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FEATURED NEWS

Eradication: The Road to Restoring the Colonial Williamsburg Garden after Boxwood Blight Invasion

by Melissa Sharifi, Colonial Williamsburg Foundation, Williamsburg, Virginia

The Colonial Williamsburg Landscape staff have tracked the spread of the boxwood blight (BB) pathogen across Virginia since it was initially discovered in the state in 2011. In 2017, BB was identified in a neighborhood just a mile from Colonial Williamsburg, with additional cases identified in



surrounding neighborhoods each following year. The Colonial Williamsburg Landscape team identified the first case of boxwood blight in its historic gardens at the end of July 2021. Several mature English boxwood situated in the Ludwell-Paradise House gardens had boxwood blight infection. How the pathogen got into this garden is unknown. An abnormal period of high humidity and prolonged rains along with cooler nighttime temperatures surely aided in the spread of this disease as it swept across the hedges contained in this walled garden. Typical blight symptoms ranged from minor brown leaf spots and black streaking on the stems, to complete defoliation. Any intact areas of the hedges showed large greasy looking patches of infection.

To prevent the disease from spreading, the Ludwell-Paradise garden was immediately quarantined. All gates were secured with either screws or locks, allowing access to only authorized landscape staff. Within a week of detection, the complete removal of the boxwood in this garden had begun. The removal is part of the protocol to prevent the blight from spreading to the mature boxwood plants across the grounds of the living museum. These boxwood hedges in the Ludwell-Paradise garden were over 10' tall and up to 25' wide in some areas.



RECENT DELIVERABLES (November 2021 to February 2022)

Research

- 1 Research article
- 4 Seminars

Extension & Outreach

- 2 Field demonstrations
- 2 Webinars/virtual meetings
- 7 Extension presentations
- 4 Extension publications
- 124 Samples diagnosed
- 24 Email/phone inquiries answered
- 1025 People reached with articles/news

Education

- 6 Postdoctoral associates
- 2 Graduate students

Publicity

- 2 Press releases

The entire removal process took close to 2 weeks and was managed by a 3-person team including the Colonial Williamsburg Arborist and IPM technician. The exhausting process took place during the month of August in sweltering heat. A portable restroom, shade tent and decontamination shower facility were installed in the garden. A large structure was built in the garden out of lumber and tarps to house a wood chipper and a covered dump trailer. The crew reported directly to the garden each morning and lunch was

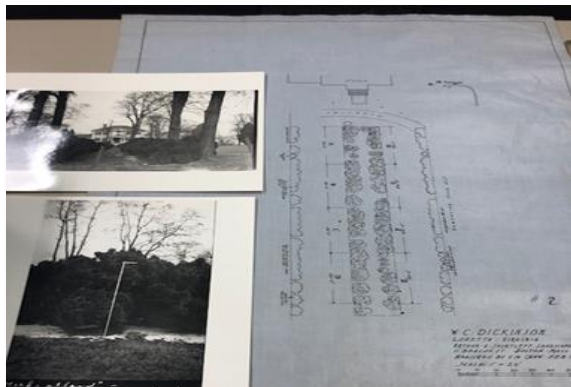


delivered to them over the fence. The shrubs were flush cut and chipped into the covered trailer and then dumped into a 10' deep trench dug specifically for their disposal far away from any other boxwood site.



Upon removal of the shrubs, the groundcover was push mowed and bagged to collect any fallen leaves. The entire garden floor was then flamed with propane torches. Once the removals and flaming were complete, topsoil was brought in and graded to a depth of several inches to encapsulate any leaves that may have been missed. Finally, the new soil was

overseeded in the Fall with a mustard cover crop. The mustard is scheduled to be terminated and tilled under this Spring in hopes of benefiting from a naturally occurring chemical in the mustard thought to have strong anti-fungal properties.



