Chestnut 101

or Chestnut for Dummies

MA/RI CHAPTER

Important terms and concepts in TACF restoration of American Chestnut

Brad Smith

MA/RI ANNUAL MEETING

Old Sturbridge Village

November 14th, 2010

What is an American Chestnut?

Few people living today remember the large American Chestnut tree

All members of the Fagaceae

American Beech

Chestnut Oak

Chinese Chestnut

Sawtooth Oak

American Chestnut

Leaf shape, color, teeth

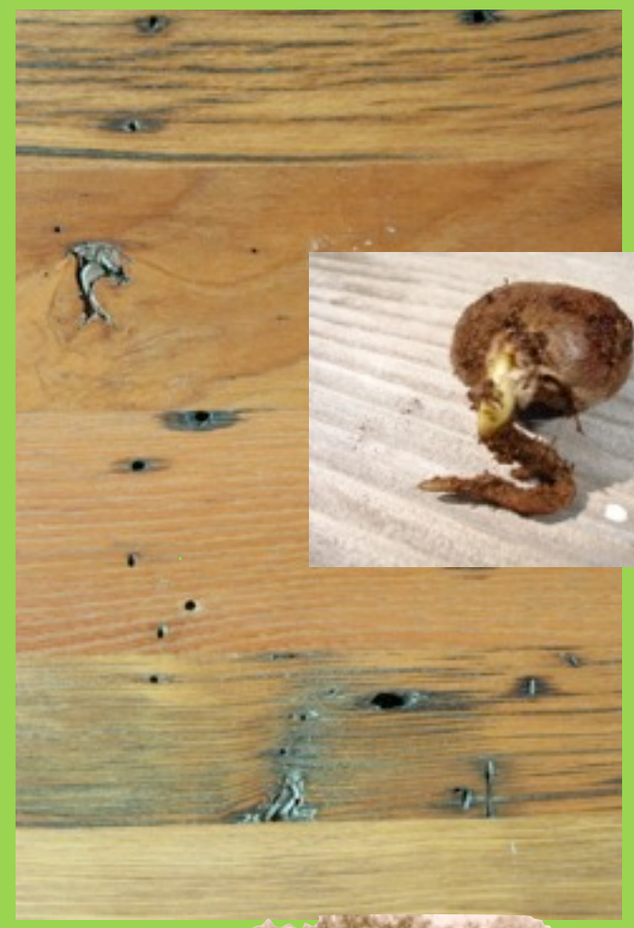
You need a microscope and experience

If you say “Chestnut”, this is what most people think of..

Horse Chestnut

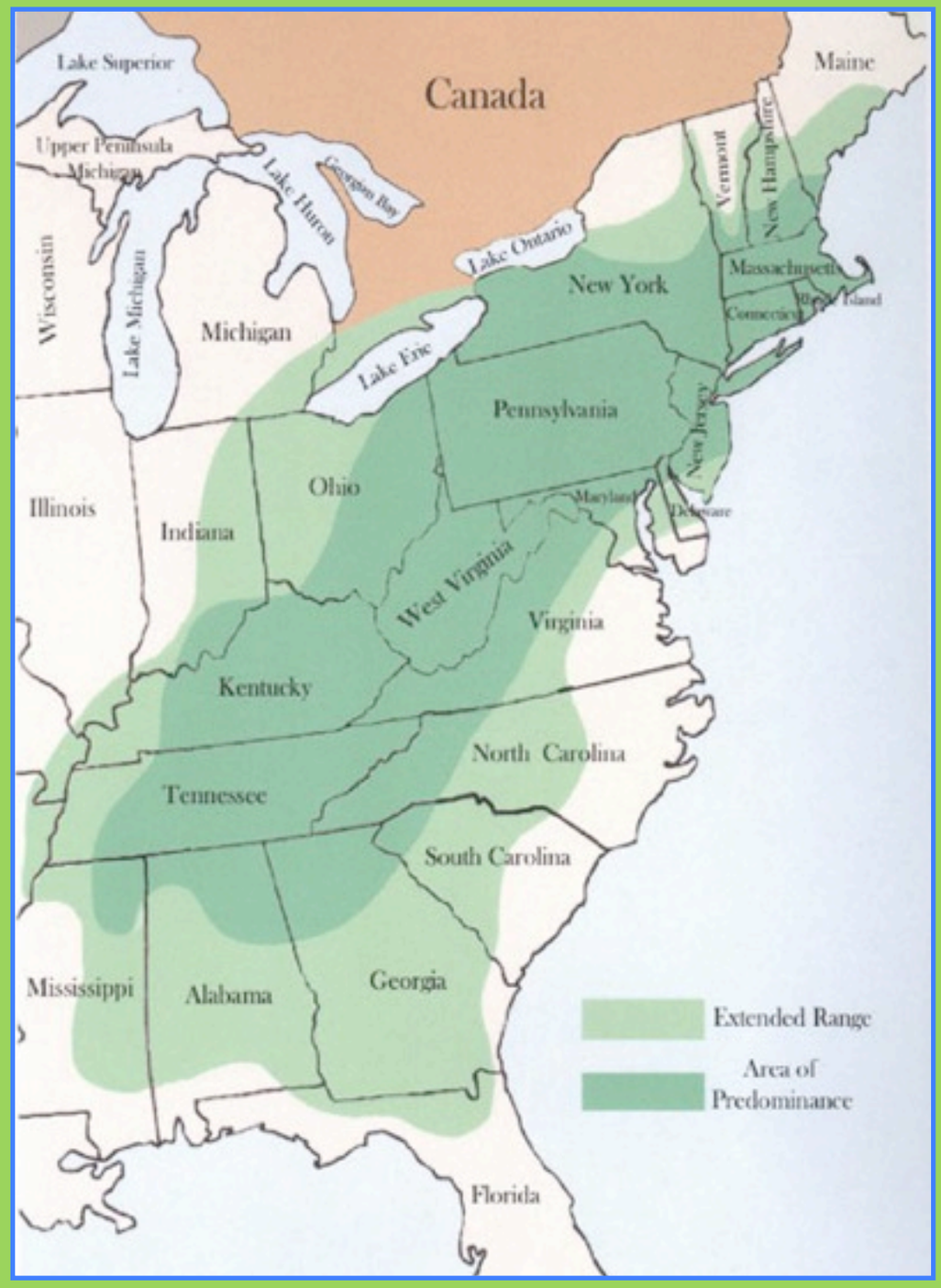
Hippocastanea

American Chestnut



American Chestnut (*Castanea dentata*)

- Ranged from Maine to Georgia and west of the Mississippi River
- Over 200 million acres
- 4 billion trees



From Maine to Georgia?

American Chestnut

- Chestnuts were an important wildlife food source, forming a staple for such animals as turkey, ruffed grouse, black bear and many others.

American Chestnut

- Chestnuts were important to native Americans for:

- Food: eaten raw, boiled, dried, roasted for a coffee-like beverage & ground into flour

- Shelter (Bark Shingles)

- Medicine

- Transportation – hollowed-out log canoes

Chestnutting was a favorite Fall activity.

CHESTNUTTING. — By Winslow Homer. (See Page 691.)

