



Mila

Truffles & Host Trees

New Combinations and Opportunities

(And a Few Words about Plant Propagation)

North American Truffle Growers Association

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Why are we looking at alternative host tree species?

With current hosts, we have problems with:

- Diseases and pests
- Cold hardiness
- Productivity
- Excessive growth rate

Challenges:

- Higher pH tolerance
- Heat/cold tolerance
- Disease and pest resistance
- Propagation
- How does it compare to known productive species? Harvest volumes?



***Corylus avellana* orchard
with Eastern Filbert Blight (EFB)**





Potential Host Species Considerations

- **Compatibility, ectomycorrhizal?**
- **Which truffle species?**
- **Cold and heat tolerance**
- **Disease and insect resistance**
- **Management strategy**
- **Biodiversity**
- **Years of production**
- **Growth rate and habit**
- **What quantifies a 'successful' host?**



Host tree options:

- ***Fagaceae***

Quercus sp. (oaks), *Castanea sp.* (chestnuts), *Fagus sp.* (beeches)

- ***Betulaceae***

Corylus sp. (hazelnuts, filberts), *Carpinus sp.* (hornbeams)

- ***Pinaceae***

Pinus sp. (pines)

- ***Malvaceae***

Tilia sp. (lindens)

- ***Salicaceae***

Populus sp. (poplars)





The Carolina Truffières research orchard is:

- Located just south of Asheville, North Carolina
- Southern Appalachians, temperate rainforest
- USDA Zone 7A, 2200' elevation, average annual precipitation is 47 inches
- Primarily silt loam and sandy loam soil

We are evaluating:

- 8 truffle species
- 11 *Corylus* species and cultivars
- 7 *Quercus* species
- 2 *Castanea* species
- 4 *Pinus* species
- 7 Other genera/species
- Management practices (pruning, irrigation, companion plants, etc.)





***Corylus sp.* (hazelnuts, filberts)**

- ***Corylus americana*** (American hazelnut)
- ***Corylus avellana*** (European hazelnut)
- ***Corylus avellana* cultivars** – OSU & Rutgers
- ***Corylus avellana* hybrids** – OSU & Rutgers
 - C. americana, C. colurna, C. cornuta, and C. avellana*
- ***Corylus colurna*** (Turkish filbert)
- ***Corylus cornuta*** (Beaked filbert)
- ***Corylus sp.*** – Asia
 - C. heterophylla, C. sieboldiana , & others*





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'Raritan' hazelnut PP 32,460



Cross made in 2004 at OSU

Parents:

OSU 539.031 x OSU 616.018

- Blanched kernel market
- **Quantitative EFB resistance** (high tolerance) from Tonda di Giffoni and Sant Pere
- **S alleles 3, 22**
- Vigorous, upright tree
- Highest yielding in our trials
 - Mature trees >40 lbs dry in shell nuts per tree



- Round kernels, most 12-14 mm in diameter
- Kernel weight avg. - 1.14 grams
- Kernel percent avg. - 47.7%
- Blanch avg. - 2.3/7.0 (1 = best)
- Nuts fall free of husk at maturity
- Very high level of tolerance to EFB (little to no cankers formed under high disease pressure; most lack stromata)



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‘Raritan’ hazelnut



‘Somerset’ distinguishing traits

- Compact growth habit
 - Small statured tree compared to others. May find place in higher density orchards
 - Precocious (bears heavy as young tree)
- Very thin shells and round kernels
- Free of EFB in our trials
 - ‘Ratoli’ single gene resistance
 - On same linkage group as ‘Rush’ resistance, different than ‘Gasaway’



Corylus avellana ‘Somerset’ PP 32,494



***Corylus avellana* 'Somerset' PP 32,494
with *Tuber canaliculatum***

- **New Rutgers selection**
- **EFB resistant**
- **Compact growth habit**



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'OSU 541.157' The Beast™ hybrid hazelnut



Pictures courtesy of Oregon State University



- Developed at OSU from a cross in 1990 using F₁ hybrid NY 616
- Tested at Rutgers since 2000 then Nebraska
- Released by Hybrid Hazelnut Consortium in 2020

