

The American Chestnut Tree



<https://www.acf.org/md/chestnut-background/student/>



Student Objectives

Wednesday, February 10, 2021

During today's lesson, students will be able to:

1. Explain how the backcross breeding method works and is helping to develop disease-resistant populations of new trees.
2. Perform a 'mock' genetic backcross.

Warm-Up

Complete the following Punnett Square. In this situation you are crossing 2 pink flowers. In the flowers, the colors are co-dominant and the traits will blend.

R- Red Flower

r – White Flower



	R	r
R		
r		



1. Describe the phenotype of the offspring.
2. What are the genotypes of the offspring?

An Introduction to the Backcross Breeding Method

It's in the genes!!!

Think about the following in the next few slides ...

1. What methods have been used as attempts to save the American Chestnut?
2. Which traits are “desirable” in an American Chestnut hybrid?
3. What is a Back-Cross?

Early Attempts

Attempts to save the chestnut include:

- isolating diseased chestnuts
- attacking the blight fungus
- Attempts to mutate disease-resistant trees
- breeding for resistance to stop the blight

Early efforts to save the American Chestnut included clear-cutting buffer strips



<http://www.tripeast.com/platform.htm>

Cutting isolation strips to prevent the spread of the fungus-
unsuccessful.

Introducing a virus that would kill the fungus (carried by wasps)-
unsuccessful.

Chestnut gall wasp (*Dryocosmos kuriphilus*) laying its egg in the bud of a chestnut tree (Photo by S. Moriya)



<http://www.agnet.org/library/image/ac1997g1.html>

Natural Resistance

Looking for natural resistance in wild trees- to date there are existing unaffected trees, but it is unclear whether they are disease resistant or just lucky.

Actual American
Chestnut Tree
from Mt. Airy,
MD



Hypovirulence

- Scientists have attempted using a weaker strain of the fungus (that does not kill the tree) to build resistance in chestnuts.
- This works much like a vaccination would... This method is still being studied.

Irradiation

Attempting to cause a mutation that will give chestnuts resistance.

- Irradiating chestnuts in the hopes that mutations might result in blight resistance was an outgrowth of President Eisenhower's Atoms for Peace Program.
- It was suggested by Dr. Singleton of the University of Virginia who had some success irradiating corn.
- To date, data is still being collected that may show positive results.

So, Let's Summarize What the Genetic Problem Is....

- Make a hybrid tree that is blight resistant yet still has “American Chestnut” qualities?

The Players

American

Chinese



American Chestnut



Leaf



Stem



Nut

Low / No Resistance From Blight

Chinese Chestnut



Leaf



Stem



Nut

High Resistance From Blight

Comparison

Chinese Chestnut



American Chestnut →



American Chestnut produces a sweet, small nut.

Chinese chestnut produces a large, generally tasteless nut



How Do You Perform a Genetic Cross in Chestnut Trees?

1. Select trees to be crossed
2. Take pollen from one tree and use it to fertilize the ovary of the second tree.



Male (catkin)

Female (flower)



