. e. Nesting sporangium f. Zoospores, sporangium, and oogonium. g. Zoospores. h. Chlamydospores. i. Irregular coralloid hyphal swellings.

Plant Disease Research

Tobacco Disease Research

The Connecticut Agricultural Experiment Station Valley Laboratory was established in 1921 as the Tobacco Substation to combat tobacco problems and diseases such as wildfire, a devastating disease caused by a bacterial plant pathogen. Wildfire was eventually eliminated by the development of plant resistance to this pathogen. Ever since, tobacco breeding to incorporate genetic plant resistance to plant pathogens has been used to successfully manage diseases. Plant resistance is the most economical, environmentally responsible, and often most effective way to control diseases. The development of plant resistance to Tobacco Mosaic Virus (TMV) in the 1950s, to ozone damage (weather fleck) in the 1960s, black shank in the 1970s, and Fusarium wilt in the 1980s and early 1990s effectively controlled serious diseases which each threatened to seriously impact or even wipe out cigar wrapper tobacco production in the Connecticut River Valley. There are currently a number of pathogens that threaten the crop. Dr. LaMondia conducts an ongoing breeding program to develop resistance to: *Fusarium oxysporum* (causing Fusarium wilt); *Globodera tabacum* (the tobacco cyst nematode); tobacco mosaic virus, and *Peronospora tabacina* (blue mold) for both shade and broadleaf types. An inbred line, C9 was initially released in 1991 and is still being produced as a wilt and TMV resistant cultivar. A new hybrid with similar resistance profiles and increased uniformity was released as B1 and is being grown commercially. In 2011, a male-sterile F1 hybrid 'B2' highly resistant to Fusarium wilt, TMV and the TCN and with moderate resistance to blue mold and black root rot was released and subsequently licensed. Black shank, caused by *Phytophthora nicotianae*, has re-emerged as a serious pathogen in Connecticut and we working to develop a hybrid broadleaf tobacco wrapper line with significant resistance to the pathogen. Our first candidate line, B3, was evaluated under field conditions in 2014 and 2015 and, while resistant, was found to be lacking in sufficient wrapper leaf quality. Additional crosses are now being made. Black root rot, caused by the fungus *Thielaviopsis basicola*, has been damaging and increasing in impact in recent years with cool wet springs. We obtained sources of dark wrapper tobacco with high levels of black root rot resistance from cooperating scientists in Kentucky. A back-cross program was used to transfer resistance to CT broadleaf, and resistant plants were selected for broadleaf characteristics. Inbreds have been developed and have been used to develop hybrid lines with resistance to multiple pathogens. A number of these lines are being evaluated under commercial conditions and two (D1 and D2) have now been licensed with a seed company for commercial seed production. Breeding for resistance to Potato Virus Y (PVY) has been a high priority, however, the burley tobacco cultivar (TN-86) that is the commercial source of resistance to Potato Virus Y (PVY) has been evaluated and found not to be resistant to the new PVY strains that occur in potato, tobacco, and other solanaceous crops. No source of resistance to the new strains is currently known, so this objective has been put on hold.

Impacts:

- C9 and B1 broadleaf tobacco carry resistance to Fusarium wilt and TMV. C9 has been widely grown since its release (> 80% of acreage) and has prevented more than $5 million in losses each year since 1992. B1 is more uniform and is replacing C9 over time.
- The development of a male-sterile hybrid broadleaf cigar wrapper tobacco with resistance to most of the major pathogens, including Fusarium wilt, TMV, the TCN and blue mold, will allow sustainable production with reduced disease and much reduced pesticide inputs. Growing B2 eliminates the need for nematode management at over $500 per acre per year. New varieties in development are resistant to black root rot, for which there are no current management options.
- B1, B2, D1, and D2 have been released as new cultivars and licensed to a local seed company. Proceeds will support further research on plant resistance. Adding resistance to black root rot will further reduce plant losses to disease.

Hop Research

Hop (*Humulus lupulus*) cultivation in the Northeastern United States dates to the first settlers but disappeared for a century because of disease pressure and the enactment of Prohibition. Subsequently, it was established in the Pacific Northwest, which is currently the largest production area worldwide (53,282 acres; IHGC - 2017 Statistical Report).

Yellow Lupulin glands of female hop cones contain resins, acids, and essential oils, which are responsible for aroma, flavor, and bitterness in beer.

New York State has the largest production area in the Northeast (400 acres, IHGC-2017 Statistical Report) followed by Vermont and Massachusetts (25 acres each; IHGC - 2017 Statistical Report) and Maine (24 acres). Commercial hop production has just started in CT and New Jersey (15 acres each). The increasing popularity of the microbrew culture, local brewpubs, home brewing, and the growing demand for regional products have created a niche market for high quality hops in the Northeast.

Feasibility of Hop Cultivation in Connecticut

A five-year study by Drs. James LaMondia, Katja Maurer, and Elisha Allan-Perkins was conducted to investigate the feasibility of hop production in CT, culminating in a CAES Bulletin entitled "Impact of cultivar, trellis height and pruning on commercial hop production in Connecticut." The most common diseases and pests were downy mildew (which is the most damaging disease in the northeastern U.S.) two-spotted spider mites, and potato leafhoppers, the latter being a unique pest to hops in the Northeast. Diseases and pests can be controlled by intensive scouting rigorous sanitation measures, pesticides, biological controls (e.g., predators), removing weeds, and stripping the lower leaves off of the bines. A region-specific integrated pest management program was established, which includes intensive scouting and timely control measures, and is available as the Guidelines for Integrated Pest Management for Hops in Connecticut. The trial has proven the general feasibility of successful hop production in CT. Within a few years we have gone from nothing to commercial hop yards in production and the incorporation of the Connecticut Hop Growers Association. Two new pests include European corn Borer and a new fungal disease.

European Corn Borer

European corn borer (ECB) is a moth pest whose costly damage to hop bines first became evident in Connecticut in 2019, resulting in significant bine damage and cone loss. ECB is primarily a corn pest but has more than 200 plant hosts and is the most important insect pest in peppers. It is likely that 2019 had the first significant ECB incidence in hopyards due to weather-related delayed corn plantings, as was also the case for Michigan hop growers, whereby moths found hop leaves and bines to be a good alternative for their egg-laying and development.

Adult ECB females are 1/2 - 5/8" long light-yellow moths (Figure 1, lower), with wavy brown markings on their wings. Males are slightly smaller and darker (Figure 1, upper). ECB has a four-stage life cycle: egg, larva/caterpillar, pupa and adult moth. The insects overwinter in the stems of last year's host plants. Based on the lack of significant incidence in hops prior to 2019, corn and other plants are likely preferred hosts compared to hop. However, when host plant seeding, transplanting or emergence is delayed, ECB moths may lay eggs on hop plants as in 2019. In addition, hop bines from the previous year should be buried, burned or managed so that ECB do not overwinter and survive.

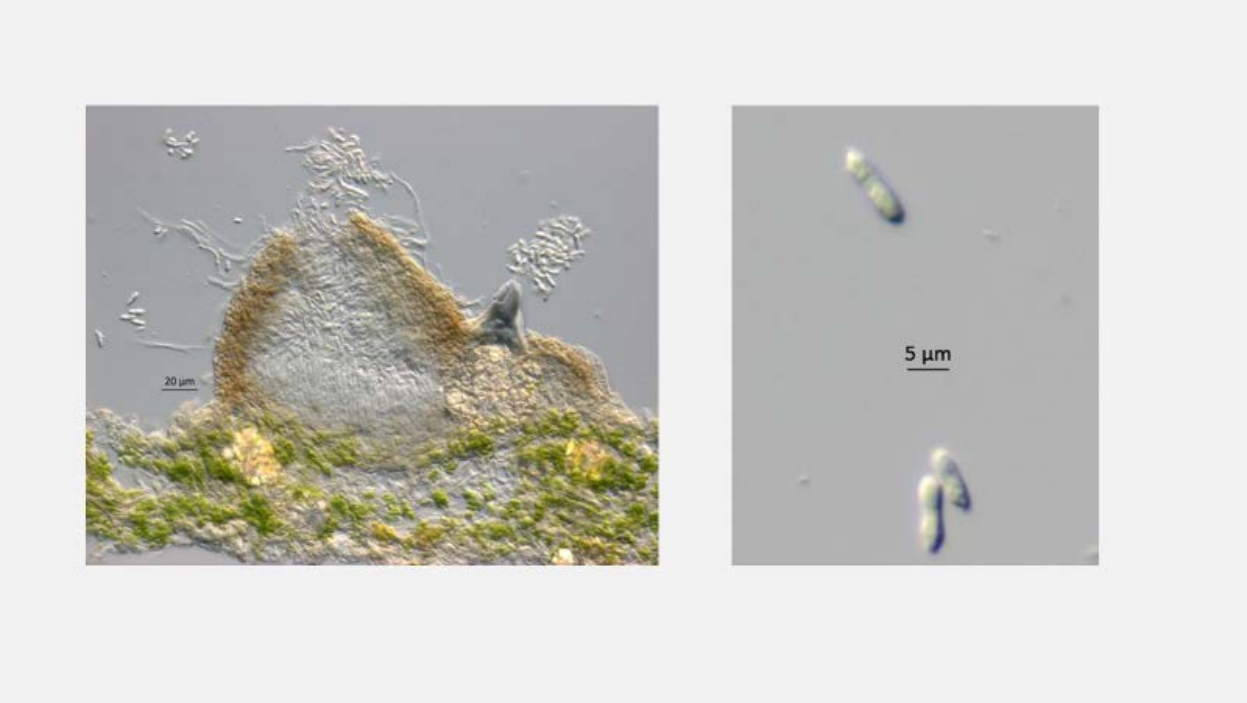
Scout early in the season, after first moth flight, and watch for small larvae and their bore holes. Refer to UConn's pest alert (http://ipm.uconn.edu/pa_vegetable/pestMessages.php), as there are early-season updates on ECB moth flights. Once larvae are inside the bines, contact-pesticides are ineffective since the stem provides a physical protective barrier. Therefore, any pesticide applications should target first generation moths to prevent egg laying or kill younger larvae. Insecticides containing Bt (*Bacillus*

thuringiensis) may also be used before larvae penetrate plants. An early planting of Bt-corn may act as a trap plant, especially for the second generation as there are often 2 generations per year in southern New England. Early monitoring and translaminar systemic insecticide application of spinosads (Entrust) may impede ECB early, before heavy vascular tissue feeding by larvae affect cone production. A foliar application of chlorantraniliprole (Coragen) may also be used. In both cases, control is best attempted before larvae bore into bines.