Corylus x 'The Beast'™ PP 33,561

(*C. avellana* x *C. americana* 'Rush')



Corylus avellana 'Jefferson'
with *Tuber macrosporum*

- Resistant to EFB in WNC
- Upright habit
- Large nuts



Corylus heterophylla
With *Tuber melanosporum*



Corylus heterophylla

Genus *Quercus* (500+/- species)

- *Quercus* subgenus *Quercus* ('New World' oaks)
 - Section: ***Quercus*** (white oaks)
 - Section: *Ponticae*
 - Section: *Protobalanus*
 - Section: *Lobatae*
 - Section: *Virentes*
- *Quercus* subgenus *Cerris* ('Old World' oaks):
 - Section: ***Cerris***
 - Section: ***Ilex***
 - Section: *Cyclobalanopsis*
- Intersectional hybrids (180 and counting)



Genus: *Quercus*

Subgenus: *Quercus*

Section: Quercus

includes:

- *Quercus faginea* – Portuguese oak
- *Quercus macrocarpa* – Burr oak
- *Quercus lobata* – valley oak or California white oak
- *Quercus muehlenbergii* – Chinkapin oak
- *Quercus pubescens* – Downy oak
- *Quercus robur* – English oak



Genus: *Quercus*
Subgenus: *Quercus*
Section: *Cerris*

includes:

- *Quercus cerris* – Turkey oak
- *Quercus coccifera* – Kermes oak
- *Quercus phillyreoides* (fka *Q. ilex ssp. phillyreoides*) – Ubame oak
- *Quercus rotundifolia* (aka *Q. ilex ssp. ballota*, *Q. ballota*) – Holly oak





Quercus phillyreoides

Ubame oak

fka *Q. ilex* ssp. *phillyreoides*

Native to Japan, Korea, SE China

Successful host in Australia and in WNC

Tight, compact habit when young; then opening up with age

Evergreen

Once established, cold hardy to Zone 6



Quercus muehlenbergii

Chinkapin oak

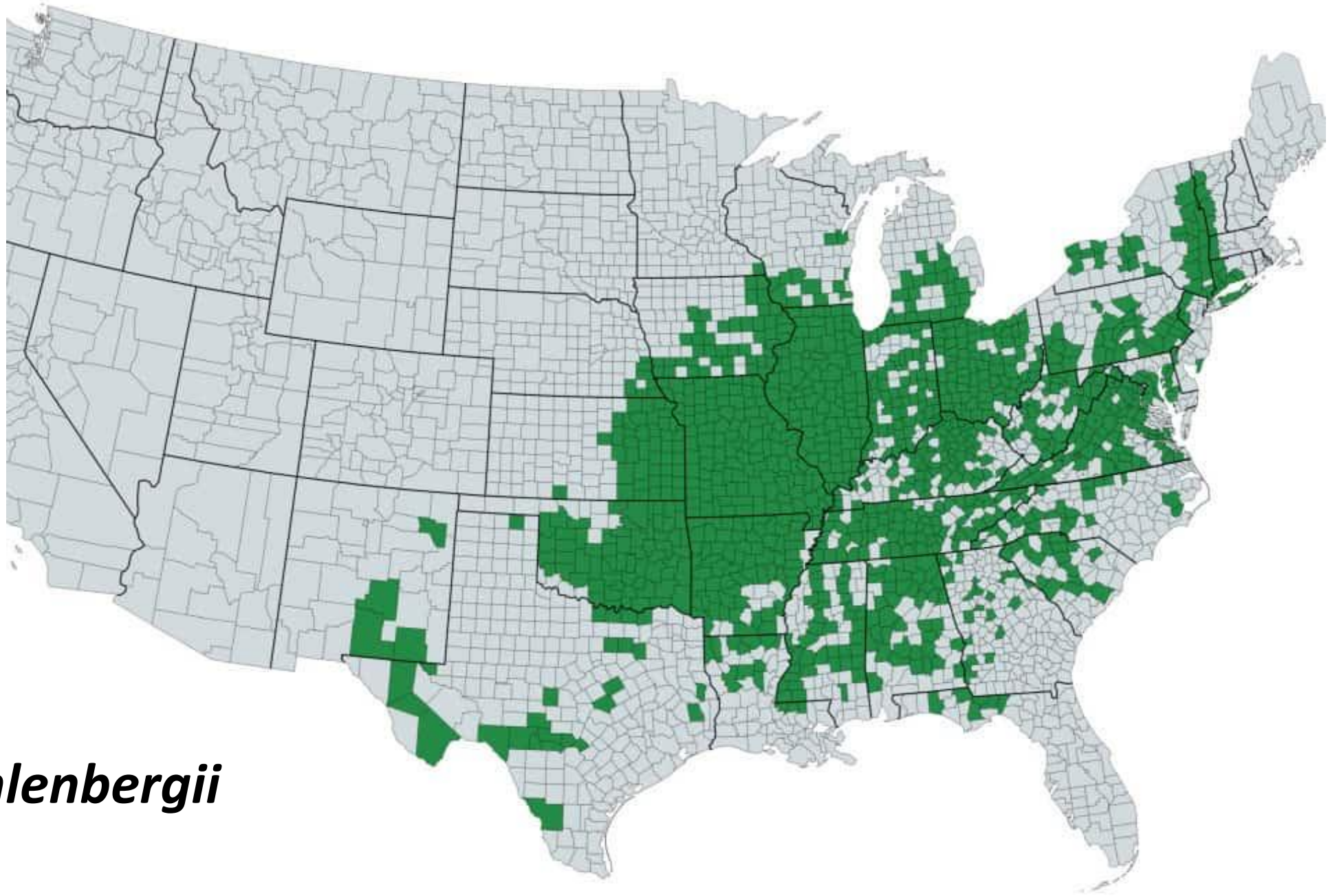
Native to much of eastern U.S.