3. Harvest the nuts and plant the hybrid trees.

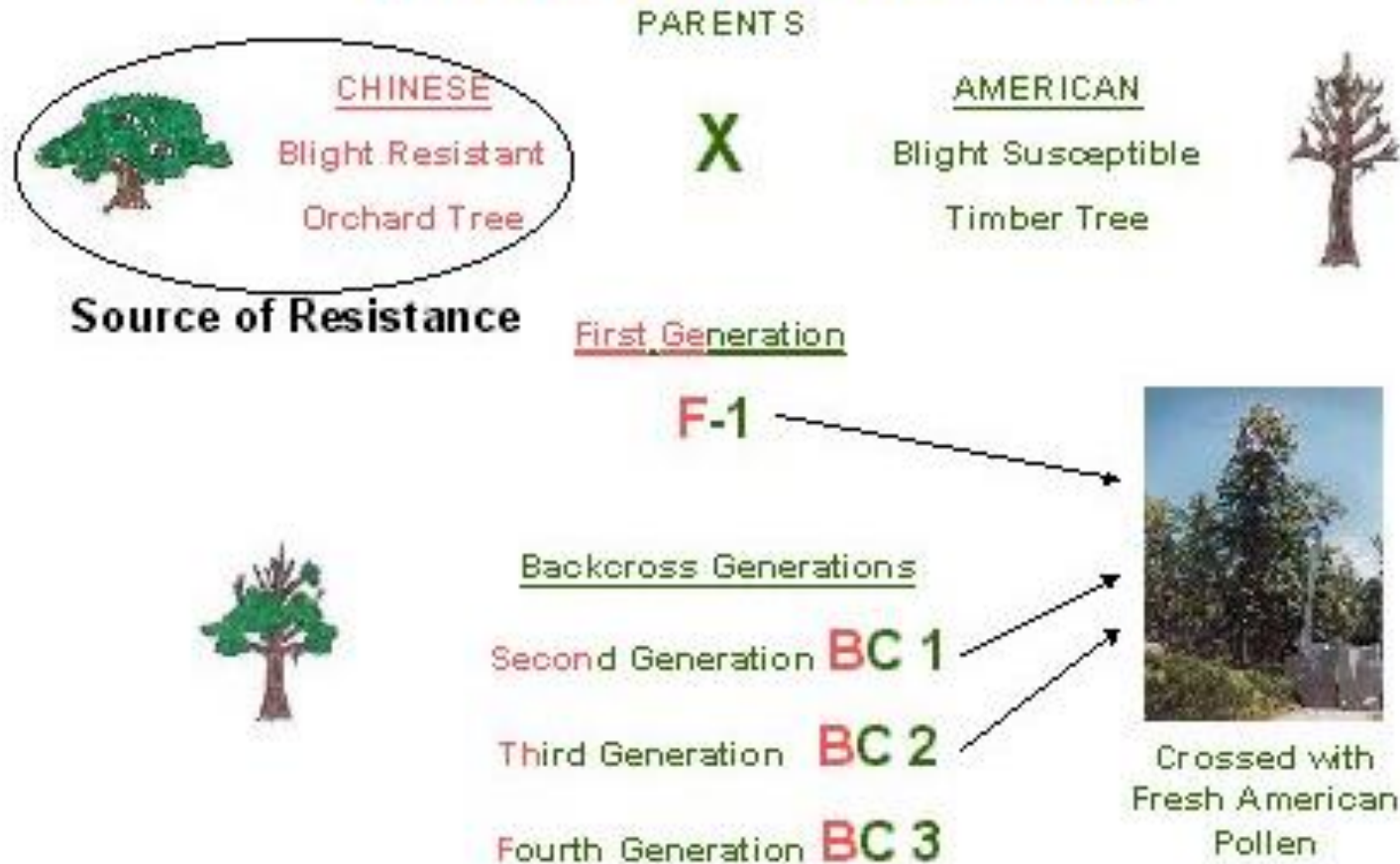


What is a Back-Cross?

- Cross two different trees (Chinese and American).
- Then, cross the offspring BACK to the American species.

Backcrossing- TACF's method

(The Path of Most Resistance)