Boxwood in Ludwell-Paradise came from a plantation in South Carolina

The Ludwell-Paradise shrubs were very important to the Foundation and had a very interesting story. They were original to the restoration; however, the plants were initially located on a plantation in South Carolina. The already-mature plants were purchased during the restoration

of the Colonial town in the 1930s. The plants were hand dug and transported to Williamsburg by railway. The Ludwell-Paradise boxwood had been used to propagate new plants at the landscape nursery for future use in the historic area gardens. The age of the boxwood is unknown but some most likely were over 200 years old. This garden was visited by millions of visitors for decades and the boxwood cherished by many.

In addition to quarantine and eradication efforts exemplified above, our protocol includes staff training to help recognize the blight symptoms and signs, stringent sanitation practices when working in the gardens, and serving as better educators and advocates on boxwood blight mitigation for visitors. The Colonial Williamsburg Foundation has made huge investments to preserve as many boxwood as possible, but has suffered a great loss by having to remove the Ludwell-Paradise boxwood shrubs for the sake of others. We are doing everything we can to keep the disease from spreading throughout the rest of the Foundation's extensive boxwood collection.



Boxwood shipment on arrival at Williamsburg in the 1930s

FEATURED RESEARCH

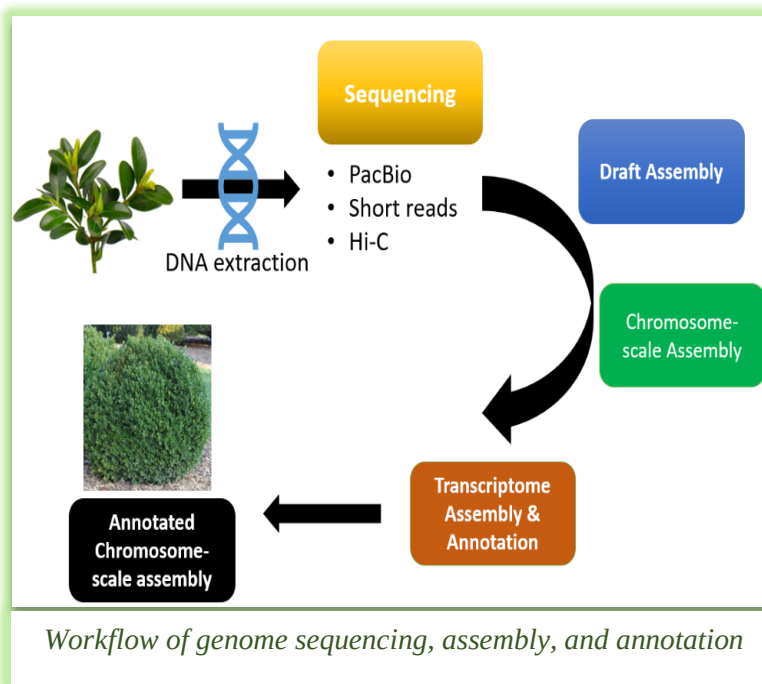
USDA Scientist Set to Release Boxwood Whole Genome Sequence by Fred Gouker, Research Geneticist, USDA-ARS, U.S. National Arboretum Floral and Nursery Plant Research Unit

Since the release of the first plant genome sequence in 2000, more than 400 plant genome sequences have become available. Since this time, multiple technologies and bioinformatics tools have been developed to sequence, assemble, annotate, and analyze plant genomes. All these data and tools have greatly helped us to better understand the evolutionary histories of plant species and provide genomics resources for molecular studies and aid in breeding for economically important traits.

Although boxwood has been cultivated for thousands of years, very little is known about the genomic makeup of this iconic shrub. By knowing what genes lie within the boxwood genome, researchers will better understand what gives them specific plant architecture or enables them to withstand pests and diseases like boxwood blight. To help

answer these questions, researchers at the USDA-ARS National Arboretum are sequencing the genome of English boxwood (*Buxus sempervirens* ‘Suffruticosa’). Developing this reference genome will allow the development of high-resolution genetic markers that can be used to identify significant associations between genes and traits such as boxwood blight resistance. This will help researchers and breeders identify individuals that could be used for developing hybrids with improved ornamental traits including pest and disease resistance.