2019 Field photo of ECB damage.

New and Emerging Diseases of Hops in Connecticut

Drs. Allan-Perkins and LaMondia continually monitored hops in Connecticut for new and emerging diseases. In 2018, a new fungal disease was observed at two research hop yards in Connecticut. This new pathogen affected all hop cultivars being grown and caused leaf spots and browning of cones. The causal organism was isolated, and Koch's postulates were performed to confirm pathogenicity. The disease symptoms were similar to the previously described Phoma wilt; however, morphological and phylogenetic analyses placed the causal organism as a new species of *Diaporthe*. We described the pathogen as a fungus new to science and proposed the name *Diaporthe humulicola*. The disease increased under hot, humid conditions (around 24°C and 90% relative humidity), which prevail during the summer in the northeastern United States as well as other parts of the country. An in vitro preliminary assessment of fungicide sensitivity revealed that pyraclostrobin and boscalid inhibited D. *humulicola* growth in culture and should be further assessed for field efficacy against this new disease of hop. The proper identification and monitoring of this pathogen will be important to inform hop growers of this new threat.



Diaporthe humulicola

Breeding of Wild Connecticut Hops

Hops are native worldwide, with most cultivated varieties for brewing belonging to the European lineage. However, hops are native to North America and can be found growing wild in Connecticut. Nearly a century after hop farming ceased, a few hardy hop plants continue to survive in CT along the edges of farms, forests and in isolated areas. We have identified wild hops in Madison, Sharon, Bloomfield and other locations around CT. Whether these plants are northeast native *Humulus lupulus* var. *lupuloides*, survivors of the European *Humulus lupulus* var. *lupulus* or hybrids of the two variants, our hypothesis is that these plants, which have survived many decades without management, may have resistance or tolerance useful in starting a local hops breeding program. The collection of male plants is especially important. These hops may also have unique flavor or quality characteristics suitable for producing beers with a unique Connecticut terroir. We have collected promising new hop accessions obviously well adapted to Connecticut, to screen them for resistance to pest problems and use these plants as sources of unique characteristics to result in a local hop specialty crop. Wild/native hops were located from 8 different areas ranging from forest to field edges to linear rail trails. Some of the hops found were identified as non-native invasive Japanese hops and not collected. Rhizome pieces or rooted cuttings were started and planted in the CAES Windsor hopyard. Thirty-one plants representing fifteen distinct hop accessions from eight different locations were planted. Overwinter survival from fall 2018 to spring 2019 was determined to be 87%. Hop quality testing determined that native hops alpha acids ranged from 5.4 to 10.5%, and samples were provided to the Connecticut Hop Growers Association for beer production testing. One of the collected hop accessions was a male and crosses are being made to well adapted commercial varieties. The resulting seedlings will be used in a breeding program to establish Connecticut hop varieties that are well-adapted to growing in our climate. This will provide Connecticut hop growers with healthy plant material that may need less management inputs and may have unique flavor profiles that will be desirable in the brewing industry.

Impact:

- Hop cultivation increased from a curiosity crop to commercial acreage with a Hop Growers Association, and a pelletizing facility.

Boxwood Blight

Boxwood blight is a new, introduced disease in Connecticut. The fungus that causes boxwood blight, *Calonectria pseudonaviculata* (*C.ps*), forms leaf spot and stem lesions resulting in defoliation and dieback of boxwood. The impact of the disease has been very high; boxwood plant losses in nurseries were estimated at over $5.5 million in Connecticut in the first two years since October 2011. While production nurseries have not experienced problems in Connecticut, boxwood blight has been widespread and damaging in landscapes in 2018 due to wet conditions conducive to disease.

Movement of *C. pseudonaviculata* Through a Landscape

Boxwoods are an important component of established landscapes, especially historical plantings in which they are highly valued. A better understanding of how boxwood blight moves through a landscape from an infected plant to other cultivars and how fungicides can be used to manage disease spread are important for preserving boxwoods in landscapes. Dr. LaMondia is conducting the second year of a field trial to determine how an infected boxwood plant will spread infection to surrounding boxwoods under conditions of no fungicide treatments, the use of a protectant spray (a fungicide that stays on the surface of the plant), and the combination of protectant sprays with systemic sprays (fungicides that move into the plant). The fungicide treatments are evaluated using a calendar-based spray approach (every month regardless of disease detection or weather) versus an incidence-based spray approach (fungicides will only be applied after disease is detected). Additionally, temperature and humidity are monitored in the plot to determine how these two environmental conditions affect disease development. The first and second-year results showed a strong dependency on heat and moisture for disease spread. Plant susceptibility was more important than fungicide treatment in effect on movement of the disease. These results will help develop better management practices to reduce or prevent the spread of boxwood blight through established landscapes, including historical plantings.

Our results to date have shown that there were fewer boxwood blight lesions on the plant adjacent to the source plant when fungicides were applied than when they were not. There were no differences between protectant fungicides alone versus protectant plus systemic fungicides in this experiment. Cultivar susceptibility also played a role, as English suffruticosa had significantly more lesions than Green Velvet or Winter Gem despite being only planted in the second year (replacing Tide Hill that suffered winter damage) and being significantly smaller in size. We did not have enough disease, spread and time to determine whether there were interactions between cultivar susceptibility and fungicide protection.


Field plots for boxwood blight management.

Boxwood blight severity on plants adjacent to the source (infected) plant on June 19 and August 6, 2019.

		Boxwood blight lesions on plant #1	
Treatment	Variety	June 19	Aug 6
Untreated	English	5.0	4.5
Untreated	Green Velvet	29.8	0.8
Untreated	Winter Gem	8.8	0.5
Protectant	English	0.5	0.5
Protectant	Green Velvet	1.8	0.1
Protectant	Winter Gem	0.6	0.0
Protectant+Systemic	English	0.8	1.4
Protectant+Systemic	Green Velvet	0.1	0.1
Protectant+Systemic	Winter Gem	1.5	0.1

Fungicide treatment	leaf lesions per plant August
Untreated	1.9 A
Protectant	0.2 B
Protectant plus systemic	0.5 AB

Variety	leaf lesions per plant August
English	1.7 A
Green Velvet	0.3 B
Winter Gem	0.2 B

Epidemiology – dispersal of conidia of Boxwood Blight

We investigated *Calonectria pseudonaviculata* conidial dispersal from sporulating lesions on boxwood leaves and sporulating cultures on half-strength PDA (½ PDA). *Botrytis cinerea* infected blossoms were used as a control. Dispersal of *C. pseudonaviculata* or *Botrytis* conidia was confirmed by capture using an Allergenco air sampler at 15 liters/min and by microscopic observation of conidia and *C. pseudonaviculata* growth on 15-cm-d ½ PDA Petri dishes. *C. pseudonaviculata* conidia were not dispersed by either dry or moist air currents directed at conidia and conidiophores from 2 mm away at air speeds of 19.8 m/s for 10 min or by a fine mist with water droplets (mean diam. 20µ) with air speeds of 1.7 m/s. *C. pseudonaviculata* spores were dispersed by splash of water droplets at air speeds of 9.0 to 19.8 m/s. *C. pseudonaviculata* conidia released from phialides by water could not be wind dispersed after the water had evaporated. Secondary water dispersal was reduced as conidia strongly adhered to a surface after drying. Boxwood leaves dropped from heights of 15, 33, or 66 cm landed with more than 60% of leaves facing abaxial surface up. The cupped shape of most boxwood leaves may result in the abaxial surface with sporulation facing up. That orientation may also aid in retention of water films to wet and release conidia for splash dispersal. This is consistent with observations of increased disease severity in lower boxwood canopies and reinforces suggestions for best management practices including mulching and pruning lower branches to reduce the incidence and severity of disease.

Airborne particles were collected over a 10-minute period using an Allergenco MK-3 air sampler at a 15 liters/min air flow rate placed 5 to 20-cm downstream from the source of conidia.

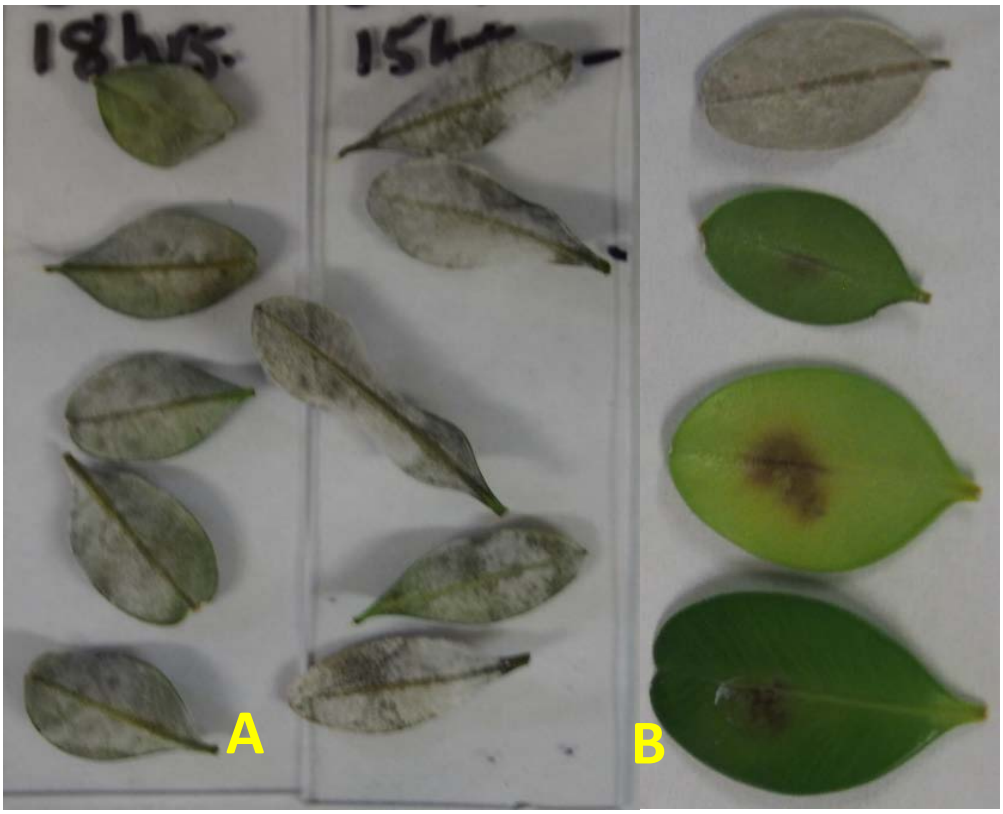
Epidemiology – effects of temperature and leaf wetness duration on infection

