

## Combating Our Fungal Foes: Giants Among Plant Diseases

Elizabeth Roche  
ANR Educator  
Cuyahoga County

 THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES

Plant pathogens have shaped our landscape and the foods we eat today....

- Chestnut blight
- Late blight of potato
- Wheat stem rust
- Panama disease
- Coffee Rust
- ....and many more

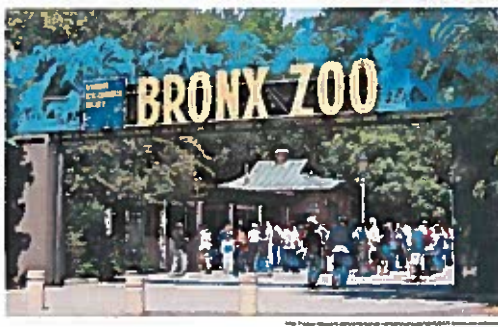
 THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES



"When Europeans arrived in North America, they found forests filled with American chestnut trees. These mighty plants, which could grow to be 100 feet tall, were the most abundant trees in the forests, making up 25 percent of the standing timber of the eastern United States. Chestnut trees anchored the ecosystems of eastern American forests, providing food and shelter to a vast number of species. They were also a mainstay of loggers, who could fill an entire train car with boards cut from a single tree."



In 1904, a scientist observed that a chestnut tree at the Bronx Zoo was dying. It turned out to be infected with a fungus that came to be known as chestnut blight.



### Chestnut blight

- *Cryphonectria parasitica* is our fungal foe
- Attacks American chestnuts, which have no natural resistance
- Infects via wounds, grows under the bark and kills off cambium
- The fungus releases a toxic oxalic acid that kills off the tissue
- The tree develops cankers on its trunk
- Cankers girdle the tree, cutting off the water & nutrient supply



**O** THE OHIO STATE UNIVERSITY  
 COLLEGE OF FOOD, AGRICULTURE, AND ENVIRONMENTAL SCIENCES



### Chestnut blight

- In 1912 the Plant Quarantine Act was passed
- Gives APHIS authority to regulate the importation and interstate movement of nursery stock and other plants that may carry pests and diseases that are harmful to agriculture
- Pruning and fungicide sprays attempted, no success



**O** THE OHIO STATE UNIVERSITY  
 COLLEGE OF FOOD, AGRICULTURE, AND ENVIRONMENTAL SCIENCES

### Chestnut Blight

- Breeding attempts with Asian chestnut varieties that show resistance to disease
- Inserted genes from wheat plants on trial plants
- If all goes well, may be re-introduced into the forest landscape



**O** THE OHIO STATE UNIVERSITY  
 COLLEGE OF FOOD, AGRICULTURE, AND ENVIRONMENTAL SCIENCES

### Irish Potato Famine

- Culprit: Late Blight (*Phytophthora infestans*)
- First plant disease for which a microorganism was proved to be the causal agent
- Birth of plant pathology as a science
- About one million people died from starvation or from typhus and other famine-related diseases
- Two million emigrated from Ireland



**O** THE OHIO STATE UNIVERSITY  
 COLLEGE OF FOOD, AGRICULTURE, AND ENVIRONMENTAL SCIENCES



### *Phytophthora infestans*

- Black brown lesions on the leaves
- Rapidly kills entire plant
- Oomycete aka water mold
- Cool, wet conditions are favorable
- Quickly infected and spread through the monoculture of potato in Ireland
- Heinrich Anton de Bary studied this disease, is considered the founder of plant pathology

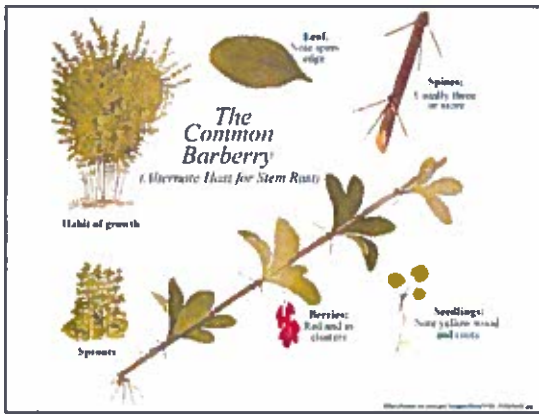


### Wheat Stem Rust

- Rusts are the most economically significant diseases
- Was once the most feared disease of cereal crops
- Estimated that more than \$5 billion are lost to cereal rusts
- Rust colored spores break through the stem
- Spread via wind and rain splash




 THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE  
AND ENVIRONMENTAL SCIENCES