Through the use of several sequencing technologies (Illumina short-read, PacBio long-read, Dovetail Hi-C), we have been able to develop a chromosome-scale assembly (DNA sequence information) and annotation (identification of genes). Initial results show the genome to be quite complex. The boxwood genome has approximately 1.01 billion base pairs of DNA, close to 32,300 protein-coding genes and is diploid, meaning this particular species has two sets of chromosomes. For reference, humans have 3 billion base pairs of DNA and two sets of chromosomes. When comparing the boxwood genome to that of other related plant species, there are some gene families unique to boxwood that may provide valuable information for future breeding efforts. The ability to interrogate genomic regions related to specific traits of interests and develop genetic markers to find these regions in other boxwood species have not previously existed for boxwood and can only be developed through the efforts of whole-genome sequencing. This work will greatly contribute to the development of modern genetic tools that can be used in breeding blight resistant cultivars for the boxwood community.



EXTENSION HIGHLIGHT

International Webinar on Box Tree Moth by Margery Daughtrey

Over 160 people attended a BBIG/HRI webinar December 2, 2021 on boxtree moth. The presentation was made by Dr. Marc Kenis, the Head of the Risk Analysis and Invasion Ecology Section at CABI in Delémont, Switzerland. Dr. Kenis provided his unique view of the invasion, impact and management of box tree moth in Europe. Due to 2021 finds of this pest in several states, this pest has become all too relevant to boxwood lovers in the US; the problem has been



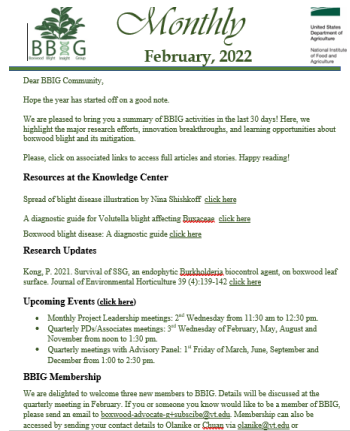
anxiously anticipated since it was found in North America for the first time in Ontario, Canada in 2018. In Europe, both planted and wild *Buxus* spp. have been under the assault of this species since 2007. The moth comes from Eastern Asia, from whence many boxwood are imported into Europe each year. The insect spreads very quickly, abetted by horticultural trade. Dr. Kenis explained that the number of generations per year vary according to climate, with 2 generations/year in N. Switzerland, but 3-4 overlapping generations/year in southern Europe. A single generation is not sufficient to totally defoliate a hedge. Changes in climate leading to increased summer temperature will unfortunately increase the problem with box tree moth. To catch up with Dr. Kenis' seminar, [click this link](#).

New Extension and Outreach Initiatives



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Volutella Blight Diagnostic Guide Receives APS Editor's Pick Recognition



A Diagnostic Guide for Volutella Blight Affecting Buxaceae

Xiao Yang,^{1,2,†} Vanina L. Castroagudín,^{2,3} Margery L. Daughtrey,⁴ Andrew L. Loyd,⁵ Jerry E. Weiland,⁶ Nina Shishkoff,¹ Fulya Baysal-Gurel,⁷ Luisa Santamaria,⁸ Catalina Salgado-Salazar,³ James A. LaMondia,⁹ Jo Anne Crouch,³ and Douglas G. Luster^{1,†}

The scientific community and press alike received the “Diagnostic Guide for Volutella Blight affecting Buxaceae” publication with wide acceptance. The publication is one of the results of an ongoing multi-institutional collaboration among scientists working on America’s favorite plant, Boxwood. Accepted for publication in July, the guide was published in November, 2021 in the American Phytopathological Society (APS) Journal, *Plant Health Progress* with an open access to the public. The *Plant Health Progress* Editorial Board later announced the decision to select the publication as the Editor’s pick and APS distributed a press release to this effect. The recognition by APS is a testament to the invaluable information in this well-researched and well-written manuscript that addresses a burning question to boxwood growers and the ornamental industry in the United States. The diagnostic guide also presented a detailed comparison of symptoms of two additional boxwood diseases; boxwood blight and boxwood dieback. Press recognition of the publication came in the January 6, 2022 edition of the *Science News*, citing the publication as a comprehensive diagnostic guide to a well-established (>150 years) boxwood disease. The article quoted United States Department of Agriculture plant pathologist, Doug Luster: “We hope first responders can use this guide to quickly and accurately diagnose

Volutella blight ...”. If you have not yet seen the guide, it can be accessed via [this link](#). The *Science Magazine* article can be accessed via [this link](#).