The objective of this study was to evaluate the effect of leaf wetness period and temperature on infection rate and sporulation on three boxwood cultivars with different level of susceptibility under controlled conditions. Three boxwood cultivars; Suffruticosa (highly susceptible), Green Velvet (moderately susceptible), and Winter Gem (less susceptible) have been evaluated in terms of disease development and sporulation in detached leaf assay studies at four different temperatures and six different periods of leaf wetness (8, 12, 15, 18, 21, and 24 hr). These experiments were conducted in four growth chambers that

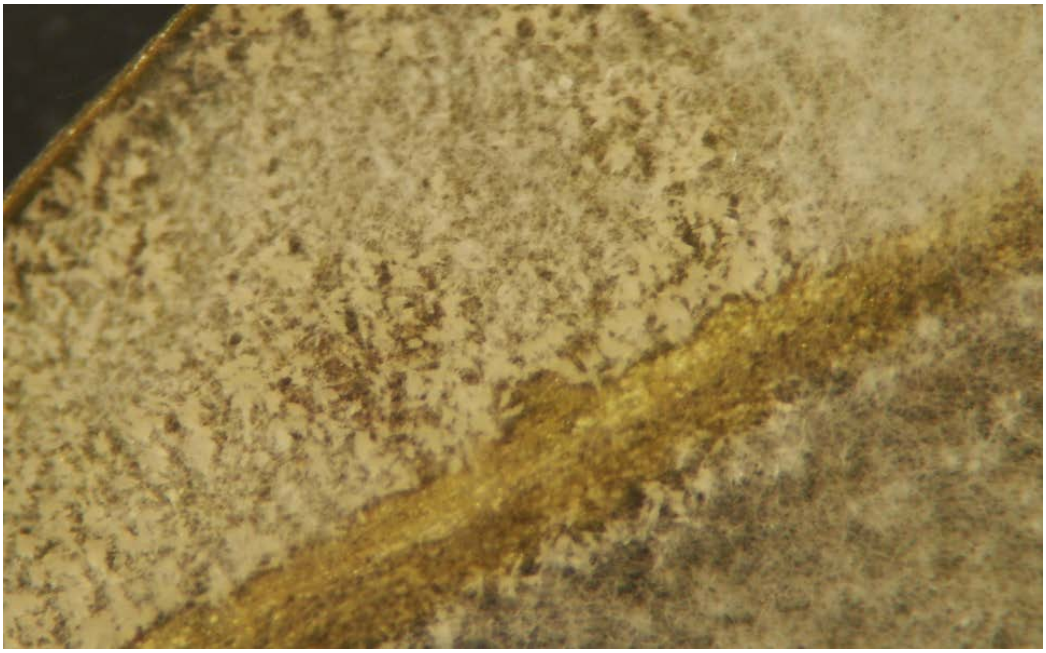
were set to 18, 22, 25, and 30°C. Fully expanded leaves from three boxwood cultivars were collected. Leaves were surface sterilized by washing them in 10% bleach solution for 30s, then rinsed two times with tap water for 30s each time. The leaves were air dried and placed on labelled glass slides in a petri dish (9-cm diameter), five leaves with adaxial surface facing upward per slide and two slides in each Petri plate per treatment, and inoculated with one drop of spore solution. The Petri plates were placed them in 45.7 X 30.5 X 15.2 cm; 13.2 L capacity humidity chambers and incubated in growth chambers. After respective wetness period of treatments, drop was drained from the leaf and allowed leaf to dry for 15 min at room temperature before returned to the moist chambers.

Data collection: Humidity chambers were opened for data collection at 3, 6, and 9 DPI. Number of leaves of each cultivar with infection and sporulation was recorded from different treatments.

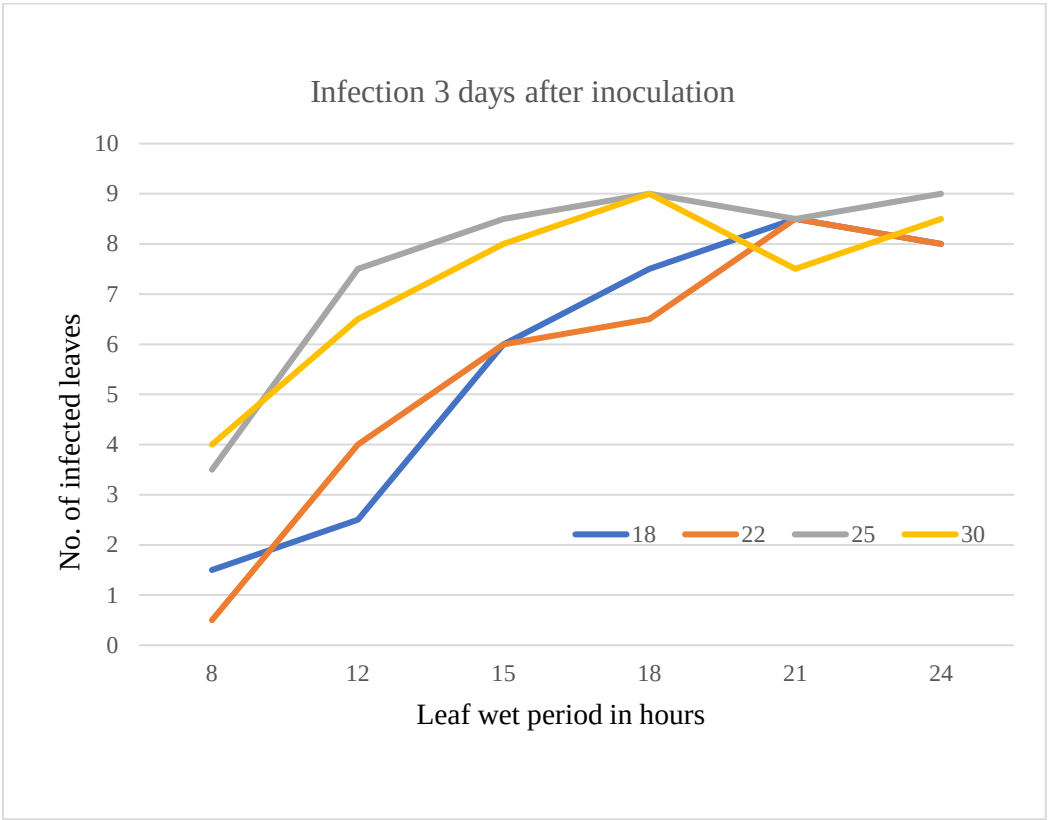
- Leaf infection were observed three days after inoculations in high humidity moisture chambers
- The greatest number of infected leaves noticed at 21, and 24 hours, followed by 18 hours of leaf wetness period, and was lowest for 4-12 hours
- The highest rate infection and sporulation was observed at 25°C with humidity > 95%
- Our results indicate that the relative humidity has great impact on disease development
- Temperatures between 18 and 24°C highly favorable for the infection and sporulation
- Leaf wetness period of 15-24h favorable for boxwood blight and there is no difference in the disease incidence between 21 and 24h of leaf wetness



A) Boxwood leaves with heavy infection and sporulation by *Calonectria pseudonaviculata.* B) Initial disease symptoms on leaves.



Microscopic view of conidia on abaxial side of heavily infected boxwood leaf.



Infection rate on susceptible boxwood cultivar after three days of infection.

Impact:

- This identification of resistant boxwood and development of epidemiological data on spread and infection study will aid in developing better disease prediction models and effective management strategies.

Development of the Boxwood Blight Resistance Evaluation Program

The breeding of disease-tolerant boxwood cultivars is important for reducing the incidence of boxwood blight in Connecticut while providing landscapers with cultivars that have desired traits. In order to better assess boxwood tolerance to blight among cultivars, Dr. LaMondia is collaborating with researchers across the United States to create a standard protocol for boxwood evaluations that can be conducted across institutions. This will include rating cultivars against previously tested plants to assign a scaling of 1 (most susceptible) to 5 (least susceptible). The evaluation program began in 2018 and has grown in its second year to include a total of 21 cultivars being assayed at the Valley Laboratory and at 3 other institutions in the United States. These ratings will be used by plant breeders to assess tolerance and by nurseries to convey susceptibilities to consumers.

We evaluated 15 replications of 15 boxwood varieties obtained from Saunders Brothers and 3 from Willoway Nurseries in Ohio as #1 size plants. They were: Calgary; Cranberry Creek; Dee Runk; Green Gem; Green Beauty; Franklin's Gem; Green Mountain; Green Velvet; Justin Brouwers; Little Missy; Nana; sempervirens; Vardar Valley; Winter Gem; Sprinter; two SB lines and English/suffruticosa. The Calgary, Cranberry Creek, and Sprinter were from Willoway. Plants were inoculated with 3.5×10^6 per plant under ideal conditions (average temperature 21.5C, high 27, low 15C raining with rain and high humidity continuing over the following week), in a white plastic hoop house to allow us to separate the less susceptible varieties. We observed a very good range of responses in these varieties that were pretty consistent within variety so this should be a good first step towards achieving the goal of defining resistance and susceptibility in boxwoods. We evaluated percent leaf infection, leaf and stem lesions per plant and percent defoliation. The very susceptible varieties such as *B. suffruticosa* were severely diseased and *B. suffruticosa* was eventually killed.