Tolerant of high pH soils

Open canopy

Relatively small stature

Success with *T. melanosporum*



range of

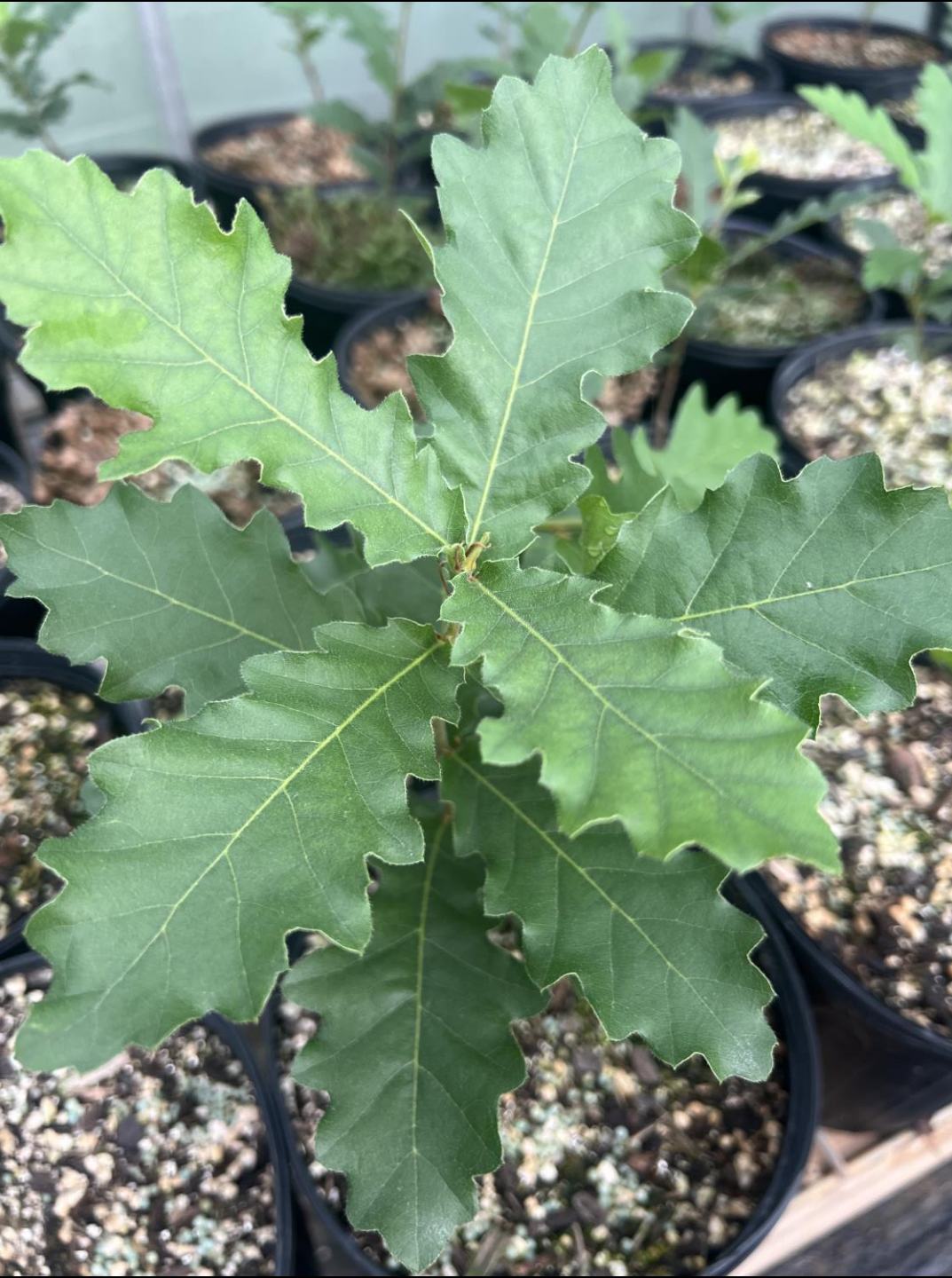
Quercus muehlenbergii



Quercus faginea

Portuguese oak

- Deciduous
- Open habit
- Proven host in Europe



Quercus cerris

Turkey oak

- Deciduous
- Proven host in eastern Europe
- Open canopy

Castanea sp.

- *Castanea crenata* – Japanese chestnut
- *Castanea x (C. dentata x C. mollissima)* – Hybrid chestnut
 - success with *Tuber aestivum var. uncinatum*
 - *Tuber canaliculatum*?
 - early success with *T. melanosporum*
 - co-crop potential





Castanea x (C. dentata x C. mollissima)



Pinus sp. (pines)

Typically used for *Tuber borchii* only; however,

- *Pinus pinea* (Italian stone pine)
- *Pinus strobus* (white pine)
- *Pinus taeda* (loblolly pine)
- *Pinus yunnanensis* (Yunnan pine)?
- *Pinus armandii* (Armand's pine)?





Tuber borchii
on *Pinus taeda* (loblolly pine)

Burwell Farms
North Carolina, USA



And a few comments about woody plant propagation:

What exactly are you growing in your orchard?

Seed propagation

- a) Woody seedlings are **NOT** genetically identical to the parent tree
- b) Attributes may vary depending on provenance of seed (i.e. cold hardiness)