Diagnostic Hint by Margery Daughtrey

The most colorful boxwood samples received for diagnosis are usually NOT boxwood blight caused by *Calonectria pseudonaviculata*. The photo shows a portion of a *Buxus* ‘Winter Gem’ with bright red areas on the leaves, received from a nursery this fall. Using a dissecting microscope and exploring the undersurface of the leaf, we were able to find evidence of oviposition of the boxwood leaf miner. A few larvae were present in these leaves, but most of these were dead. This cultivar is not very susceptible to boxwood leaf miner, but in a nursery where other more susceptible cultivars were growing nearby, leaf miners had laid eggs in the leaves and the tissue responded to this insult.



Upcoming International Boxwood Seminar

Progress in Boxwood Blight Management in the United Kingdom and New Zealand: 1990s to 2021

March 10, 2022, 3:00 p.m. Eastern

Matthew Cromeey, Senior Plant Pathologist @Royal Horticultural Society, UK

FREE REGISTRATION



PROJECT MEETING BRIEF

The second session of BBIG Annual Meeting took place on Friday, December 3. Project Directors and associates met with Advisory Panelists to discuss plans for the second year of the BBIG project. Dr. Hall presented his research on a baseline model to study the cost-benefit in boxwood blight management. Dr. Luster spoke on Dr. Shishkoff’s upcoming research activities to fill epidemiology knowledge gaps of the blight pathogen. Dr. Crouch shared her intention to utilize a scanning microscope or FISH-based approach to study the colonization and systemic infection of the blight pathogen on boxwood. Dr. Hong gave insight on the biological control, epidemiology, and microbiome studies to be conducted in the second year of the project. Dr. Yang gave a presentation highlighting the collaborative efforts that resulted in two publications on boxwood and *Volutella* blight. After a short break, members reconvened and Margery Daughtrey led the review of important BBIG extension activities and the BBIG International Webinar Series to be carried out in the coming year. Karen Snover-Clift highlighted her efforts with the National Plant Diagnostic Network to understand the spread of the blight pathogen based on the number of samples received for diagnoses in different locations across the US. Dr. Santamaria and Dr. Baysal-Gurel are working on extending boxwood blight awareness, detection and management knowledge to Spanish speaking nursery workers. During their first outreach outside Oregon, both scientists will work with nurseries across Tennessee. The professional development session targeting the BBIG postdocs and the graduate students was next. Dr. Yang presented the summary of his transition from PhD to his desired job with the postdoc opportunity with BBIG. He



Improve communication skills

- Improve multichannel communication
- Network
- Get out of comfort zone and be an organizer



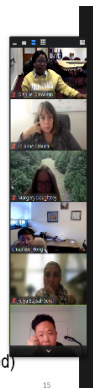
Build collaboration

- Research collaboration
- Teaching opportunities
- Identify mentors and references
- Leadership opportunities



Knowledge innovation

- Learn new skills
- Participate in diverse research projects
- Publications (peer-reviewed, non-peer-reviewed)
- Presentations



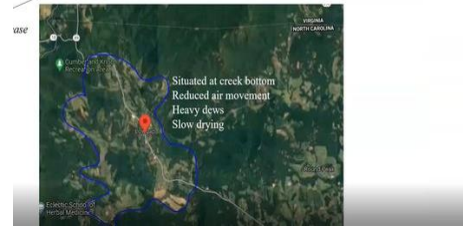
Dr. Xiao Yang highlights opportunities for students and postdocs within BBIG

encouraged students to embrace the numerous mentors and calls for publications while in BBIG to improve communication skills, collaboration and learn new skills.