1870 “ Chestnutting” by Winslow Homer

American Chestnut

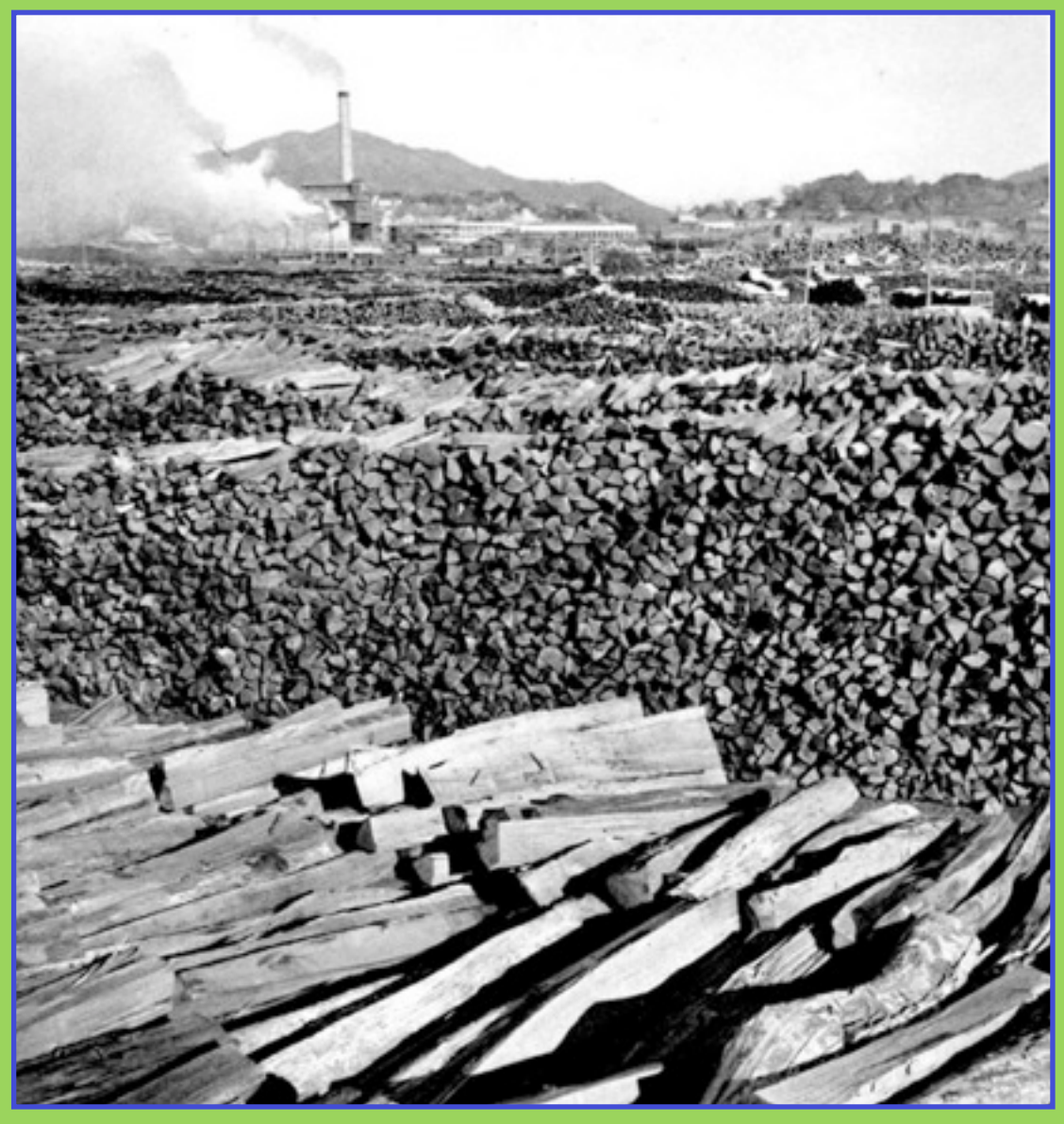
- Chestnut wood was used extensively by the early settlers for cabins, shingles, fences.

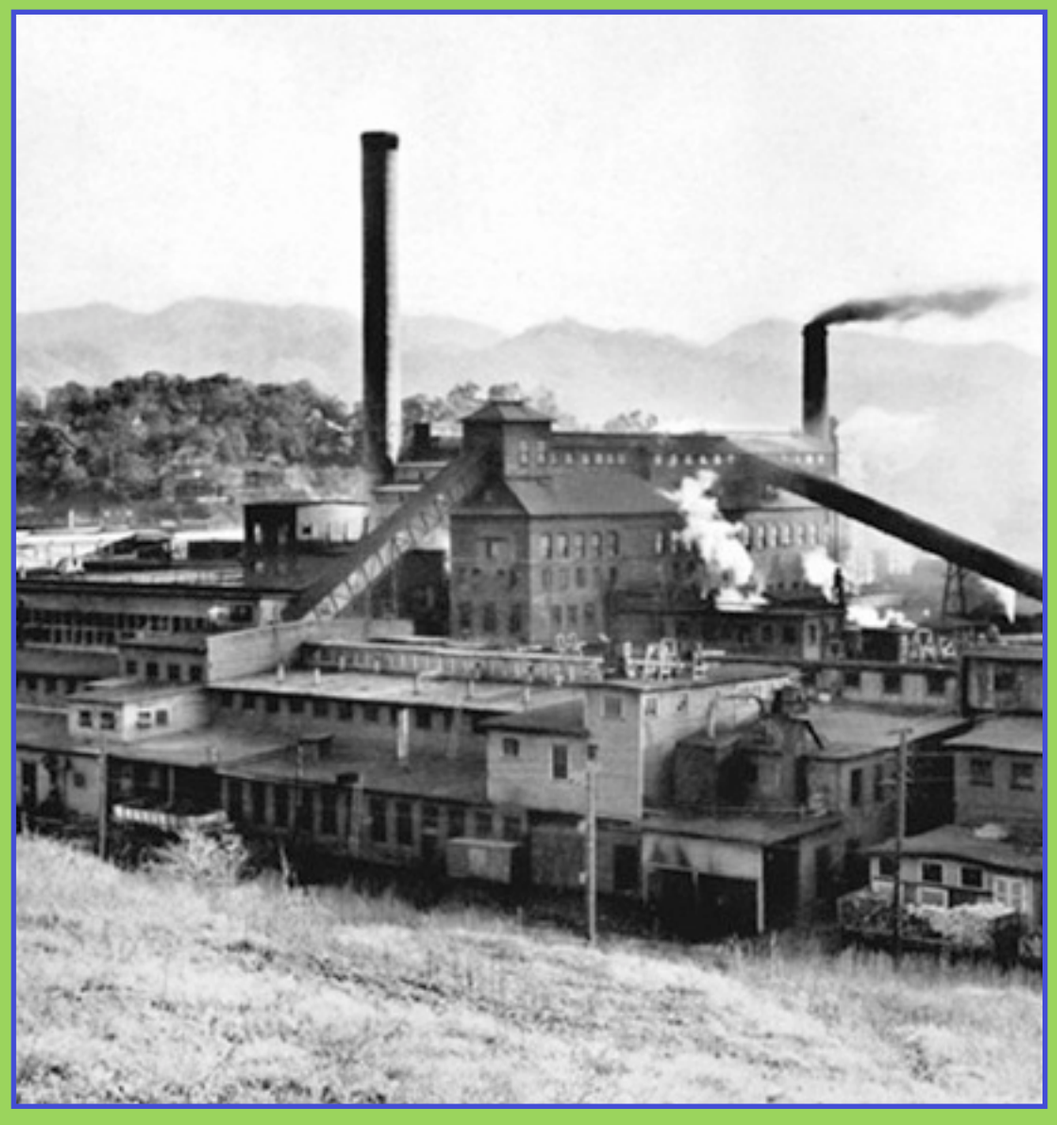
American Chestnut

- Chestnut was also an important wood for furniture making.