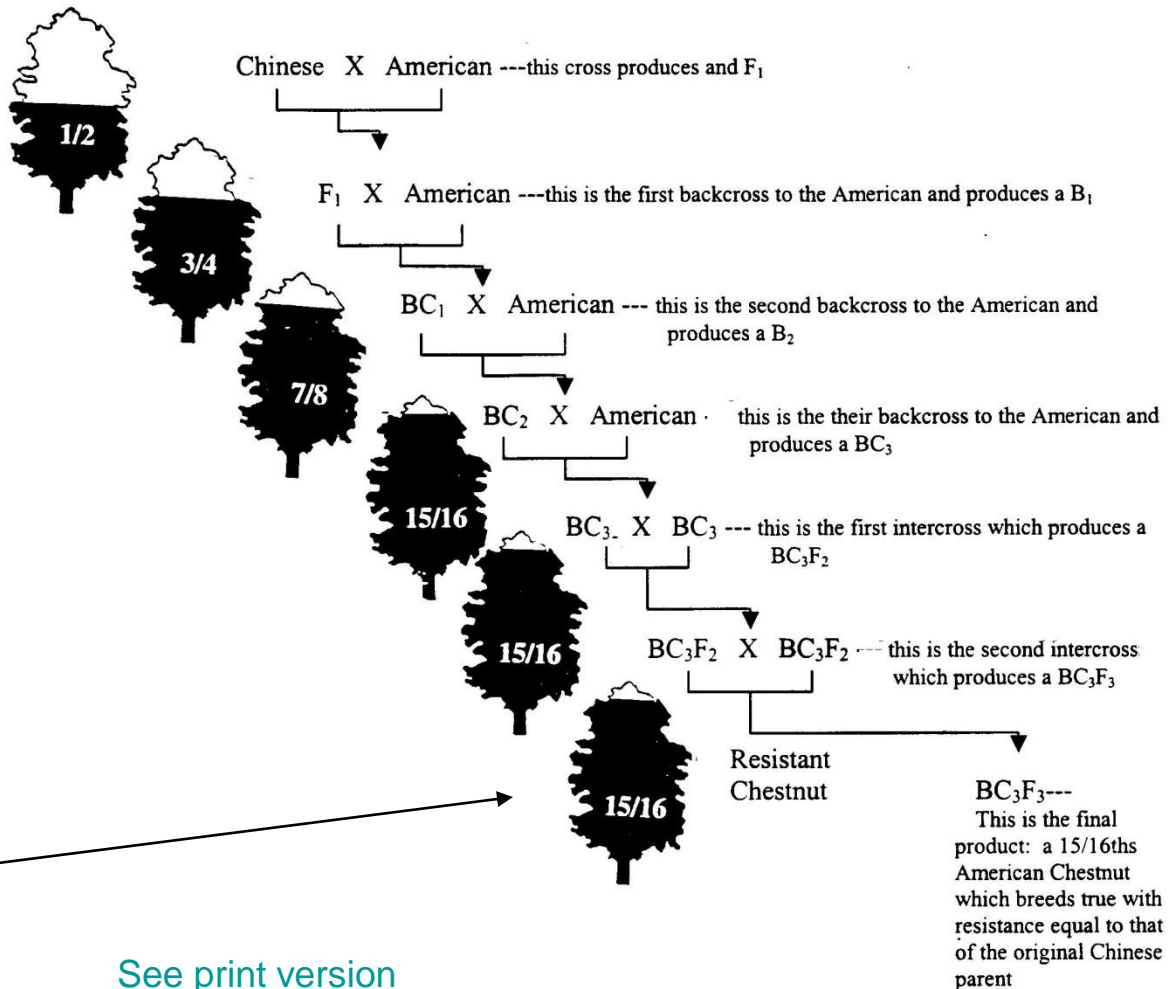


- For three generations, the resulting offspring is backcrossed with a pure American to get a Backcross 3 (BC3). The process is to confer blight resistance from the Chinese chestnut and keep the form and function of the American Chestnut.
 - BC3 is intercrossed with other BC3 trees
 - American gene content at each generation:
 - F1 = 1/2
 - BC1 = 3/4
 - BC2 = 7/8
 - BC3 = 15/16
 - BC3F2 = 15/16
 - BC3F3 = 15/16

THE BACKCROSS METHOD (3)

The American Chestnut Foundation's Backcross Breeding Program

With Each cross, additional American chestnut characteristics are regained. However, blight resistance equal to that of the Chinese parent is achieved only at the final cross.



American chestnut with resistance equal to that of the Chinese parent.

[See print version](#)

- Of this BC3F3 = 15/16: One out of the 4 offspring will have 1 copy of both resistant genes
- The process is repeated until a final cross of 2 trees with partial resistance yields 1 having 2 copies of both resistant genes making it fully resistant

Resulting Generations



Backcross 1



Backcross 2

Testing and Selection at Each Generation...

- The backcross breeding strategy was developed by Dr. Charles Burnham in 1982.
- An essential element of the strategy includes a selection process at each generation.

Testing and Selection at Each Generation...

- When the seedlings from each generation reach about 5 years of age, they are inoculated with a known strain of the blight and their reactions are observed.
- Only the trees that appear to have some blight resistance are allowed to grow fruit and breed to make the next backcross generation.

Testing and Selection at Each Generation...

- The offspring of the blight resistant trees that emerge from inoculating the third backcross generation are allowed to intercross with each other.
- The intercross progeny will have inherited blight resistance from both parents and will be the basis for blight-resistant trees.

Evidence of Success

- There have been many trees developed that, so far, show an increased resistance to blight.
- They are vigorous trees and have been used in back-cross pollination for other generations of trees.



Evaluate:

- Complete the “Bean There Done That” activity to demonstrate your ability to perform a ‘mock’ backcross.