The 3rd Boxwood Blight Epidemiology meeting was held on February 7, 2022 via Zoom. The BBIG subgroup comprised of scientists from Belgium, Germany, UK and US deliberated on how to better understand the epidemiology of the blight pathogen and its spread using weather datasets.

Project Directors and their associates met on February 17, 2022, discussing the research and extension progress. Dr. Fred Gouker presented a seminar on the boxwood genome assembly project. To read more on Dr. Fred Gouker's research, check the highlights of his seminar on Pg. 3 of this newsletter issue.

What Weather Conditions Make an Area Hotspot for Boxwood Blight?



Dr. Urmila Adhikari discusses intended use of summarized data to understand boxwood blight epidemiology

NEW MEMBER

Dr. Prabha Liyanapathirana recently joined the BBIG team as a post-doctoral researcher at the Otis L. Floyd Nursery Research Center in Tennessee State University, McMinnville, TN. She completed her Masters' degree from Tennessee State University where her research was focused on sustainable management of soilborne diseases in nursery production. She obtained her Ph.D. in Plant Pathology from Auburn University, where she studied the adaptation strategies in the *Xanthomonas* genus. In her new role, Prabha is evaluating fungicides and bio-fungicides for effective management of boxwood blight disease. She will be involved in outreach activities of the BBIG project as well. She can be reached at pliyanap@Tnstate.edu



RECENT PUBLICATION

Kong, P. 2021. Survival of SSG, an endophytic Burkholderia biocontrol agent, on boxwood leaf surface. Journal of Environmental Horticulture 39 (4):139-142

PROJECT DIRECTORS AND MANAGERS

Chuan Hong (Project Director), Virginia Tech, Virginia Beach, VA
Margery Daughtrey (Extension Leader), Cornell University, Riverhead, NY
Douglas Luster (Research Leader), USDA, ARS, Foreign Disease & Weed Science Research, Ft. Detrick, MD
Charles Hall, Texas A&M University, College Station, TX
Jerry Weiland, USDA, ARS, Horticultural Crop Research Lab, Corvallis, OR
Fulya Baysal-Gurel, Tennessee State University, McMinnville, TN
Fred Gouker, USDA, ARS, Floral & Nursery Plants Research, Beltsville, MD
Ping Kong, Virginia Tech, Virginia Beach, VA
Jo Anne Crouch, USDA, ARS, Mycology & Nematology Genetic Diversity and Biology Lab, Beltsville, MD
James LaMondia, Connecticut Agricultural Experiment Station, Windsor, CT
Jay Pscheidt, Oregon State University, Corvallis, OR
Luisa Santamaria, Oregon State University, Aurora, OR
Nina Shishkoff, USDA, ARS, Foreign Disease & Weed Science Research, Ft. Detrick, MD
Karen Snover-Clift, Cornell University, Ithaca, NY
Xiao Yang (former Project Manager, from April to December 2021), USDA ARS Ft Detrick, MD
Olanike Omolehin (Current Project Manager), Virginia Tech, Virginia Beach, VA

ADVISORY PANEL & LIAISON TO AMERICANHORT

Jill Calabro (Chair), Sr Product Development Manager, Valent USA Corporation, Walnut Creek, CA
Lynn Batdorf, Boxwood Cultivar Registration Authority, International Society for Horticultural Science
Frank Collier, Owner, Pleasant Cove Nursery, Rock Island, TN
Michael Gaines, President, CW Arborists, Ltd., Sagaponack, NY
John Keller, Planning & Research Vice President, Monrovia – Grow Beautifully in CA, CT, GA, OR
Bennett Saunders, General Manager, Saunders Genetics, LLC., Piney River, VA
Richard Schnall, Vice President, Rosedale Nurseries, Inc., Hawthorne, NY
Casey Sclar, Executive Director, American Public Gardens Association, Kennett Square, PA
Mark Sellow, Owner, Prides Corner Farms, Lebanon, CT
Martha Sleeper, Plant Health Manager, Hines Growers, Forest Grove, OR
Jennifer Gray (Liaison to AmericanHort), Administrator, Horticultural Research Institute, Washington, DC

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