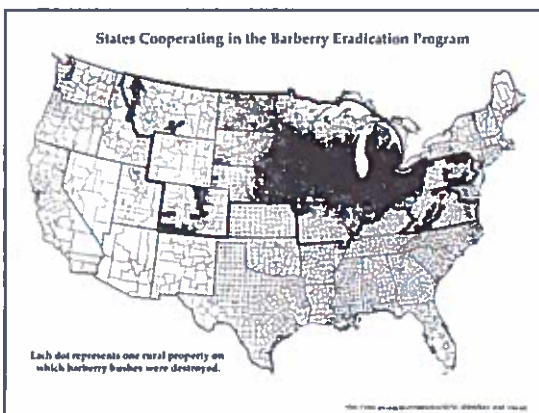


### Barberry vs Bread

- Barberry is an alternate hosts
- Provides a source of inoculum for wheat
- Sexual reproduction produces new strands of the pathogen
- Barberry used for yellow dye, jams, and tools from the wood
- Barberry eradication program after connection to stem rust was discovered




**THE OHIO STATE UNIVERSITY**  
 COLLEGE OF FOOD, AGRICULTURAL AND ENVIRONMENTAL SCIENCES



### Norman Borlaug

- Plant pathologist, worked at CIMMYT in Mexico
- Borlaug bred wheat that was resistant to stem rust as well as adaptable to different growing conditions
- This wheat spread quickly to farmers in need



**THE OHIO STATE UNIVERSITY**  
 COLLEGE OF FOOD, AGRICULTURAL AND ENVIRONMENTAL SCIENCES

## Green Revolution

- Continued his work in Asia and Africa
- One of seven people to have won the Nobel Peace Prize, the Presidential Medal of Freedom and the Congressional Gold Medal
- Credited with saving over a billion lives from starvation



THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL  
AND ENVIRONMENTAL SCIENCES

<http://www.ohio-state.edu/~colfae/colfae/colfae.html>

## Norman Borlaug

"In 1970 Norman E. Borlaug was awarded the Nobel Peace Prize for a lifetime of work to feed a hungry world. Although a scientist with outstanding contributions, perhaps Dr. Borlaug's greatest achievement has been his unending struggle to integrate the various streams of agricultural research into viable technologies and to convince political leaders to bring these advances to fruition."



THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL  
AND ENVIRONMENTAL SCIENCES

<http://www.ohio-state.edu/~colfae/colfae/colfae.html>



<http://www.ohio-state.edu/~colfae/colfae/colfae.html>

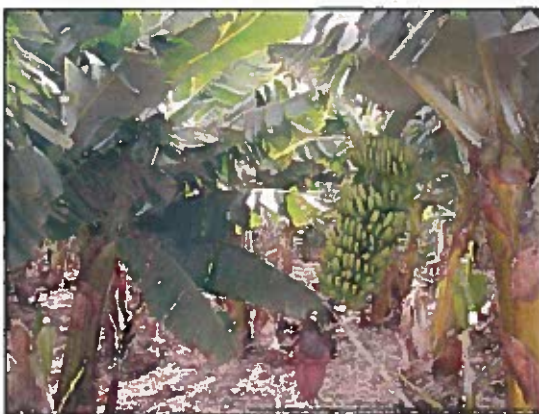
## Go Bananas

- In the early 1900s, people ate a delicious banana called Gros Michel
- In the 1950s this banana was wiped out by Panama disease
- Banana producers adopted the Cavendish variety, the banana we eat today



THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL  
AND ENVIRONMENTAL SCIENCES

<http://www.ohio-state.edu/~colfae/colfae/colfae.html>



## Cavendish

- Cavendish was resistant to the Panama banana disease
- Less tasty, but better than no bananas
- Producers switched to this variety and changed growing practices to accommodate



THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL  
AND ENVIRONMENTAL SCIENCES

<http://www.ohio-state.edu/~colfae/colfae/colfae.html>

### Panama Disease

- *Fusarium oxysporum f. sp. Cubense*
- Tropical Race 4
- Soil borne disease, infects root system
- Colonize the vascular system, killing the plant
- Lives in soil for years, making fields unsuitable for growing



 THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE,  
AND ENVIRONMENTAL SCIENCES

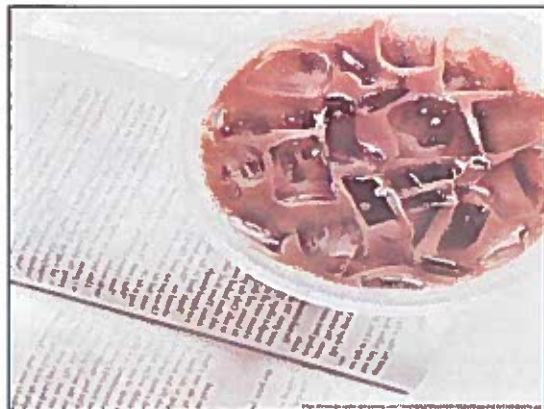


### Bye Bananas

- All widely cultivated bananas today descend from two wild banana species: *Musa acuminata* and *Musa balbisiana*
- Almost all commercially grown bananas are genetically identical
- No seeds
- Cavendish and wild bananas are not suitable for direct crossing
- What variety will be developed next? How long will it take?




 THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE,  
AND ENVIRONMENTAL SCIENCES



### Coffee Killer

- Coffee rust is the most economically important coffee disease in the world
- Coffee is the most important agricultural product in international trade (monetary)
- *Coffea arabica* (arabica) and *Coffea canephora* (robusta), the two most important commercial coffee species are susceptible
- Currently found in nearly all the world's coffee-growing regions




THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES



### Save the Coffee


- Quarantine for more than a century
- Set to prevent rust spreading to Americas
- New infections were eradicated by killing the plants plus the plants in 30m radius by spraying of herbicide mixed with diesel fuel
- Now very few coffee-growing regions of the world where coffee rust



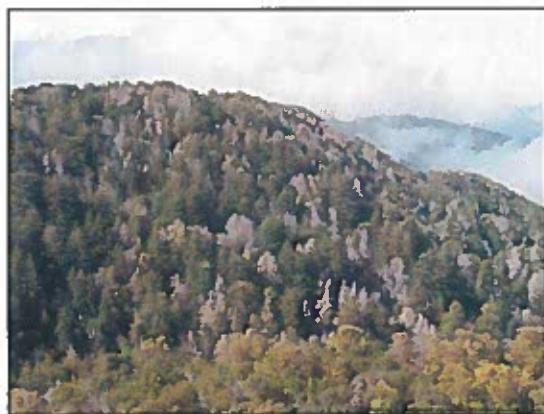
THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES

### Save the Coffee

- Significant losses of yields in infected trees
- Even a small reduction has a huge economic impact on producers
- virtually all of America's coffee had descended from a single rust-susceptible plant
- *H. vastatrix* is now found in nearly all the coffee-producing areas of the world




THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES



### Sudden Oak Death

- Forest disease that has caused widespread dieback of trees in California and Oregon
- *Phytophthora ramorum* affects leaves and twigs of oak species
- Bleeding cankers
- 1990s serious dieback from this disease occurred
- Origin is unknown



THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURAL,  
AND ENVIRONMENTAL SCIENCES



### Threats from Pythophthora

- Change in species composition
- Ecosystem function
- Fire frequency
- Decreased water and soil quality
- Nursery concerns
  - Will this spread across the US?




**O** THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE,  
AND ENVIRONMENTAL SCIENCES



### Laurel Wilt of Avocado

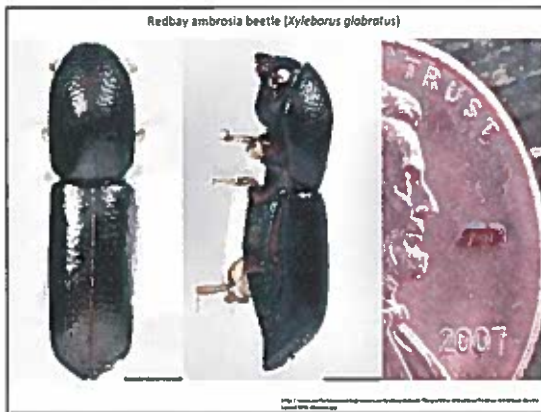
- Fungal pathogen associated with ambrosia beetle
- Threatens Florida growers, potential to impact California growers
- \$342 million of avocados at stake



**O** THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE,  
AND ENVIRONMENTAL SCIENCES







## Save the Guac!

- No current effective control
- Research is being done currently for solutions
- Education
- Scouting
- Avocado prices rising

THE OHIO STATE UNIVERSITY  
COLLEGE OF FOOD, AGRICULTURE, AND ENVIRONMENTAL SCIENCES

### References:

- <https://www.ars.usda.gov/ARSUserFiles/comp/Avocado/2014/20140820.pdf>
- <https://www.apsnet.org/publications/apsnetfeatures/Pages/Barberry.aspx>
- <http://www.apsnet.org/publications/apsnetfeatures/Pages/CherryBlightDisease.aspx>
- <http://www.apsnet.org/edcenter/intros/lessons/long/basis/mycel/Pages/collection.aspx>
- <http://www.apsnet.org/edcenter/intros/lessons/long/Domycetes/Pages/light.aspx>
- <https://www.britannica.com/event/Great-Famine-Irish-history>
- <http://canadadisease.org/en/theproblem>
- [http://www.huffingtonpost.com/2013/12/16/banana-blight-threatens-plantations-ivet-spread\\_n\\_4453573.html](http://www.huffingtonpost.com/2013/12/16/banana-blight-threatens-plantations-ivet-spread_n_4453573.html)
- <http://phenomena.national Geographic.com/2013/03/11/surrecting-a-forest/>
- <http://www.soldenakdeath.org/about-soldenak-death/history-barbarous/>
- [https://www.worldfoodware.org/en/dr\\_norman\\_e\\_borlaug/extended\\_biography/](https://www.worldfoodware.org/en/dr_norman_e_borlaug/extended_biography/)