American Chestnut

- In the South, chestnut bark and wood were also used for tannin extraction.





Even the fire-scarred, worm-eaten timber of the dry ridges was utilized for tannic acid extraction. An entire plant at Champion Fibre's Canton Division was devoted to the production of "chestnut extract" for worldwide distribution to tanneries. It was the company's most profitable enterprise, because after the tannin was boiled out the wood pulp could be used for paper making

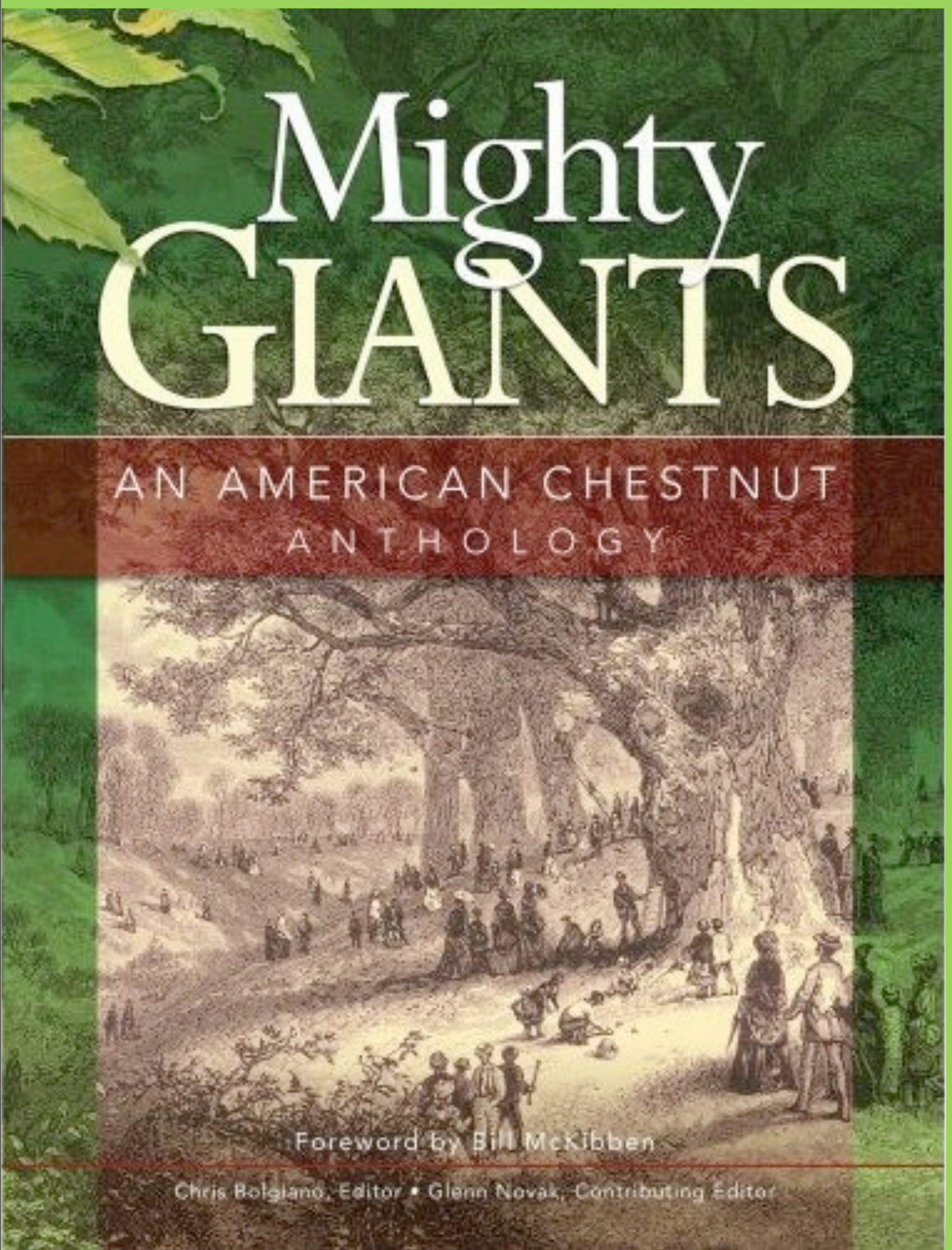
- **Chestnut was extensively used for utility poles.**

A chestnut - pole - treating plant.

- **Cape Cod Chestnut pole still in service since 1928!**

The Chestnut Blight

- As the blight advanced, people panicked, quickly cutting down chestnut trees and clearing the land to prevent fires.



Mighty Giants: An American Chestnut Anthology is the inspiring story of an American symbol and the struggle to save it from the brink of extinction, the saga of a unique and exceptional tree that supported a way of life, that fed and sheltered our ancestors, and "touched almost every phase of our existence." From Indians and early explorers, to colonists, naturalists, loggers, industrialists, and beyond, from presidents, poets, and artists, including Jefferson, Lincoln, Carter, Thoreau, Frost, Homer, Andrew Wyeth, and many more, the story of our once mighty, towering native chestnut tree is a lesson for our times. It is ultimately a story of how people, working together, can harness the power of community, scientific knowledge, and our growing awareness of the workings of nature to make a difference.

Chestnut Blight?

Is a bark fungus, imported from Asia in the late 19th Century on nursery stock.

Cryphonectria parasitica

Accidental Tree Genocide

Within 50 years of its official recongition in 1904, every mature Chestnut tree was girdled and killed by blight.

The blight fungus is devastating for a number of reasons:

- No effective resistance in American chestnut.
- Abundant production of spores on diseased bark.
- **Multiple hosts: chinkapins, oaks, shagbark hickory, red maple & sumac.**
- Spores stick on birds and animals.
- Adapted to a variety of environmental conditions.
- Rapid host mortality preventing natural selection for host resistance.

no scientific solution ☹

Why isn’t American Chestnut extinct?

Blight can not survive in the soil and chestnut has an amazing capacity to re-sprout from its root collar.

mud packing & commercial fungicides can delay the death of important trees

Other Enemies of Our Once Mighty Chestnut

PHYTOPTHERA “INK DISEASE”

GALL WASP

Friends of Our Once Mighty Chestnut

HYPOVIRULENCE

GENETIC TESTING

Early "Scientific" Solutions

Even though scientists realized the Chinese and Japanese Chestnut were resistant, early efforts to stop the blight were unsuccessful.

- USDA
- PENN BLIGHT COMMISSION
- CT AG EXP STATION

Many Hybrid Chestnuts were introduced and tried that were mainly **first crosses** between Chinese x American and Japanese x American.