The data obtained is listed below in the Table. The number of lesions is from the first evaluation of disease resulting from the initial inoculation. That indicates susceptibility from the initial inoculum source which was the same for all plants. We continued to count lesions over time (which is influenced by the number of spores produced from the first set of lesions and speed of spore production so the inoculum each plant receives may be different as the epidemic progresses) but in some cases, the lesion number actually went down as lesions coalesced and leaves dropped. The AUDPC (area under the disease progress curve) somewhat corrects for that over time. We also evaluated the percent of the leaf area infected in the initial disease evaluation to take into account plant size. Each variety is ranked for each data point and averaged overall in the last column. Each of the data types tells us something a bit different. In total we should be able to understand differences such as Nana has a fair amount of early infection, but little disease developed over time, so it likely did not produce secondary inoculum. Sprinter ranked slightly worse overall than English, but only because it was significantly bigger and could have more lesions with less of the leaf area affected. The preliminary first variety evaluation resulting from the screen can be read as very susceptible (red), susceptible (no color), moderately susceptible (yellow) and less susceptible (green).

Boxwood Variety Blight Susceptibility Evaluation

Variety	# plants	# lesions	Percent infected	AUDPC	Overall Rank
Little Missy	15	9.3 (2)	0.3 (1)	43 (2)	1
Winter Gem	15	6.7 (1)	2.5 (4)	76 (5)	2

Franklin's Gem	15	14.7 (5)	1.0 (3)	46 (3)	3
Nana	15	56.3 (10)	0.5 (2)	32 (1)	4
Green Mountain	15	12.5 (3)	2.8 (6)	70 (4)	4
Green Beauty	15	14.4 (4)	2.5 (5)	103 (7)	6
SB 108	15	22.1 (7)	3.7 (8)	101 (6)	7
SB 300	15	17.6 (6)	3.5 (7)	112 (8)	7
Green Gem	15	23.7 (8)	3.8 (9)	209 (10)	9
sempervirens	15	78.7 (12)	5.2 (10)	184 (9)	10
Dee Runk	15	33.1 (9)	12.3 (13)	251 (11)	11
Green Velvet	15	115.7 (14)	8.0 (12)	409 (12)	12
Justin Brouwers	15	91.5 (13)	6.9 (11)	559 (14)	12
Vardar Valley	15	67.5 (11)	16.7 (14)	490 (13)	12
Cranberry Creek	12	452.7 (16)	18.8 (15)	1098 (15)	15
Calgary	12	1216.3 (17)	32.5 (16)	1280 (16)	16
English/ suffruticosa	15	258.1 (15)	87.3 (18)	2163 (18)	17
Sprinter	12	2953.3 (18)	47.9 (17)	1542 (17)	18

VALLEY LABORATORY SERVICE ACTIVITIES

Requests for Information

A total of 6,241 inquiries were answered at the Valley Laboratory during the past year. The majority of these queries were answered by Ms. Rose Hiskes (53%) in the inquiry office (65% of these from the public sector) or by Dr. LaMondia (18% of total inquiries; 82% of which were commercial). About 65% of the information requests to the inquiry office were from the public sector; the remainder was from commercial growers, government, nonprofit, educational, or other (35%). The majority of inquiries answered by Ms. Hiskes concerned insects (29%), diseases (13%), pesticides (15%), or horticulture (7%). Most concerned landscape and nursery (41%), vegetable (7%), and structural entomology (10%). Dr. LaMondia responded to disease (55%), horticulture (25%), insect (5%), fertility (4%), pesticide (4%), weed (1%), and animal (1%) inquiries. These inquiries primarily concerned tobacco (40%), nursery and landscape (39%), hops (8%), vegetables (6%), fruit (4%), and golf turf (3%). All scientists and many of the staff at the Valley Laboratory assist growers and homeowners.

Valley Laboratory scientists made 51 presentations to grower, professional, and citizen groups (about 3,200 people), were interviewed 17 times, and made 147 visits to commercial nurseries, greenhouses, farms, forests, and landscapes to diagnose complex problems or conduct research projects. Dr. LaMondia maintains surveillance to notify the Connecticut River Valley growers about the presence and likely threat of tobacco blue mold disease in North America and inform about management options. His laboratory conducted 172 nematode diagnostic samples and conducts testing as an APHIS certified pinewood nematode export testing facility.

Soil Testing

A total of 3,793 soil tests were expertly performed by Ms. Diane Riddle during the past year. About 55% were performed for commercial growers and 45% for homeowners. Of the commercial samples submitted, 57% were for landscapers; 13% for tobacco growers; 4% for vegetable growers, 7% for municipalities, 2% for golf course superintendents; 2% for nursery growers; 2% for small fruit, 4% for Christmas tree growers, and 4% for research.

Impact:

- Approximately 25% of soil samples tested did not require additional fertilizer. Reducing the over-application of fertilizers protects the environment.

The Gordon S. Taylor Conference Room

Many agricultural organizations used the conference room at the Valley Laboratory regularly for their meetings. During the past year 10 different groups used the room on 27 occasions. Our most frequent users were the CT. Rhododendron Society, CT Invasive Plants Working Group, Invasive Plant Council, CT. Nursery & Landscape Association, Land Trust Alliance North East Program, CT. Vineyard & Winery Association, West Hartford Farmers Market, Forest Practices Advisory Board, and the F.E.M.C. Ms. Jane Canepa-Morrison scheduled the meetings and James Preste and Isaac Buabeng arranged the furniture and ensured that the room was available after hours. The Conference Room was closed to the public on March 16 and remained closed through the rest of the fiscal year.

Valley Laboratory Information Office Insect, Disease and Plant Health Inquiries

Ms. Rose Hiskes diagnosed a wide range of insect, disease, weed and plant health problems on herbaceous and woody ornamentals, lawns, vegetables, fruit and Christmas trees for homeowners, commercial businesses, other government agencies and nonprofits. Because of the COVID-19 virus, our offices closed to the public in mid-March. We continued to take public samples via a covered bin outside on a table in a protected entryway. Samples were processed in such a way as to keep staff safe.

Insects

During the fall, spring and summer months, insect pests, such as chinch bugs, white grubs, the dusky birch sawfly and butternut curculio affected lawns, trees, shrubs and flowers in landscapes. Delusory parasitosis, a sensation of being bitten by insects, was a problem for many clients in the past year. The spotted lanternfly continues to loom on our horticultural horizon in Connecticut.

Connecticut lawns continue to suffer from chinch bugs and white grubs. Chinch bugs were active in lawns into October and showed up again in June this year. One turf sample came in in early June with both chinch bugs and over 1” of thatch. As of mid-July 2020, we’ve received oriental beetle corpses from dryer vents, a report of 30-40 Asiatic garden beetles in a pot of basil and a report from a man who caught an oriental beetle inside his shirt. While adult white grubs (Japanese beetle, Asiatic garden beetle, Oriental beetle, European chafer) feed on the foliage of many herbaceous and woody plants, the larvae are root feeders on just as many herbaceous and woody plants.

While the birch leaf miner has almost disappeared from the Connecticut landscape, another birch pest, the dusky birch sawfly, is being brought into the office more. This pest overwinters as a pupa in the ground. Adults lay eggs on gray, black, paper and yellow birch in May. If the first generation is not controlled, the second generation is much larger, causing extensive defoliation. Larvae behave in typical sawfly manner, when motion or changes in light are detected, they rear up their heads in unison. They feed as a group from the outer leaf margin inward.

A walnut sample was submitted in early June, with many tips hollowed out and spots on the leaves. Thousand cankers disease immediately came to mind. On examination two larvae were found burrowing in the tips. A teneral adult was crushed in the process. After consulting with Dr. Alicia Bray, Central

Connecticut State University, who did a post doc on thousand cankers, it was determined that insect behavior was not consistent with the twig beetle that vectors thousand cankers disease. Larvae found in the sample were confirmed to be butternut curculio.

Prior to COVID-19 and worries at nurseries, garden centers, orchards, vegetable farms and retail stores about keeping employees and shoppers healthy; the spotted lanternfly (Figure 1) was a top worry. Would it be found established somewhere in Connecticut with trees dripping sap or on vines full of red and black bugs in vineyards? COVID-19 will not slow the natural movement of this insect, but because of less human travel, chances of human spread of this pest have lessened. As of the mid-July this insect has not been reported again in Connecticut. Educational material in the form of fact sheets and wallet ID cards were given out at Plant Science Day, August 7, 2019, and the Big E, September 17, 2019. The Connecticut Biology Teachers Association and many garden clubs came to the office to get literature on this pest to hand out to their members. Hopefully we can get an early detection and rapid response when this pest is found in Connecticut.

Figure 1. Spotted lanternfly adult laying eggs. Photo by Greg Hoover

Human insect pests continue to create problems for Connecticut citizens. While bedbug numbers declined in this office, the number of people coming in with delusory parasitosis increased. Under stressful conditions and at times because of medication side effects, people can feel they are being bitten by insects when no insects are present. Will the stresses of COVID-19 and related unemployment cause an even greater uptick in this problem?

Diseases

Last October, lawn samples came in with rust disease, which is favored by the cool temperatures and rains of fall. This leaf disease produces rust colored spores in primarily Kentucky bluegrass and perennial ryegrass. Culturally, keeping grass growing vigorously causes the spores to be mowed off before this disease becomes full blown. In June lawn samples were submitted with *Pythium* blight during a period of hot, humid, wet weather. This is a foliar disease and once weather cools and rains space out further, most grasses recover. For homeowners, it is usually not worth it to apply turf fungicides.

Woody plants and annuals had various diseases this year. During spring 2020 red maple samples came in at a high rate with anthracnose. As leaves emerged the weather was quite cold and rainy. Though infection happened then, symptoms did not show up until June. Depending on the initial health of the tree, this is usually only an aesthetic problem and no treatments are necessary. Downy mildew on sunflower (Figure 2) showed up late June. Like *Pythium*, this is a disease favored by hot, humid weather and warm nights. Plants become severely infected quickly and roguing, or removing the plants, is the only viable solution to the problem.

Figure 2. Downy mildew on sunflower. Photo by Diane Ohanian.