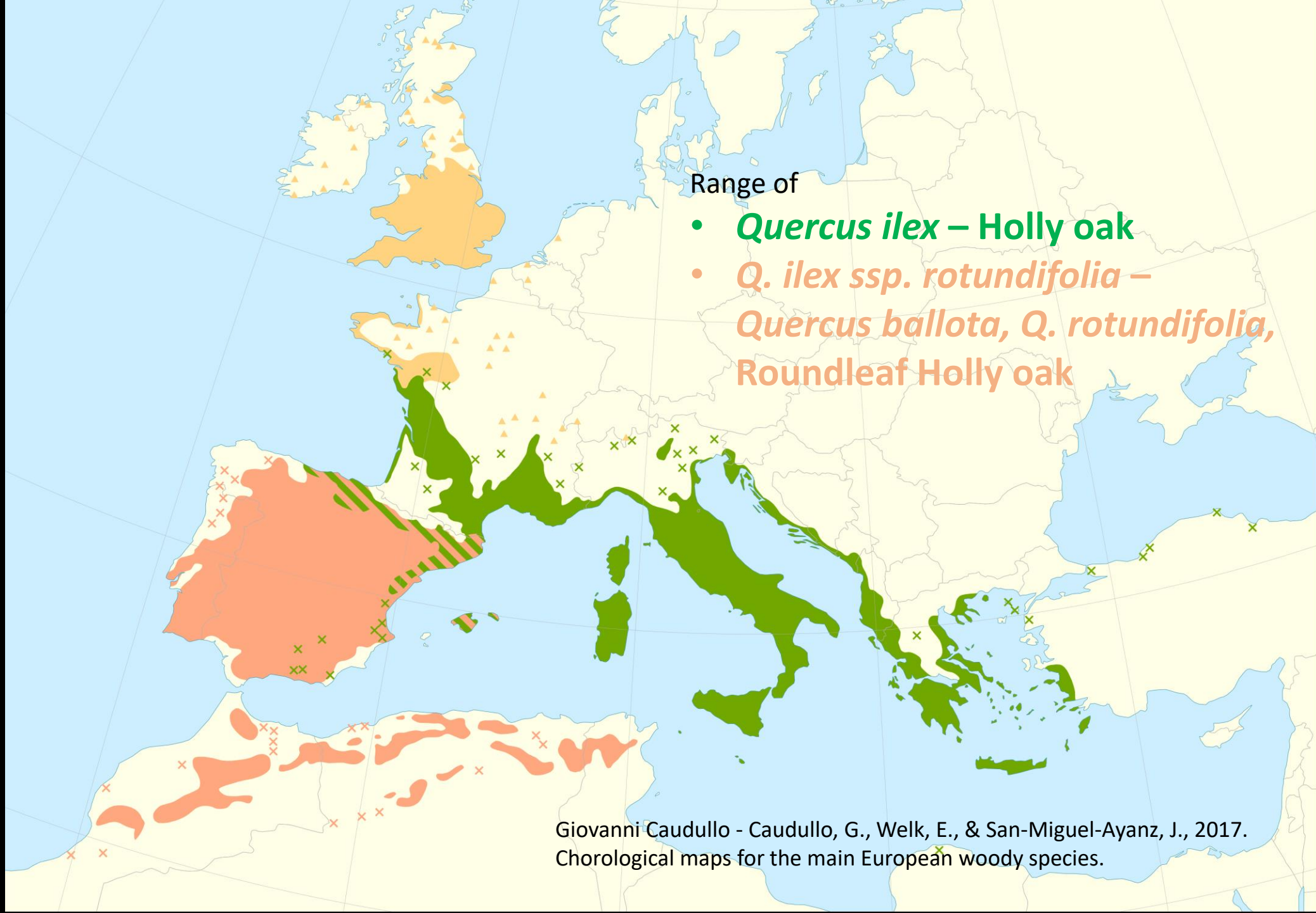
Asexual (clonal) propagation

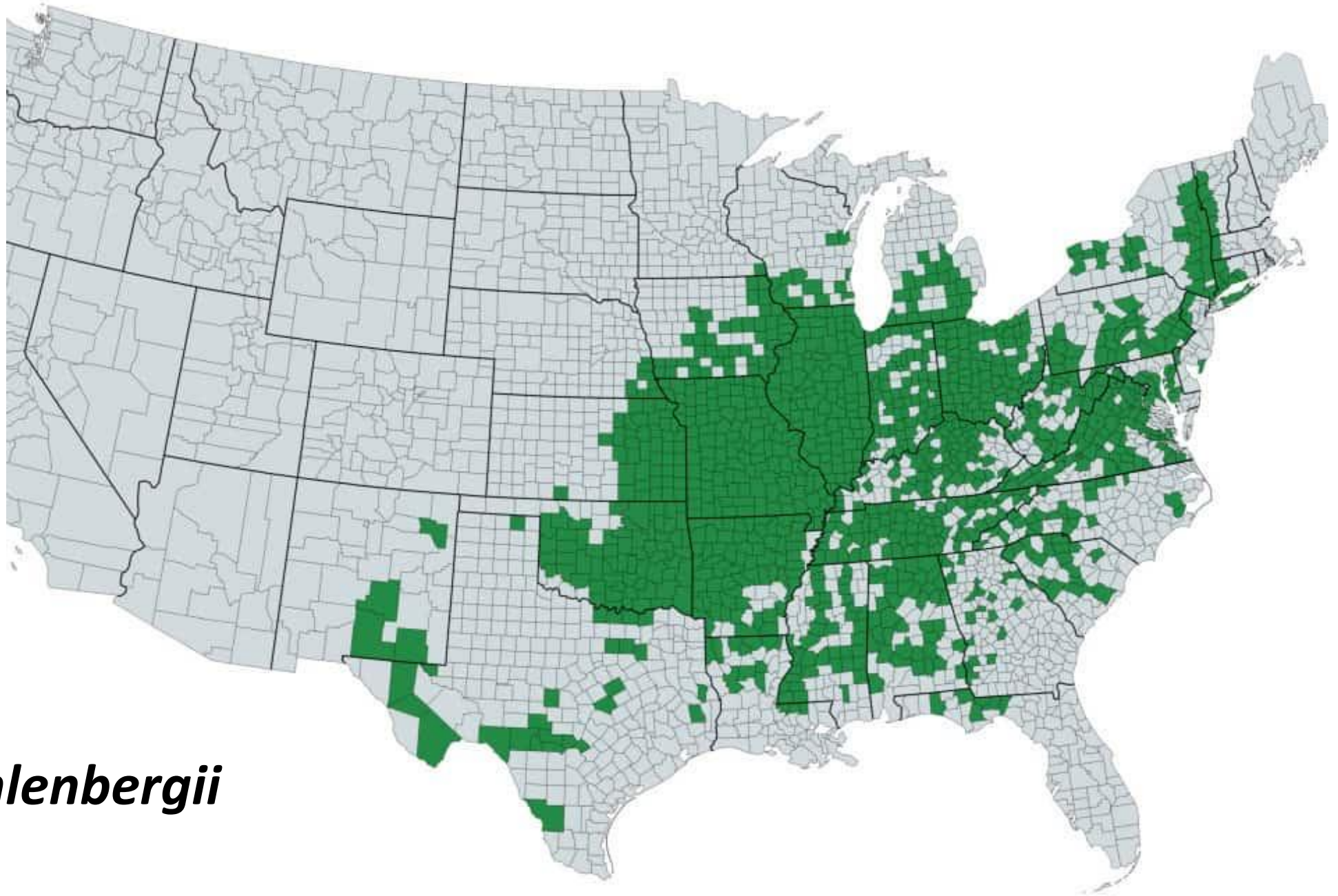
- a) Rooted cuttings, micropropagation (tissue culture), layering or grafting.
- b) Genetically identical to parent tree (clonal) - cultivar
- c) Protected (trademarked, patented) plants require propagation license

Helpful definitions:

- a) Cultivar means 'cultivated variety'
- b) Variety means a specific selection of a plant for certain attributes
- b) OP – open pollinated, true genetics may be unknown
- c) Self – self pollinated, limits genetics, *Corylus* generally incapable of self pollination







range of

Quercus muehlenbergii

Chinkapin oak



Plants in tissue culture lab

Rooted cuttings of *Corylus* x 'Raritan'

Take home Message:

- We need to evaluate new host species and truffle combinations to address current problems; and we need to be smart about how we identify potential host/truffle combinations for evaluation.
- Potential host/truffle combinations are regionally dependent. There is no 'one size fits all' solution.
- Evaluations takes time.
- What is the definition of a successful host? One truffle? Commercial quantities?





*“We have not inherited the earth from our ancestors
we have borrowed it from our children”.*

Henry Clay; 1777-1852