First Cross: the first generation offspring of two different species or varieties

Hybrid: the offspring of two different species or varieties

Why not just use Chinese?

timber type

morphological (form) and **phenological** (reaction to environmental conditions) differences

orchard type

Why not just use Chinese?

timber type

morphological (form) and **phenological** (reaction to environmental conditions) differences

orchard type

PANGEA

Don’t be fooled by the maps

American Chestnut Isolated for a long time

Pangea – 250 million years ago

World Castanea Distribution

American *Castanea Dentata*

European *Castanea Sativa*

Chinese *Castanea Molissima* & *Seguinii*

Japanese *Castanea Crenata*

TACF Approach

- **Founded in 1983 as a non-profit organization, largely supported by membership contributions.**

- **Goal: To restore the American chestnut tree to the eastern U.S. through a scientific program of breeding and cooperative research.**

- **Primary approach is to use the backcross method of plant breeding to transfer blight resistance of the Chinese chestnut into American chestnut.**

- **Early hybrid breeding efforts had not gone far enough (too few generations to get desired traits)**

THE AMERICAN CHESTNUT FOUNDATION

Dr. Charles Burnham

Gregor Johann Mendel (1822 - 1884) was a member of an Augustinian order (Monastic) in Brunn Austria (Now part of Czechoslovakia)

Backcross Breeding

THE BACKCROSS METHOD

Chinese x American ----This produces an F1.

|

F1 x American ----This is the first backcross to the American and produces a BC1.

|

BC1 x American ----This is the second backcross to the American and produces the BC2.

|

BC2 x American ---- This is the third backcross and produces a BC3.

|

BC3 x BC3 ---- This is the first intercross which produces a BC3F2.

|

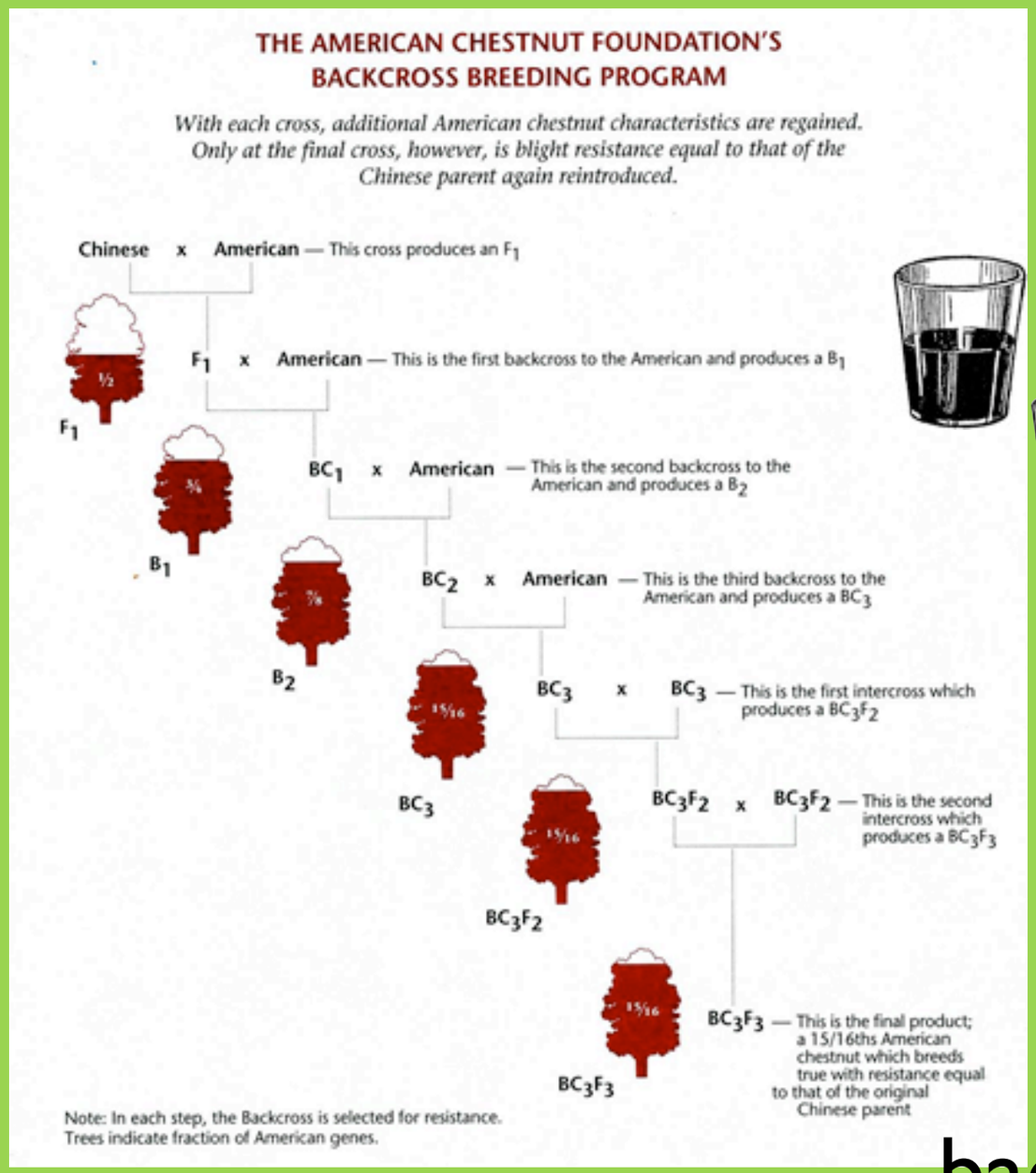
BC3F2 x BC3F2 ---- This is the second intercross which produces a BC3F3.

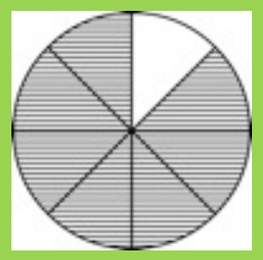
|

BC3F3 ---- This is the "final" product; a 15/16ths American chestnut with resistance equal to that of the Chinese parent.

American gene content at each generation:
F1 = 1/2
BC1 = 3/4
BC2 = 7/8
BC3 = 15/16
BC3F2 = 15/16
BC3F3 = 15/16

Backcross Breeding





labrador

or poodle?

94%

backcrossing with selection
for blight resistance and American traits

National TACF is testing the first generation BC3F3 now

Does this mean we are done?

How do state chapters fit into the Breeding Program ?

National TACF testing will take years to see if trees have the proper growth form and resistance we predict.

Forest traits could take 30 to 50 years to assess

Science Cabinet suggests BC6

State chapters are important in preserving and working local chestnut genetics into the backcross program.

Our goal is to make a blight resistant tree suitable for all the climate zones of Massachusetts & RHode Island.

Our Breeding Program

20 different lines of "Clapper"

20 different lines of "Graves"

These names refer to the original chinese parent or source of resistance in the First Cross

A line is enough surviving trees planted in an orchard (50/120) to select for resistance

Our BC3 Breeding Program Today

20 different lines of "Clapper"

20 different lines of "Graves"

This why we have 28 orchards and 6,000 trees

Nanking

But how did we get here? How did we populate our orchards?

a lucky mother tree is discovered

Tree is pollinated with BCF2 pollen air mailed in pill box from Virginia

tree visits

3x

bag'n'strip pollinate harvest

The nuts are harvested, stored for the winter in somebody's fridge, then planted in a BC3 F1 Orchard like Tower Hill

In 6 to 8 years trees are ready to "select" or challenge with direct inoculation of blight

Inoculation

Our only option* to see if 1/2 of the genes for resistance were passed on.