With many people working at home or out of work, more people are gardening. Vegetable gardening was key to the World Wars I and II effort and can help during the COVID-19 pandemic. Tomatoes are a favorite but subject to many diseases. Septoria and early blight samples have come into the office. Sweet green bell pepper plants have been brought in with bacterial leaf spot. Bloat nematode continues to show up on garlic in the state. Once infected, removal and careful selection of clean seed sources are important to containing this problem. Long rotations are needed away from garlic along with cleaning and disinfesting of workers, tools and equipment.

Weeds and Herbicides

Homeowners fight weeds in their landscapes. Some weeds are quite invasive in behavior, but because they are native, cannot be put on the state's invasive plant list. Trumpet creeper (*Campsis radicans*) and staghorn sumac are two native plants that are very aggressive and were problems for Connecticut gardeners this year.

Plant Health - Weather

Connecticut's weather continues to change. May 9 was the last snowfall for Connecticut this spring. Cold tolerant cole crops, planted in the warmth of late March, did nothing during the cold month of April this year. Then, in the heat of late May, they promptly bolted and bloomed with little harvest.

Frost, for most of the northern part of the state, came October 15-16. May 9-10 was the last freeze for the winter.

Impact: Accurate identification of pests of agricultural and human health significance has resulted in economic savings to commercial growers and homeowners, reduced human and environmental exposure to pesticides, and increased human safety.

SCIENTIFIC JOURNAL ARTICLES PUBLISHED BY STAFF DURING 2019-2020

Adisa, I. O., S. Rawat, V. L. R. Pullagurala, C. O. Dimkpa, **W. H. Elmer**, **J. C. White**, J. R. Peralta-Videa, and J. L. Gardea-Torresdey. 2020. Nutritional status of tomato (*Solanum lycopersicum*) fruit grown in Fusarium-infested soil: Impact of cerium oxide nanoparticles. *J. Agric. Food Chem.* 68(7):1986-1997, https://doi.org/10.1021/acs.jafc.9b06840.

An, J., P. Hu, F. Li, H. Wu, Y. Shen, **J. C. White**, X. Tian, Z. Li, and J. P. Giraldo. 2020. Molecular mechanisms of plant salinity stress tolerance improvement by seed priming with cerium oxide nanoparticles. *Environ. Sci: Nano*. https://doi.org/10.1039/D0EN00387E.

Armstrong, P. M., H. Y. Ehrlich, T. Magalhaes, M. R. Miller, P. J. Conway, **A. Bransfield**, **M. J. Misencik**, **A. Gloria-Soria**, J. L. Warren, **T. G. Andreadis**, **J. J. Shepard**, B. D. Foy, V. E. Pitzer, and **D. E. Brackney**. 2020. Successive blood meals enhance virus dissemination within mosquitoes and increase transmission potential. *Nat. Microbiol*. 5(2):239-247, https://doi.org/10.1038/s41564-019-0619-y.

Aulakh, J. S. 2020. Gemini G herbicide safety to *Sedum album* and *Sedum rupestre*. *Proceedings of the Northeastern Weed Science Society* 5:52.

Aulakh, J. S. 2020. Palmer amaranth: A new devastating weed at your doorsteps. *The Real Tree Line* 60(2):22.

Aulakh, J. S. 2020. Role of nitrogen and herbicides in integrated management of mugwort (*Artemisia vulgaris* L.) in cool-season forage grasses. *Invasive Plant Sci. Manag.* 1-32, doi: 10.1017/inp.2020.19.

Aulakh, J. S. 2020. Weed control efficacy and Canaan Fir (*Abies balsamea 'var. phanerolepis'*)'s tolerance to different preemergence herbicides. *Weed Technol.* 34:202-213.

Aulakh, J. S. 2020. Weed management update--indaziflam safety to Christmas trees in Connecticut. *The Real Tree Line* 60(1):12-13.

Baidaliuk, A., S. Lequime, I. Moltini-Conclois, S. Dabo, L. B. Dickson, M. Prot, V. Duong, P. Dussart, S. Boyer, C. Shi, J. Matthijnssens, J. Guglielmini, **A. Gloria-Soria**, E. Simon-Lorière, and L. Lambrechts. 2020. Novel genome sequences of cell-fusing agent virus allow comparison of virus phylogeny with the genetic structure of *Aedes aegypti* populations. *Virus Evol.* 6(1):veaa018, https://doi.org/10.1093/ve/veaa018.

Barandun, J., M. Hunziker, **C. R. Vossbrinck**, and S. Klinge. 2019. Evolutionary compaction and adaptation visualized by the structure of the dormant microsporidian ribosome. *Nat. Microbiol.* 4(11):1798-1804.

Bindraban, P. S., C. O. Dimkpa, **J. C. White**, F. A. Franklin, A. Melse-Boonstra, N. Koele, R. Pandey, J. Rodenburg, K. Senthilkumar, P. Demokritou, and S. Schmidt. 2020. Safeguarding human and planetary health demands a fertilizer sector transformation. *Plants, People, Planet* 2:302-309, https://doi.org/10.1002/ppp3.10098.

Borges, D. F., S. Preising, M. M. D. Q. Ambrósio, and **W. L. da Silva**. 2020. Detection of multiple grapevine viruses in New England vineyards. *Crop Protection* 132:105143, https://doi.org/10.1016/j.cropro.2020.105143.

Brackney, D. E., M. A. Correa, and **D. W. Cozens**. 2020. The impact of autophagy on arbovirus infection of mosquito cells. *PLOS Negl. Trop. Dis.* 14(5), https://doi.org/10.1371/journal.pntd.0007754.

Brazee, N., and **R. E. Marra**. 2019. Incidence of internal decay in American elms (*Ulmus americana*) under regular fungicide injection to manage Dutch elm disease. *Arboric. Urban For.* 46(1):1-11.

Buchman, J. T., **W. H. Elmer**, **C. Ma**, K. M. Landy, **J. C. White**, and C. L. Haynes. 2019. Chitosan-coated mesoporous silica nanoparticle treatment of *Citrullus lanatus* (Watermelon): Enhanced fungal disease suppression and modulated expression of stress-related genes. *ACS Sustain. Chem. Eng.* 7:19649-19659, https://doi.org/10.1021/acssuschemeng.9b04800.

Cao, X., G. M. DeLoid, D. Bitounisa, **R. De La Torre-Roche**, **J. C. White**, Z. Zhang, H. C. Guan, K. W. Nga, W. Zhong, **B. D. Eitzer**, and P. Demokritou. 2019. Co-exposure of food additives SiO_2 (E551) and TiO_2 (E171) with pesticide boscalid and effects on cytotoxicity and bioavailability of boscalid using a tri-culture small intestinal epithelium cell model: Potential health implications. *Environ. Sci.: Nano*. DOI: 10.1039/c9en00676a.

Cao, Y., **C. Ma**, H. Chen, G. Chen, **J. C. White**, and B. Xing. 2019. Copper stress in flooded soil: Impact on enzyme activities, microbial community composition and diversity in the rhizosphere of *Salix integra*. *Sci. Tot. Environ*. 704:135350, https://doi.org/10.1016/j.scitotenv.2019.135350.

Cao, Y., **C. Ma**, H. Chen, J. Zhang, **J. C. White**, G. Chen, and B. Xing. 2020. Xylem-based long-distance transport and phloem remobilization of copper in *Salix integra* Thunb. *J. Haz. Mat*. 392:122428, https://doi.org/10.1016/j.jhazmat.2020.122428.

Centrella, M., L. Russo, N. M. Ramirez, **B. D. Eitzer**, M. Van Dyke, B. Danforth, and K. Poveda. 2020. Diet diversity and pesticide risk mediate the negative effects of land use change on solitary bee offspring production. *J. Appl. Ecol.* https://doi.org/10.1111/1365-2664.13600.

Cheah, C., and D. Ellis. 2019. Spread of mile-a-minute vine, *Persicaria perfoliata* L. (Polgonaceae), to Connecticut islands in Long Island Sound. *Rhodora* 121(987):219-221, doi: 10.3119/19-02.

Cheah, C. 2019. Battling mile-a-minute weed in Connecticut. *The Habitat* 31(2):6-7.

Chen, F., J. Ye, A. K. S. Kameshwar, X. Wu, J. Ren, W. Qin, and **D. W. Li**. 2020. A novel cold-adaptive endo-1,4-β-glucanase from *Burkholderia pyrrocinia* JK-SH007: Gene expression and characterization of the enzyme and mode of action. *Front. Microbiol.* 10(3137):1-11, https://doi.org/10.3389/fmicb.2019.03137.

Cosme, L. V., **A. Gloria-Soria**, A. Caccone, J. R. Powell, and A. J. Martins. 2020. Evolution of kdr haplotypes in worldwide populations of *Aedes aegypti*: Independent origins of the F1534C kdr mutation. *PLOS Negl. Trop. Dis.* 14(4), p.e0008219.

Cowles, R. S. 2020. Guide to fertilizing Christmas trees, using results from the CAES soil testing labs. *The Real Tree Line* 60(2):13.

Cowles, R. S. 2020. Managing aphids and adelgids: The special role for imidacloprid (Part 1). *Great Lakes Christmas Tree Journal* 16(2):34-38.

Cowles, R. S. 2020. Managing aphids and adelgids: The special role for imidacloprid (Part 1). *The Real Tree Line* 60(2):16-18.

Cowles, R. S. 2020. Managing root aphids and white grubs: The special role for imidacloprid (Part 2). *The Real Tree Line* 60(2):19-20.

Cowles, R. S. 2020. Mineral nutrition, soil tests, and cost-effective use of fertilizers for growing Christmas trees. *The Real Tree Line* 60(1):16-17.

Cowles, R. S. 2020. Sulfur amendment of soil improves establishment and growth of firs in a field naturally infested with Phytophthora. *J. Environ. Hort.* 38(1):15-21.

Cowles, R. S. 2020. White pine weevil management in Christmas tree plantations. *Great Lakes Christmas Tree Journal* 16(1):28-30.

