

How did the “fire” move around in orchards of North America and Europe?

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Connecticut Agricultural Experiment Station

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Fire blight



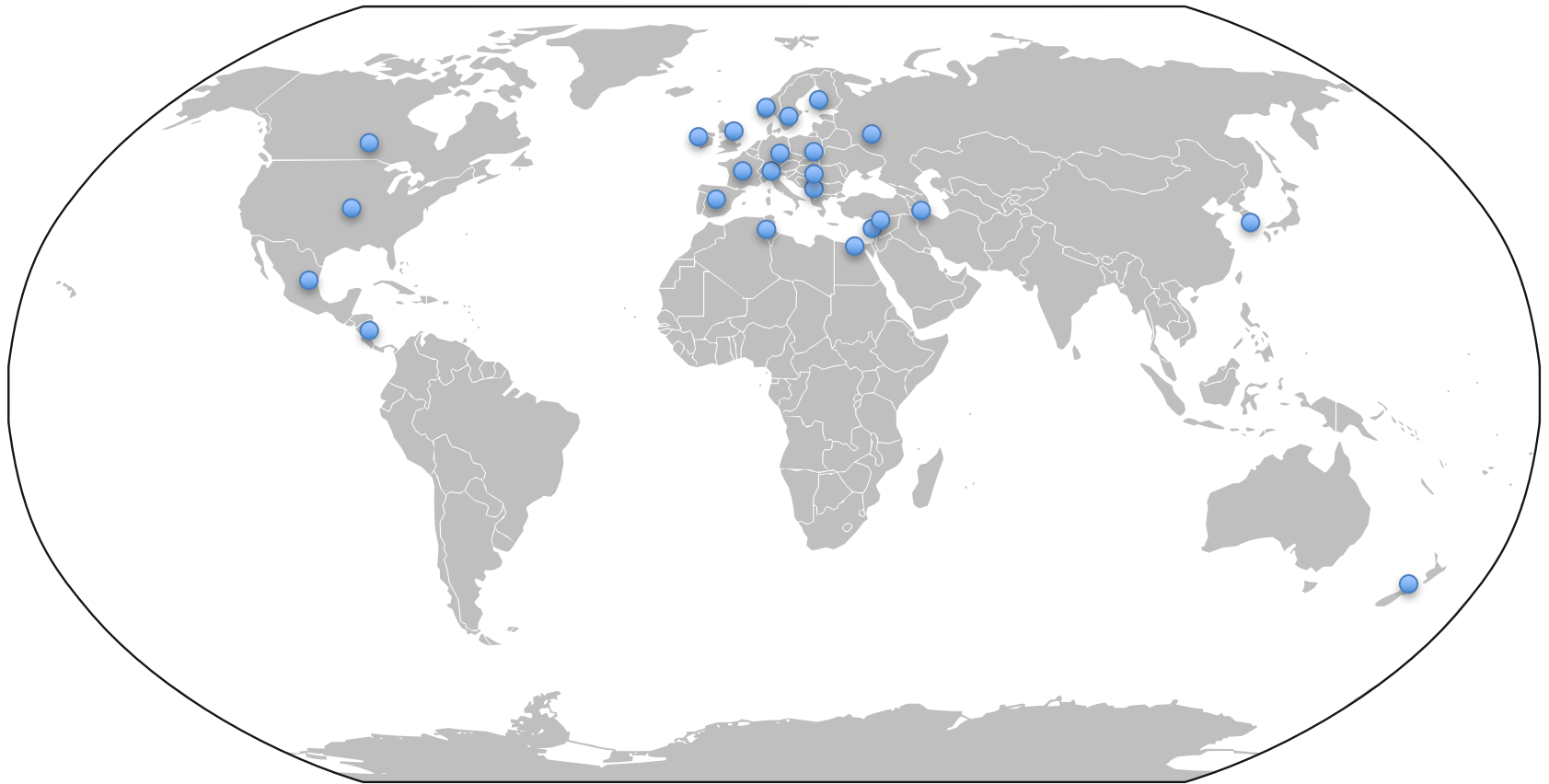
Host: Apple and pear

Pathogen: *Erwinia amylovora*





Fire blight distribution worldwide

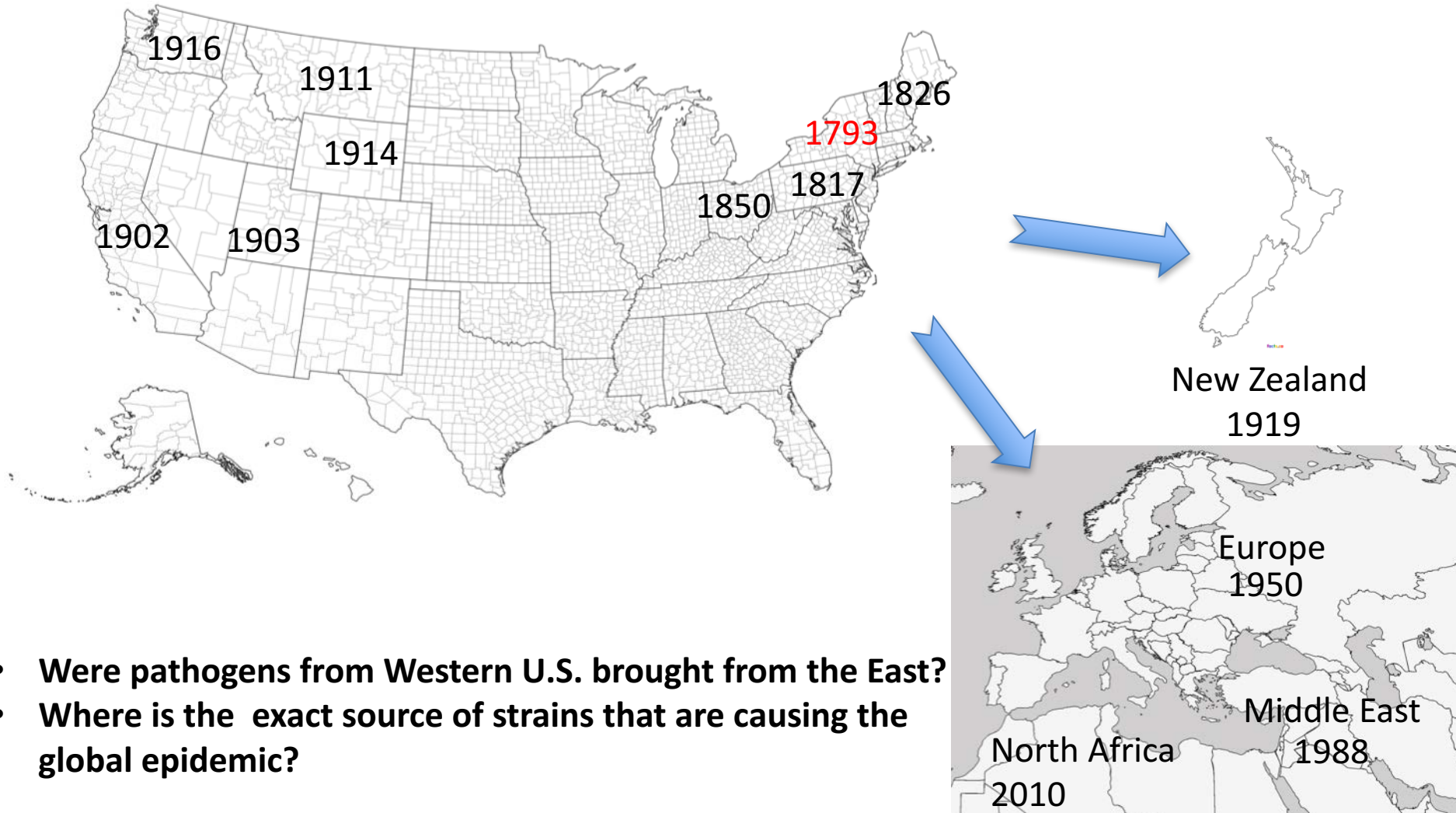


How did the pathogens spread?