Inoculation are made in Spring are then graded by a number system in the late Fall and again the next growing season.

Trees are give number from 1-5

a pure American will score above a 3

F1s will score around 3

pure Chinese should score 3 and below

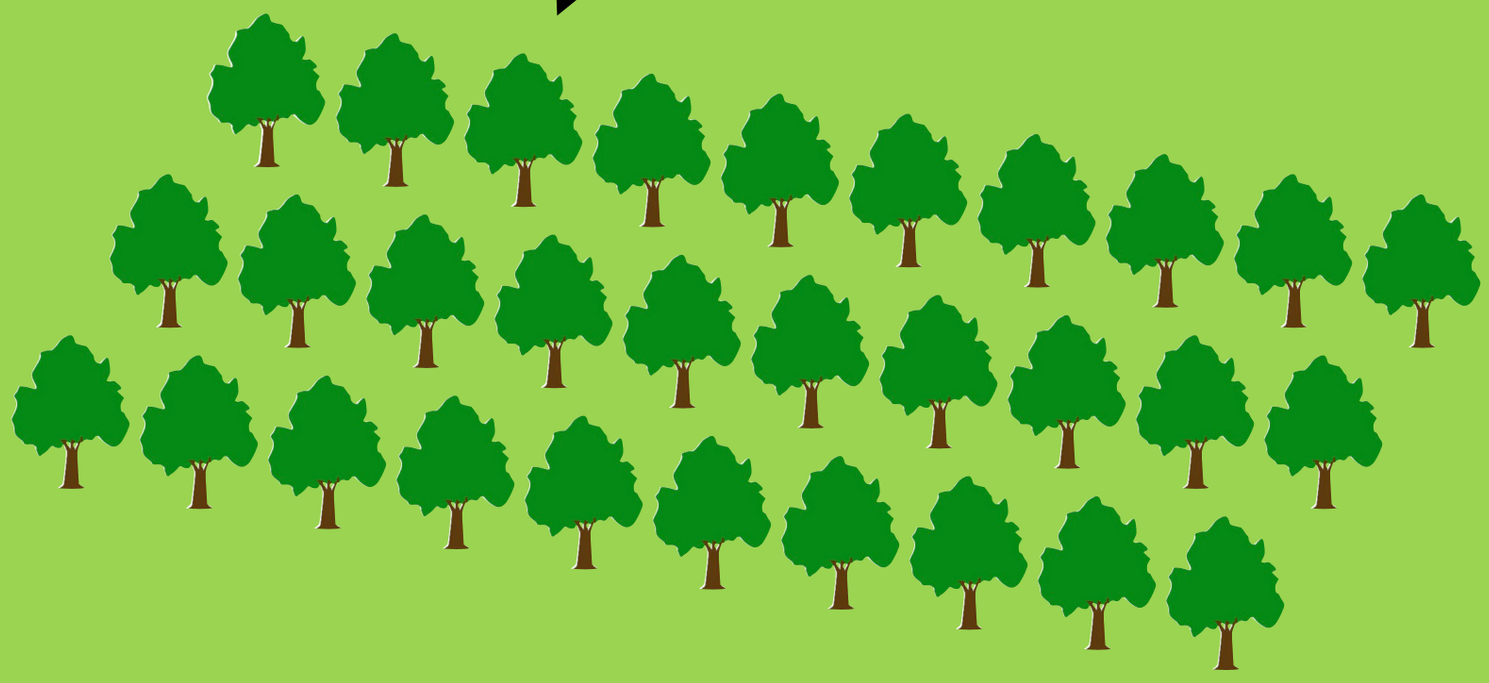
BC3 F1 Orchard

Mass mother tree

x

BC2 pollen "clapper"