Cowles, R. S. 2020. Zimmerman pine moth biology and management. *Great Lakes Christmas Tree Journal* 16(1):20-21.

da Silva, W. L., K. T. Yang, G. S. Pettis, N. R. Soares, R. Giorno, and C. A. Clark. 2019. Flooding-associated soft rot of sweetpotato storage roots caused by distinct *Clostridium* isolates. *Plant Dis.* 103(12):3050-3056, https://doi.org/10.1094/PDIS-03-19-0548-RE.

Dimkpa, C. O., J. Andrews, J. Sanabria, U. Singh, **W. H. Elmer**, and **J. C. White**. 2020. Interactive effects of drought, organic matter, and zinc oxide nano and bulk particles on wheat performance and grain nutrient accumulation. *Sci. Tot. Environ.* 722:137808, https://doi.org/10.1016/j.scitotenv.2020.137808.

Dimkpa, C. O., J. Andrews, J. Fugice, U. Singh, P. S. Bindraban, **W. H. Elmer**, J. L. Gardea-Torresdey, and **J. C. White**. 2020. Facile coating of urea with low-dose ZnO nanoparticles promotes wheat performance and enhances Zn uptake under drought stress. *Front. Plant Sci*. 11:168, doi: 10.3389/fpls.2020.00168.

Eastwood, G., A. K. Donnellycolt, **J. J. Shepard**, **M. J. Misencik**, R. Bedoukian, L. Cole, **P. M. Armstrong**, and **T. G. Andreadis**. 2020. Evaluation of novel trapping lures for monitoring exotic and native container-inhabiting *Aedes* spp. (Diptera: Culicidae) mosquitoes. *J. Med. Entomol.* 57(2):534-541.

Eisen, L., and **K. C. Stafford III**. 2020. Barriers to effective tick management and tick bite prevention in the United States [Forum]. *J. Med. Entomol*. tjaa079, https://doi.org/10.1093/jme/tjaa079.

Elmer, W., **D. W. Li**, S. Yavuz, A. Madeiras, and **N. Schultes**. 2019. Heuchera root rot, a new disease for *Plectosphaerella cucumerina*. *J. Phytopath.* 168(1):56-62, https://doi.org/10.1111/jph.12867.

Funk, A., **R. B. Huntley**, G. S. Mourad, and **N. P. Schultes**. 2020. A nucleobase cation symporter 2, EaXanP, from *Erwinia amylovora* transports xanthine. *J. Plant Pathol*. DOI: 10.1007/s42161-020-00584-5.

Gloria-Soria, A., S. Y. Mendiola, V. J. Morley, B. W. Alto, and P. E. Turner. 2020. Prior evolution in stochastic versus constant temperatures affects RNA virus evolvability at a thermal extreme. *Ecol. Evol*. 10:5440-5450, https://doi.org/10.1002/ece3.6287.

Gloria-Soria, A., J. Soghigian, D. Kellner, and J. R. Powell. 2019. Genetic diversity of laboratory strains and implications for research: The case of *Aedes aegypti*. *PLOS Negl. Trop. Dis.* 13(12):1-17.

Hao, Y., **C. Ma**, **J. C. White**, M. Adeel, R. Jiang, Z. Zhao, Y. Rao, Y. Rui, and B. Xing. 2020. Carbon-based nanomaterials alter the composition of the fungal endophyte community in rice (*Oryza sativa*). *Environ. Sci.: Nano*. 7:2047-2060.

Hao, Y., Y. Wang, **C. Ma**, **J. C. White**, C. Duan, Z. Zhao, Y. Zhang, M. Adeel, G. Li, Y. Rui, and B. Xing. 2019. Carbon nanomaterials increase methane production from livestock manure in an anaerobic digestion system. *J. Clean. Prod*. 240:118257.

Heredia, G., **D. W. Li**, L. Wendt, M. Réblová, R. M. Arias, M. Gamboa-Angulo, V. Štěpánek, M. Stadler, and R. F. Castañeda-Ruíz. 2020. *Natonodosa speciosa* gen. et sp. nov. and rediscovery of *Poroisariopsis inornata*: Neotropical anamorphic fungi in Xylariales. *Mycol. Progress* 19:15-30, https://doi.org/10.1007/s11557-019-01537-8.

Hofmann, T., G. Lowry, S. Ghoshal, N. Tufenkji, D. Brambilla, J. Dutcher, L. Gilbertson, J. P. Giraldo, M. Kinsella, M. del Capio Landry, W. Lovell, R. Naccache, M. Paret, J. Pederson, J. Unrine, **J. C. White**, and K. Wilkinson. 2020. Moving forward responsibly in nanotechnology enabled plant agriculture. *Nat. Food* 1:416-425.

Hu, J., X. Wu, F. Wu, W. Chen, **J. C. White**, Y. Yang, B. Wang, B. Xing, S. Tao, and X. Wang. 2019. Potential application of titanium dioxide nanoparticles to improve the nutritional quality of coriander (*Coriandrum sativum* L.). *J. Hazard. Mat*. https://doi.org/10.1016/j.jhazmat.2019.121837.

Hyde, J., M. A. Correa, G. L. Hughes, **B. Steven**, and **D. E. Brackney**. 2020. Limited influence of the gut microbiome on the transcriptional profile of female *Aedes aegypti* mosquitoes. *Sci. Rep.* 10(1):1-12, https://doi.org/10.1038/s41598-020-67811-y.

Hyde, J., C. Gorham, **D. E. Brackney**, and **B. Steven**. 2019. Antibiotic resistant bacteria and commensal fungi are common and conserved in the mosquito microbiome. *PLOS One* 14(8), https://doi.org/10.1371/journal.pone.0218907.

Hyde, J., M. A. Correa, **D. E. Brackney**, and **B. Steven**. 2019. Generation and rearing of axenic *Aedes aegypti* mosquitoes. *Protoc. Exch.* 10.21203/rs.2.17705/v1.

Iman, A., **R. B. Huntley**, G. S. Mourad, and **N. P. Schultes**. 2020. Apple nucleobase cation symporter 1 transports guanine and the *Erwinia amylovora* produced toxic analog 6-thioguanine. *Physiol. Mol. Plant Path.* https://doi.org/10.1016/j.pmpp.2020.101492.

Jyske, T., K. Kuroda, **S. Keriö**, A. Pranovich, R. Linnakoski, N. Hayashi, D. Aoki, and K. Fukushima. 2020. Localization of (+)-Catechin in *Picea abies* phloem: Responses to wounding and fungal inoculation. *Molecules* 25(12):2952, https://doi.org/10.3390/molecules25122952.

Kache, P. A., G. Eastwood, K. Collins-Palmer, M. Katz, R. C. Falco, W. I. Bajwa, **P. M. Armstrong**, **T. G. Andreadis**, and M. A. Diuk-Wasser. 2020. Environmental determinants of *Aedes albopictus* abundance at a northern limit of its range in the United States. *Am. J. Trop. Med. Hyg.* 102(2):436-447.

Keriö, S., E. Terhonen, and J. M. LeBoldus. 2020. Safe DNA-extraction protocol suitable for studying tree-fungus interactions. *Bio Protoc.* 10(11):e3634, https://doi.org/10.21769/BioProtoc.3634.

Kruidhof, H. M., and **W. H. Elmer**. 2020. Cultural methods for greenhouse pest and disease management. Pp. 285-330 in: *Integrated Pest and Disease Management in Greenhouse Crops*, M. L. Gullino, R. Albajes, P. Nicot, and J. C. van Lenteren, editors. Springer.

LaMondia, J. A., **R. S. Cowles**, and N. Shishkoff. 2019. The effects of sanitizers on *Calonectria pseudonaviculata* conidia and microsclerotia viability. Abstract, APS Annual Meeting, Plant Health 2019, 182-P1 https://apsnet.confex.com/apsnet/2019/meetingapp.cgi/Paper/13589.

LaMondia, J. A. 2020. Curative fungicide activity against *Calonectria pseudonaviculata*, the boxwood blight pathogen. *J. Environ. Hortic.* 38(2):44-49.

Li, D. W., R. F. Castañeda-Ruiz, and **N. P. Schultes**. 2020. Phylogenetic placement of *Acrospeira mirabilis*. *Mycotaxon* 135(2):299-308, https://doi.org/10.5248/135.299.

Li, D. W., **N. P. Schultes**, **J. A. LaMondia**, and **R. S. Cowles**. 2020. *Phytophthora abietivora*, a new species isolated from diseased Christmas trees in Connecticut, USA. *Plant Dis.* 103:3057-3064, DOI: 10.1094/PDIS-03-19-0583-RE.

Li, K., G. Wu, Y. Liao, **Q. Zeng**, H. Wang, and F. Liu. 2020. RpoN1 and RpoN2 play different regulatory roles in virulence traits, flagellar biosynthesis, and basal metabolism in *Xanthomonas campestris*. *Mol. Plant Path.* 21:907-922.

Li, Y. H. 2019. Disease alert: Delphinella shoot blight of fir. *The Real Tree Line* 59(4):10.

Liao, Y. Y., A. Strayer-Scherer, **J. C. White**, **R. De La Torre-Roche**, L. Ritchie, J. Colee, G. E. Vallad, J. Freeman, J. B. Jones, and M. L. Paret. 2019. Particle-size dependent bactericidal activity of magnesium oxide against *Xanthomonas perforans* and bacterial spot of tomato. *Sci. Rep.* 9:18530, https://doi.org/10.1038/s41598-019-54717-7.

Linske, M. A., **K. C. Stafford III**, **S. C. Williams**, C. B. Lubelczyk, M. Welch, and E. F. Henderson. 2019. Impacts of deciduous leaf litter and snow presence on nymphal *Ixodes scapularis* (Acari: Ixodidae) overwintering survival in coastal New England, USA. *Insects* 10(8):227, https://doi.org/10.3390/insects10080227.

Linske, M. A., **S. C. Williams**, **K. C. Stafford III**, C. B. Lubelczyk, E. F. Henderson, M. Welch, and P. D. Teel. 2020. Determining effects of winter weather conditions on adult *Amblyomma americanum* (Acari: Ixodidae) survival in Connecticut and Maine, USA. *Insects* 11(1):13, https://doi.org/10.3390/insects11010013.