Tower Hill

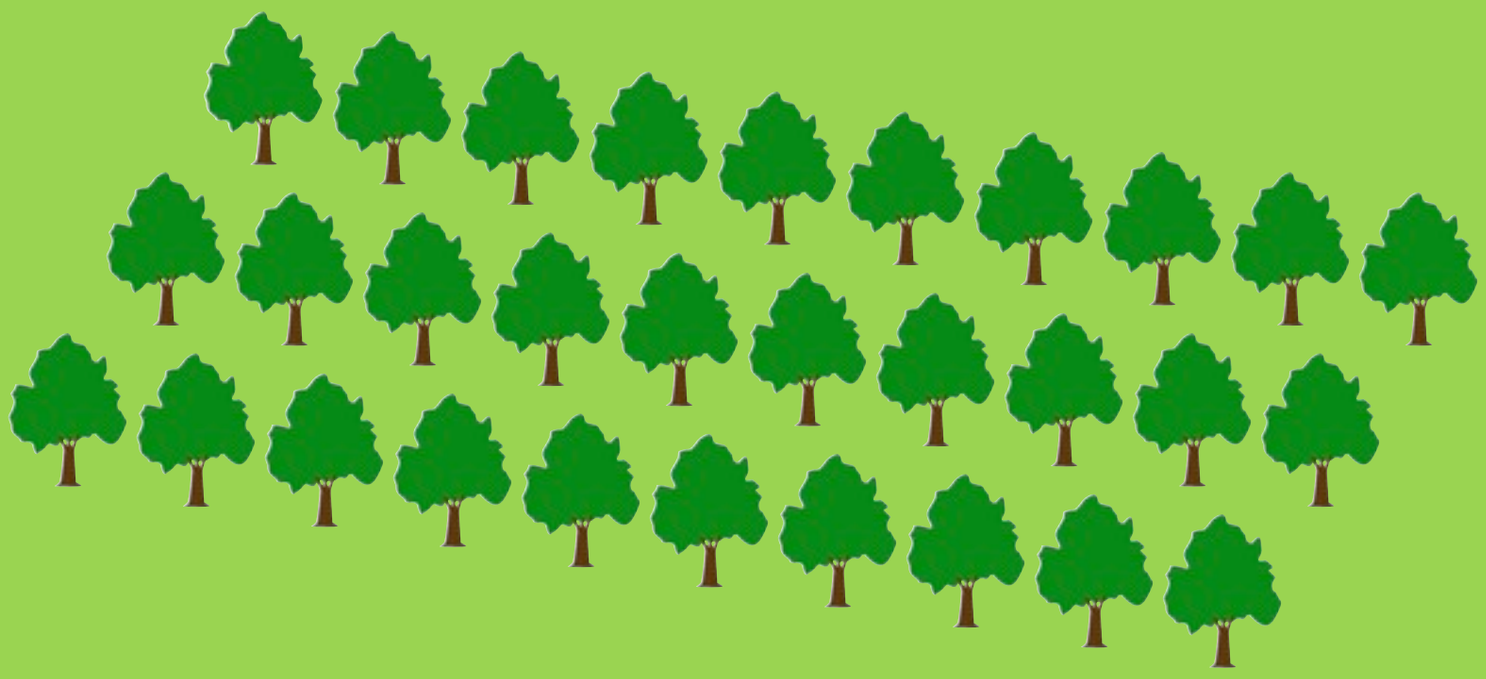


BC3 Quabbin in Clapper

BC3 F1 Orchard

after 6 to 8 years time to inoculate

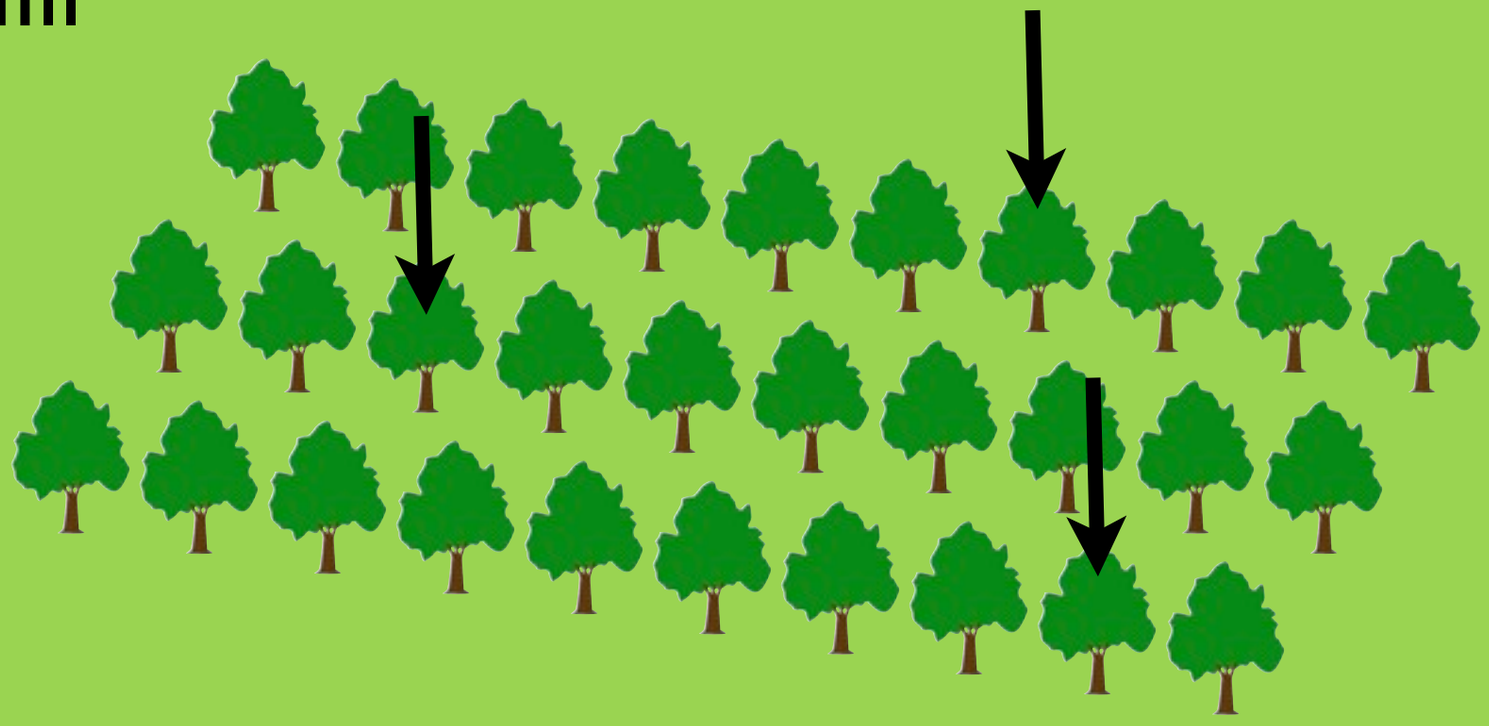
Tower Hill



BC3 F1 Orchard

Only about 8% have “full” resistance (50%)

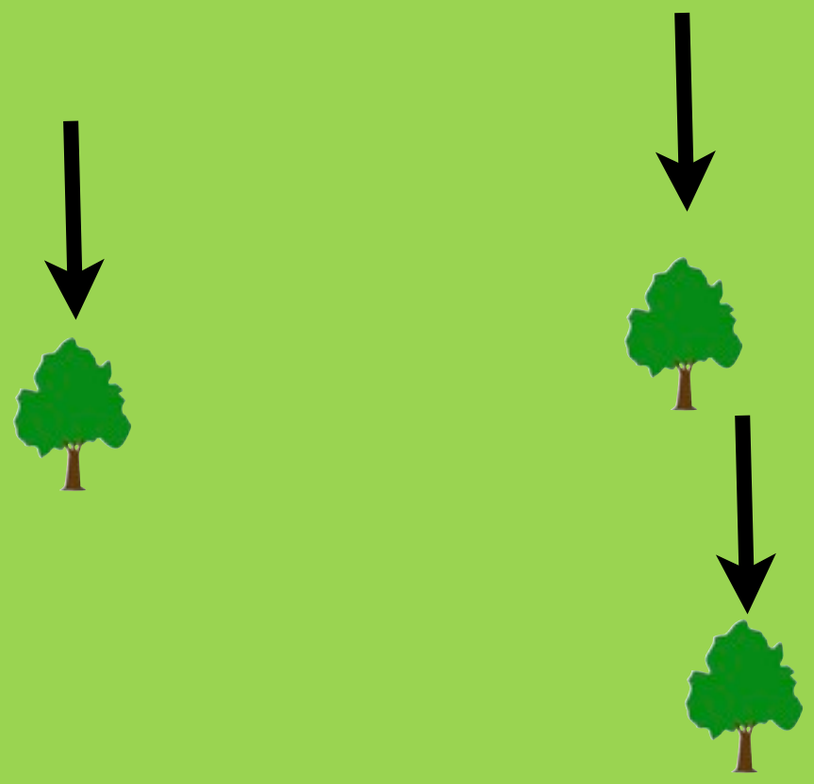
Tower Hill



BC3 F1 Orchard

All other trees are removed and the remaining BC3's are allowed to open pollinate

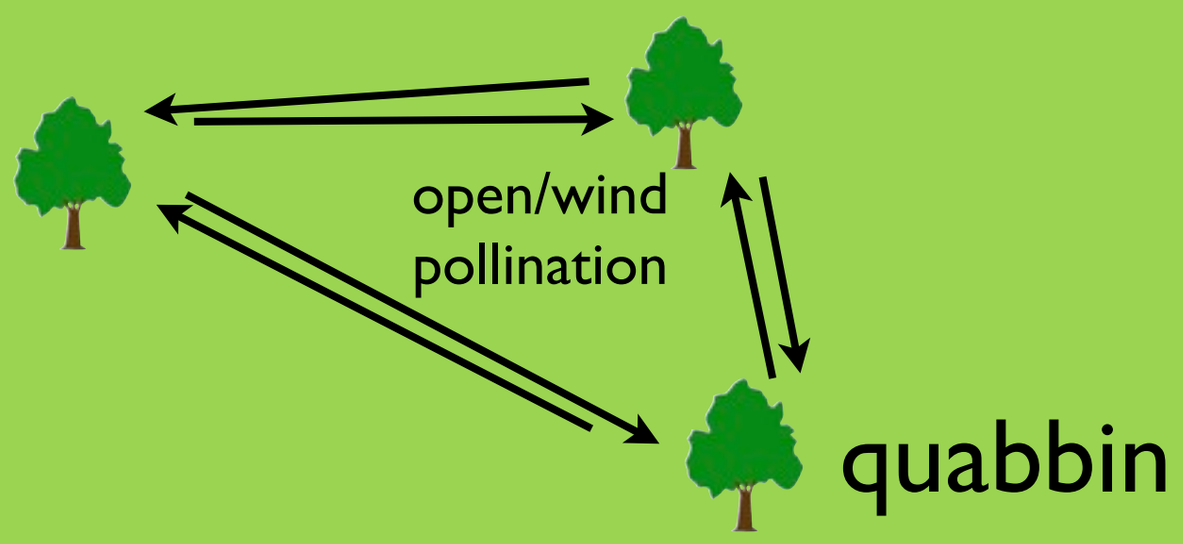
Tower Hill



BC3 F1 Orchard

The nuts from these are moved to a seed plot/ orchard

Tower Hill



BC3 F2 “Plots”