Little, E. A. H., **S. C. Williams**, **K. C. Stafford III**, **M. A. Linske**, and **G. Molaei**. 2019. Evaluating the effectiveness of an integrated tick management approach on multiple pathogen infection in *Ixodes scapularis* questing nymphs and larvae parasitizing white-footed mice. *Exp. Appl. Acarol.* 80:127-136, https://doi.org/10.1007/s10493-019-00452-7.

Little, E. A. H., and **G. Molaei**. 2020. Passive tick surveillance: Exploring spatiotemporal associations of *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum* infection in *Ixodes scapularis*. *Vector-Borne Zoonot.* 20(3):177-186, DOI: 10.1089/vbz.2019.2509.

Ma, C., H. Liu, G. Chen, Q. Zhao, H. Guo, R. Minocha, S. Long, Y. Tang, E. M. Saad, **R. De La Torre Roche**, **J. C. White**, O. Parkash Dhankher, and B. Xing. 2020. Dual roles of glutathione in silver nanoparticle detoxification and enhancement of nitrogen assimilation in soybean (*Glycine max* L.). *Environ. Sci.: Nano.* 7:1954-1966.

Maier, C. T. 2020. Larval hosts of Lamiine Cerambycidae (Coleoptera) in Connecticut and nearby states. *Coleopt. Bull.* 74:77-92.

Majumdar, S., L. Pagano, J. A. Wohlschlegel, M. Villani, W. Li, O. Parkash Dhankher, A. Zappettini, N. Marmiroli, **J. C. White**, and A. Keller. 2019. Proteomic, gene and metabolite characterization reveal uptake and toxicity mechanism of cadmium sulfide quantum dots in soybean plants. *Environ. Sci.: Nano*. DOI: 10.1039/C9EN00599D.

Marmiroli, M., F. Mussi, L. Pagano, D. Imperiale, G. Lencioni, M. Villani, A. Zappettini, **J. C. White**, and N. Marmiroli. 2020. Cadmium sulfide quantum dots impact *Arabidopsis thaliana* physiology and morphology. *Chemosphere* 240:124856.

Marmiroli, M., G. Orazio Lepore, L. Pagano, F. d'Acapito, A. Gianoncelli, M. Villani, **J. C. White**, and N. Marmiroli. 2020. The fate of CdS quantum dots in plants as revealed by Extended X-ray Absorption Fine Structure (EXAFS) analysis. *Environ. Sci.: Nano* 7:1150-1162, https://doi.org/10.1039/C9EN01433K.

Marra, R. E., and **J. A. LaMondia**. 2020. First report of beech leaf disease, caused by the foliar nematode, *Litylenchus crenatae mccannii*, on American beech (*Fagus grandifolia*) in Connecticut. *Plant Dis.* https://doi.org/10.1094/PDIS-02-20-0442-PDN.

Maynard, A. A. Growing globe artichokes and Belgian endive in Connecticut. 2019. *Proceedings of the New England Vegetable and Fruit Conference*.

McMillan, J. R., **P. M. Armstrong**, and **T. G. Andreadis**. 2020. Patterns of mosquito and arbovirus community composition and ecological indexes of arboviral risk in the northeast United States. *PLOS. Negl. Trop. Dis.* 14(2):e0008066.

Min, L. J., J. R. Ye, X. Q. Wu, **D. W. Li**, T. Wu, J. Song, and Y. H. Wang. 2020. *Burkholderia pyrrocinia* strain JK-SH007 affects zinc (Zn) accumulation and translocation in tomato. *Arch. Agron. Soil Sci.* DOI: 10.1080/03650340.2020.1735628, https://doi.org/10.1080/03650340.2020.1735628.

Molaei, G., and **E. A. H. Little**. 2020. A case of morphological anomalies in *Amblyomma americanum* (Acari: Ixodidae) collected from nature. *Exp. Appl. Acarol.* 81:279-285. DOI: 10.1007/s10493-020-00510-5.

Molaei, G., **E. A. H. Little**, **S. C. Williams**, and **K. C. Stafford III**. 2019. Bracing for the worst: Range expansion of the lone star tick in the northeastern United States. *N. Engl. J. Med.* 381:2189-2192, https://doi.org/10.1056/NEJMp1911661.

Molaei, G., **E. A. H. Little**, **K. C. Stafford III**, and H. Gaffe. 2019. A seven-legged tick: Report of a morphological anomaly in *Ixodes scapularis* (Acari: Ixodidae) biting a human host from the Northeastern United States. *Ticks Tick Borne Dis.* 11(1):101304. doi: 10.1016/j.ttbdis.2019.101304.

Molaei, G., S. E. Karpathy, and **T. G. Andreadis**. 2019. First report of the introduction of an exotic tick, *Amblyomma coelebs* (Acari: Ixodidae), feeding on a human traveler returning to the United States from Central America. *J. Parasitol.* 105(4):571-575.

Mukome, F. N. D., M. C. Buelow, J. Shang, J. Peng, M. Rodriguez, D. M. Mackay, **J. J. Pignatello**, N. Sihota, T. P. Hoelen, and S. J. Parikh. 2020. Biochar amendment as a remediation strategy for surface soils impacted by crude oil. *Environ. Pollut.* 265:115006.

Nguyen, J. N., J. R. Schein, K. A. Hunt, J. A. Tippmann-Feightner, M. Rapp, A. J. Stoffer-Bittner, V. J. Nalam, A. M. Funk, **N. P. Schultes**, and G. S. Mourad. 2020. Functional characterization of the sole nucleobase cation symporter 1 of *Nicotiana sylvestris* reveals a broad solute specificity profile. *Plant Gene* 2-20-2020 https://doi.org/10.1016/j.plgene.2020.100226.

Noori, A., A. Ngo, P. Gutierrez, S. Theberge, and **J. C. White**. 2020. Silver nanoparticle detection and accumulation in tomato (*Lycopersicon esculentum*). *J. Nano. Res*. 22:131.

Paesano, L., M. Marmiroli, M. G. Bianchi, **J. C. White**, O. Bussolati, A. Zappettini, M. Villani, and N. Marmiroli. 2020. Differences in toxicity, mitochondrial function and miRNome in human cells exposed *in vitro* to Cd as CdS quantum dots or ionic Cd. *J. Haz. Mat*. 393:122430, https://doi.org/10.1016/j.jhazmat.2020.122430.

Patel, R., and **L. Triplett**. 2020. *Xanthomonas vasicola* pv. *vasculorum*. Fact Sheet, *CABI Invasive Species Compendium*.

Pérez, C. D. P., J. C. Pozza, A. A. A. Pozza, and **W. H. Elmer**. 2020. Boron, zinc and manganese suppress rust on coffee plants grown in a nutrient solution. *Eur. J. Plant Pathol.* https://doi.org/10.1007/s10658-019-01922-9.

Pérez, C. D. P., **R. De La Torre Roche**, **N. Zuverza-Mena**, **C. Ma**, Y. Shen, **J. C. White**, E. A. Pozza, A. A. A. Pozza, and **W. H. Elmer**. 2019. Metalloid and metal oxide nanoparticles suppress sudden death syndrome of soybean. *J. Agric. Food Chem.* https://doi.org/10.1021/acs.jafc.9b06082.

Pokutnaya, D., **G. Molaei**, D. M. Weinberger, **C. R. Vossbrinck**, and A. J. Diaz. 2020. Prevalence of infection and co-infection and presence of rickettsial endosymbionts in *Ixodes scapularis* (Acari: Ixodidae) in Connecticut, USA. *J. Parasitol.* 106(1):30-37.

Qiao, H., X. R. Sun, X. Q. Wu, G. E. Li, Z. Wang, and **D. W. Li**. 2019. The phosphate-solubilising ability of *Penicillium guanacastense* and its effects on the growth of *Pinus massoniana* in phosphate limiting conditions. *Biol. Open* 8:bio046797, https://doi.org/10.1242/bio.046797.

Read, A. C., M. J. Moscou, A. V. Zimin, G. Pertea, R. S. Meyer, M. D. Purugganan, J. E. Leach, **L. R. Triplett**, S. L. Salzberg, and A. J. Bogdanove. 2020. Genome assembly and characterization of a complex zfBED-NLR gene-containing disease resistance locus in Carolina Gold Select rice with Nanopore sequencing. *PLOS Genetics* 16: e1008571.

Ruiz, M., Y. Yang, C. A. Lochbaum, D. G. Delafield, **J. J. Pignatello**, L. Li, and J. A. Pedersen. 2019. Peroxymonosulfate oxidizes amino acids in water without activation. *Environ. Sci. Technol.* 53(18):10845-10854.

Sponsler, D. B., C. M. Grozinger, R. T. Richardson, A. Nurse, D. Brough, H. M. Patch, and **K. A. Stoner. 2020.** A screening-level assessment of the pollinator-attractiveness of ornamental nursery stock using a honey bee foraging assay. *Sci. Rep.* 6:831, https://doi.org/10.1038/s41598-020-57858-2.

Stafford, K. C., III, **S. C. Williams**, J. G. van Oosterwijk, **M. A. Linske**, S. Zatechka, L. M. Richer, **G. Molaei**, C. Przybyszewski, and S. K. Wikel. 2020. Field evaluation of a novel oral reservoir-targeted vaccine against *Borrelia burgdorferi* utilizing an inactivated whole-cell bacterial antigen expression vehicle. *Exp. Appl. Acarol*. 80:257-268, https://doi.org/10.1007/s10493-019-00458-1.

Stravoravdis, S., N. R. LeBlanc, **R. E. Marra**, J. A. Crouch, and J. P. Hulvey. 2020. Widespread occurrence of a *CYP51A* pseudogene in *Calonectria pseudonaviculata*. *Mycobiology* 48(1):44-50. https://doi.org/10.1080/12298093.2019.1689600.

Tian, L., H. Zhang, X. Zhao, X. Gu, **J. C. White**, X. Li, L. Zhao, and R. Ji. 2019. CdS nanoparticles induce metabolic reprogramming in Broad Bean (*Vicia faba* L.) roots and leaves. *Environ. Sci.: Nano*, DOI: 10.1039/C9EN00933G.

Tokarev, Y. S., W. F. Huang, L. F. Solter, J. M. Malysh, J. J. Becnel, and **C. R. Vossbrinck**. 2020. A formal redefinition of the genera Nosema and Vairimorpha (Microsporidia: Nosematidae) and reassignment of species based on molecular phylogenetics. *J. Invertebr. Pathol.* 169, p.107279.

Wang, A., Q. Jin, A. Miao, **J. C. White**, J. L. Gardea-Torresey, R. Ji, and L. Zhao. 2020. High-throughput screening for engineered nanoparticles that enhance photosynthesis using mesophyll protoplasts. *J. Agric. Food Chem*. 68(11):3382-3389, https://doi.org/10.1021/acs.jafc.9b06429.

Wang, Y. X., J. Y. Chen, X. W. Xu, **D. W. Li**, and Q. Z. Wang. 2019. First report of brown apical necrosis of walnut caused by *Fusarium avenaceum* in Hubei, China. *Plant Dis.* 103(11):2956-2957, https://doi.org/10.1094/PDIS-05-19-0954-PDN.

Wang, Y., J. Y. Chen, X. Xu, J. Cheng, L. Zheng, J. Huang, and **D. W. Li**. 2020. Identification and characterization of *Colletotrichum* species associated with anthracnose disease of *Camellia oleifera* in China. *Plant Dis.* 104(2):474-482, https://doi.org/10.1094/PDIS-11-18-1955-RE.

Wang, Q. H., K. Fan, **D. W. Li**, C. M. Han, Y. Y. Qu, Y. K. Qi, and X. Q. Wu. 2020. Identification, virulence and fungicide sensitivity of *Colletotrichum gloeosporioides* s.s. responsible for walnut anthracnose disease in China. *Plant Dis.* 104(5):1358-1368, https://doi.org/10.1094/PDIS-12-19-2569-RE.

Wang, Z., S. Bakshi, C. Li, S. J. Parikh, H. S. Hsieh, and **J. J. Pignatello**. 2020. Modification of pyrogenic carbons for phosphate sorption through binding of a cationic polymer. *J. Colloid Interface Sci.* 579:258-268.

Ward, J. S., and J. Wikle. 2019. Increased individual tree growth maintains stand volume growth after B-level thinning and crop-tree management in mature oak stands. *For. Sci.* 65(6):784-795. https://doi: 10.1093/forsci/fxz042.

Wijayawardene, N. N., K. D. Hyde, L. K. T. Al-Ani, L. Tedersoo…. **D. W. Li**, et al. 2020. Outline of fungi and fungus-like taxa. *Mycosphere* 11(1):1060-1456, https://DOI.org/10.5943/mycosphere/11/1/8.

Williams, S. C., J. G. van Oosterwijk, **M. A. Linske**, S. Zatechka, L. M. Richer, C. Przybyszewski, S. K. Wikel, and **K. C. Stafford III**. 2020. Administration of an orally delivered substrate targeting a mammalian zoonotic pathogen reservoir population: Novel application and biomarker analysis. *Vector Borne Zoonotic Dis.* 20(8):603-612, https://doi.org/10.1089/vbz.2019.2612.

Williams, S. C., **M. A. Linske**, and **K. C. Stafford III**. 2020. Humane use of cardiac puncture for non-terminal phlebotomy of wild-caught and released *Peromyscus* spp. *Animals* 10(5):826, https://doi.org/10.3390/ani10050826.

Xu, T., **C. Ma**, A. Aytac, X. Hu, K. W. Ng, **J. C. White**, and P. Demokritou. 2020. Enhancing agrichemical delivery and seedling development with biodegradable, tunable, biopolymer-based nanofiber seed coatings. *ACS Sus. Chem. Eng.* https://doi.org/10.1021/acssuschemeng.0c02696.

Yang, Z., Y. Yan, A. Yu, B. Pan, and **J. J. Pignatello**. 2020. Revisiting the phenanthroline and ferrozine colorimetric methods for quantification of Fe(II) in Fenton reactions. *Chem. Eng. J.* 391, 123592.

Yuan, X., **Q. Zeng**, J. Xu, G. B. Severin, X. Zhou, C. M. Waters, G. W. Sundin, A. M. Ibekwe, F. Liu, and C. H. Yang. 2019. Tricarboxylic acid (TCA) cycle enzymes and intermediates modulate intracellular cyclic di-GMP levels and the production of plant-cell-wall degrading enzymes in soft rot pathogen *Dickeya dadantii*. *Mol. Plant-Microbe Interact.* 33:296-307.

Zhang, C., B. Wu, B. Pan, S. Zhang, and **J. J. Pignatello**. 2020. Deep removal of arsenite from water with no need for pre-oxidation or in-line oxidation. *Chem. Eng. J.* 401, 126046.

Zhang, H., M. Huang, W. Zhang, J. L. Gardea-Torresdey, **J. C. White**, R. Ji, and L. Zhao. 2020. Silver nanoparticles alter soil microbial community compositions and metabolite profiles in unplanted and cucumber-planted soil. *Environ. Sci. Technol*. 54(6):3334-3342, https://doi.org/10.1021/acs.est.9b07562.

Zhang, K., M. Qiao, Z. F. Yu, **D. W. Li**, and R. F. Castañeda-Ruiz. 2019. *Morganjonesia* gen. nov. for two atypical *Corynespora* and *Teratosperma* species. *Mycotaxon* 134:457-461, https://doi.org/10.5248/134.457.

Zhang, P., Z. Guo, Z. Zhang, H. Fu, **J. C. White**, and I. Lynch. 2020. Nanomaterial transformation in plants: Implications for food safety and application in agriculture. *Small* https://doi.org/10.1002/smll.202000705.

Zhang, Z., M. Xia, **C. Ma**, H. Guo, W. Wu, **J. C. White**, B. Xing, and L. He. 2020. Rapid organic solvent extraction coupled with surface enhanced Raman spectroscopic mapping for ultrasensitive quantification of foliarly applied silver nanoparticles in plant leaves. *Environ. Sci.: Nano* 7:1061-1067, https://doi.org/10.1039/C9EN01246J.

Zhu, L. H., G. Q. Jin, D. L. Sun, Y. Wan, and **D. W. Li**. 2020. First report of *Colletotrichum gloeosporioides* sensu stricto causing leaf blotch on *Acer coriaceifolium* in China. *Plant Dis.* 104(3):983, https://doi.org/10.1094/PDIS-08-19-1716-PDN.

BULLETINS AND FACT SHEETS PUBLISHED BY STAFF DURING 2019-2020

Allan-Perkins, E., K. Maurer, and **J. LaMondia**. 2020. Impact of cultivar, trellis height, and pruning on commercial hop production in Connecticut. *CAES Bulletin 1062*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/B1062.pdf

Allan-Perkins E., K. Maurer, **M. Salvas**, and **J. LaMondia**. 2020. Guidelines for integrated pest management for hops in Connecticut. *CAES Bulletin 1063*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/B1063.pdf

Aulakh, J. S. 2020. Comparison of preemergence herbicide treatments for weed control in Canaan fir (*Abies balsamea* var. *phanerolepis*). *CAES Bulletin 1064*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/B1064.pdf

Aulakh, J. S. 2020. Giant hogweed (*Heracleum mantegazzianum*) identification and management. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Valley Laboratory/Giant-Hogweed-Heracleum-mantegazzianum-Identification-and-Management.pdf.

Aulakh, J. S. 2020. Lesser celandine (*Ficaria verna* Huds.) identification and management. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Valley Laboratory/Lesser-celandine_Factsheet.pdf.

Aulakh, J. S. 2020. Weed alert: First report of Palmer amaranth in Connecticut—watch out for this pigweed! *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Palmer-Amaranth.pdf.

Braun, J. C., **R. S. Cowles**, and **J. A. LaMondia**. 2020. The use of geostatistics to analyze factors influencing hop (*Humulus lupulus*) yield in Connecticut. *CAES Technical Bulletin TB23*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Technical_Bulletins/TB23.pdf

Hiskes, R. 2019. Field guide and plant management calendar to selected terrestrial plants found in Connecticut. *CAES Fact Sheet*.

Hiskes, R. 2019. Fungal leaf spot diseases of *Amelanchier*. *CAES Fact Sheet*.

Hiskes, R. T. 2020. Acorn pip/woolly catkin gall, *Cynpidae*: *Callirhytis quercusoperator*. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Valley_Laboratory/acorn-pip-gall-fact-sheet-2020-FINAL-jl.pdf

Krol, W. J., **B. D. Eitzer**, **C. S. Robb**, **M. Ammirata**, **T. Arsenault**, **C. Musante**, **K. Prapayotin-Riveros**, and **J. C. White**. 2020. Pesticide residues and arsenic found in produce sold in Connecticut in 2018-2019: MFRPS ISO 17025:2017 Food Testing. *CAES Technical Bulletin 21*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Technical_Bulletins/TB21.pdf

Li, Y. H. 2019. Marssonina blotch of apple. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/2019/Marssonina-Blotch-of-Apple.pdf

Li, Y. H. 2019. Peach leaf curl. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/2019/Peach-Leaf-Curl.pdf

Li, Y. H. 2019. Stemphylium gray leaf spot of tomato. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/2019/Stemphylium-Gray-Leaf-Spot-of-Tomato.pdf

Li, Y. H. 2020. Black rot of grape. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/2020/Black-Rot-of-Grape-(1).pdf

Li, Y. H. 2020. Boxwood blight. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/2020/Boxwood-Blight-(1).pdf?la=en&hash=A4C6AF39765F27FDDEB5B4DC3FD3B6F3

Li, Y. H. 2020. Seed germination and purity analysis 2019. *CAES Technical Bulletin 22*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Technical_Bulletins/TB22.pdf

Maynard, A. A., and **J. S. Ward**. 2019. Brassica trials 2004-2012. *CAES Bulletin 1061*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/B1061.pdf

Salvas, M., and **J. A. LaMondia**. 2020. European corn borer (*Ostrinia nubilalis*): A new pest affecting Connecticut hops. *CAES Fact Sheet*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Valley_Laboratory/ECB-Hops_FactsheetFINAL.pdf