Tower Hill

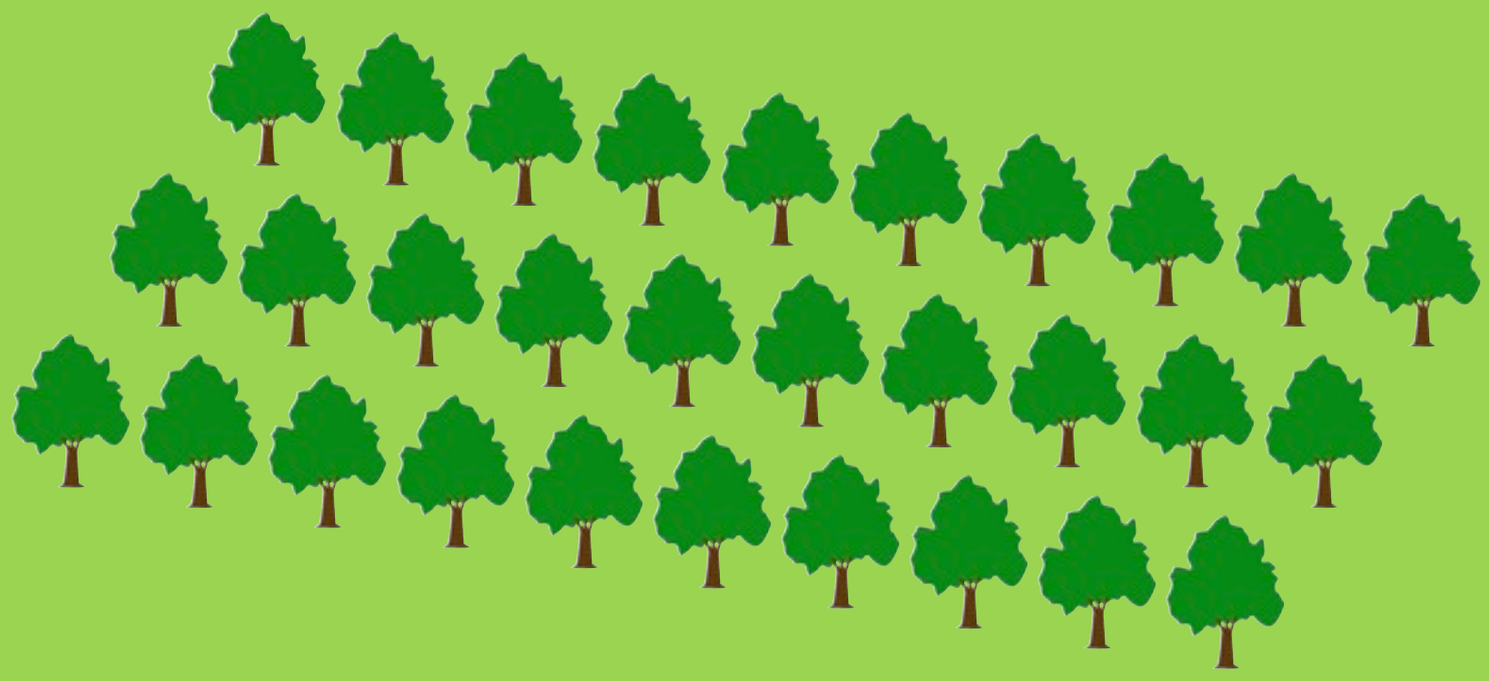
quabbin

Moore State Park

BC3 F2 Plots

Time to inoculate again after only 2-4 years

Moore State Park

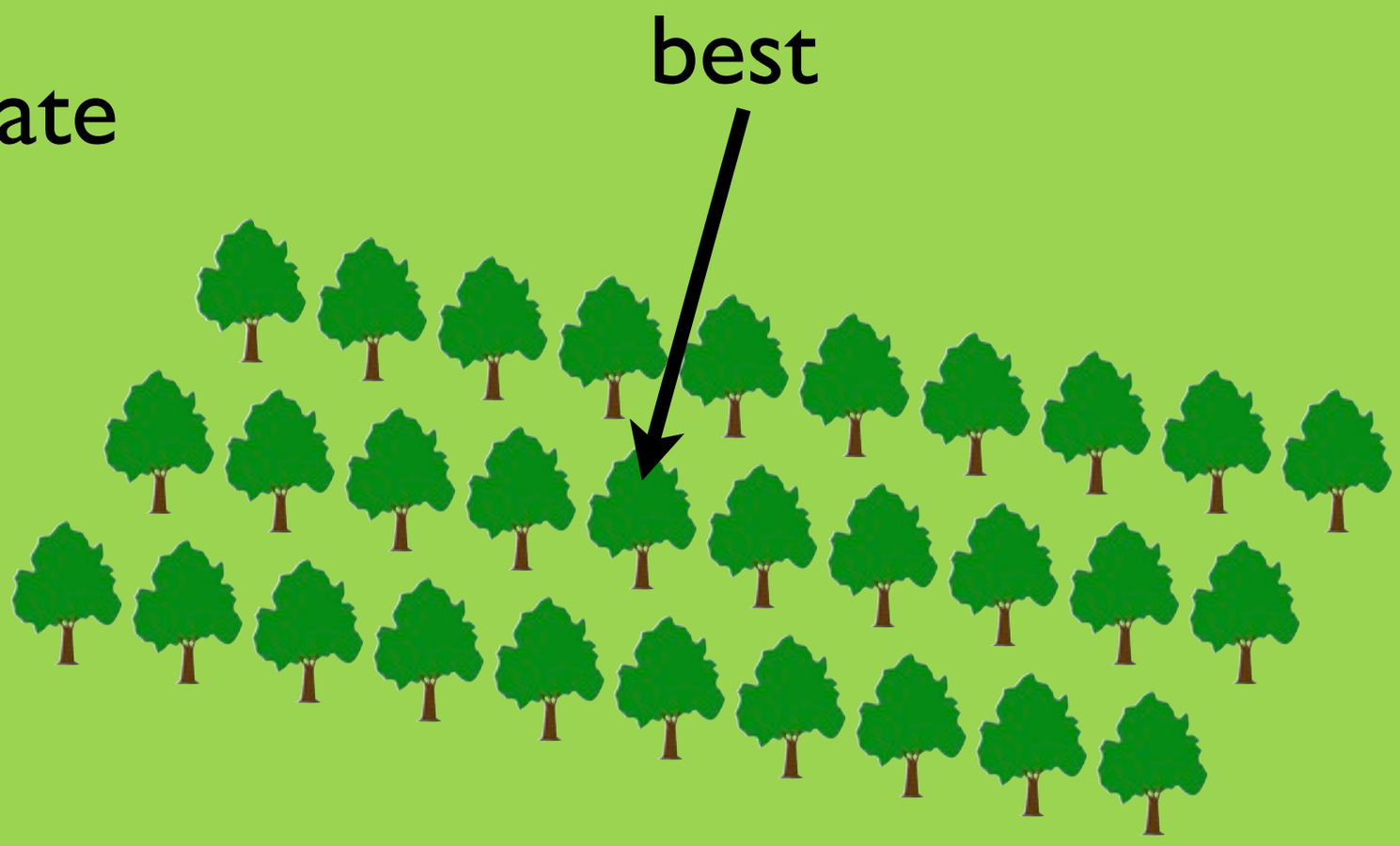


Seed Plot of 150 closely spaced

BC3 F2 Plots

This time to we keep
the best 1 out of 150

Moore State
Park



Seed Plot of
150 closely
spaced

Seed Plots for BC3 x F2

1 foot spacing

The few best survivors of each 150 tree plot become producers of BC3 F3 seed when open pollinated. This generation will be put back into the forest and breed true for blight resistance!

Two-year-old plot

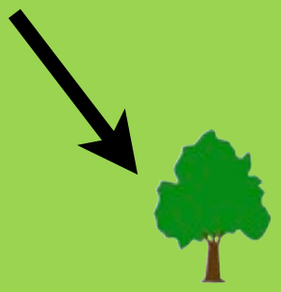
Inoculated BC3F2

BC3 F2 Plots

Other seed plots are next to this one

best Concord (graves)

from Wayland



best Quabbin (clapper)

from Tower Hill

Moore State Park

Moore State Park Seed Orchard

best Concord (graves)

from Wayland

best Northbridge (clapper)

Wrentham

best Quabbin (clapper)

from Tower Hill

Each champion BC3 F2 from the plot cross pollinates with other champion in the “Seed Orchard”

Moore State Park Seed Orchard

The children of the seed orchard are BC3 F3 nuts

Concord

Northbridge

Quabbin

BC3 F2 Seed Orchard

Moore State Park Seed Orchard

topsfield

concord

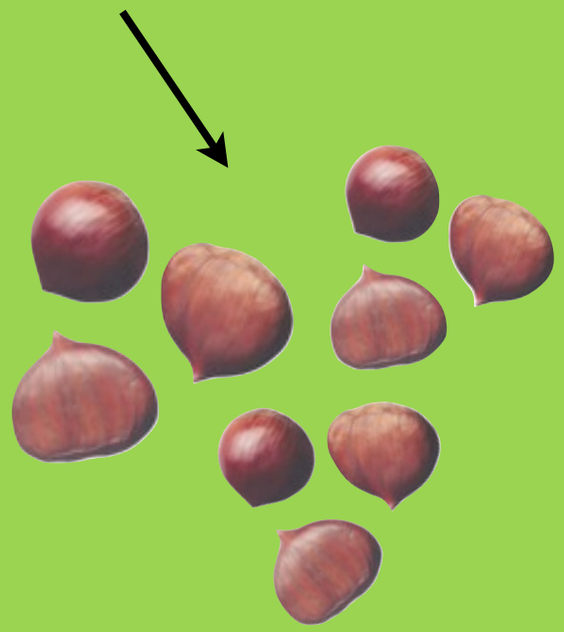
quabbin

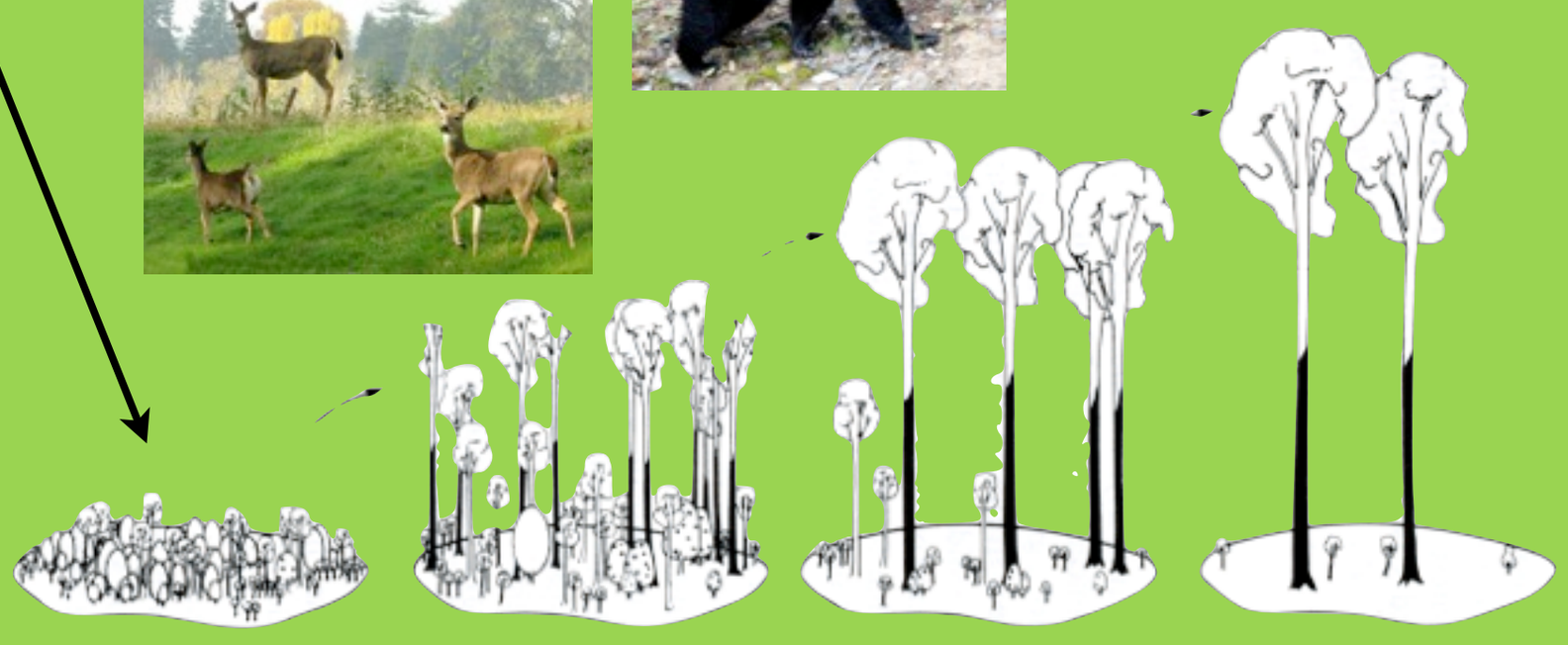
northbridge

leominster

milford

Seed Orchards BC3 F3





What can members do help?

Attend Board and Annual Meetings

Help with orchards, inoculation and spotting new mother trees

Help spread the word about TACF and share the American Chestnut story.

Continue your membership which supports the 25 years of science has been done and will have to be done to return Chestnut to the forest.

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MA/RI Chapter of the American Chestnut Foundation

The End