Known facts about origin of fire blight

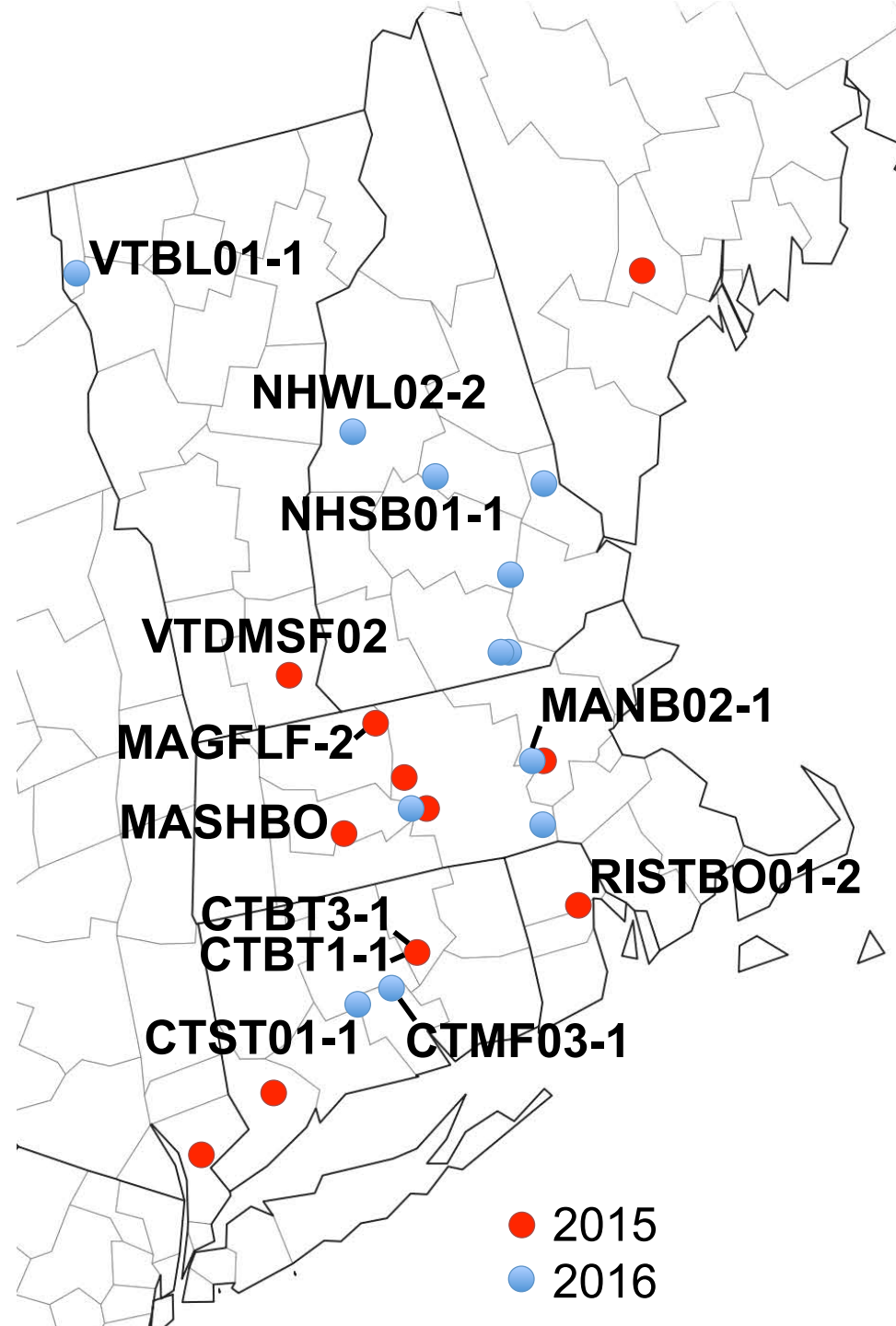
- Fire blight pathogens were originally present on wild hosts in North America.
- Apples and pears are native to middle east (Kazakhstan), and were not present in North America before 1600s.
- European settlers brought apples and pears to the New World and started planting them in orchards in North America.
- Pathogen-susceptible hosts--- Fire blight!

Emergence and spread of Fire blight



- **Were pathogens from Western U.S. brought from the East?**
- **Where is the exact source of strains that are causing the global epidemic?**

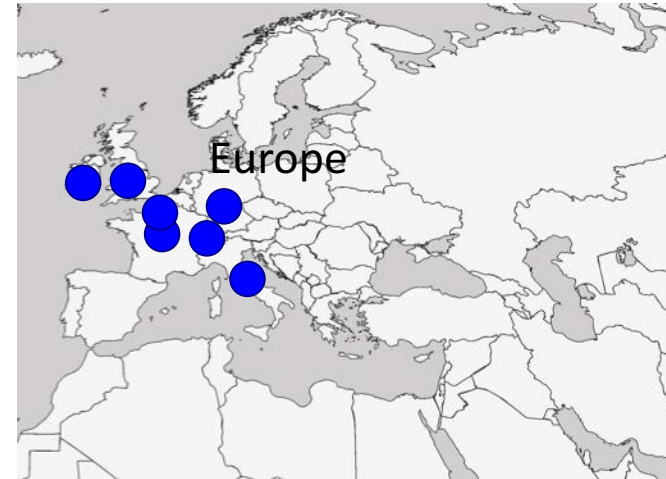
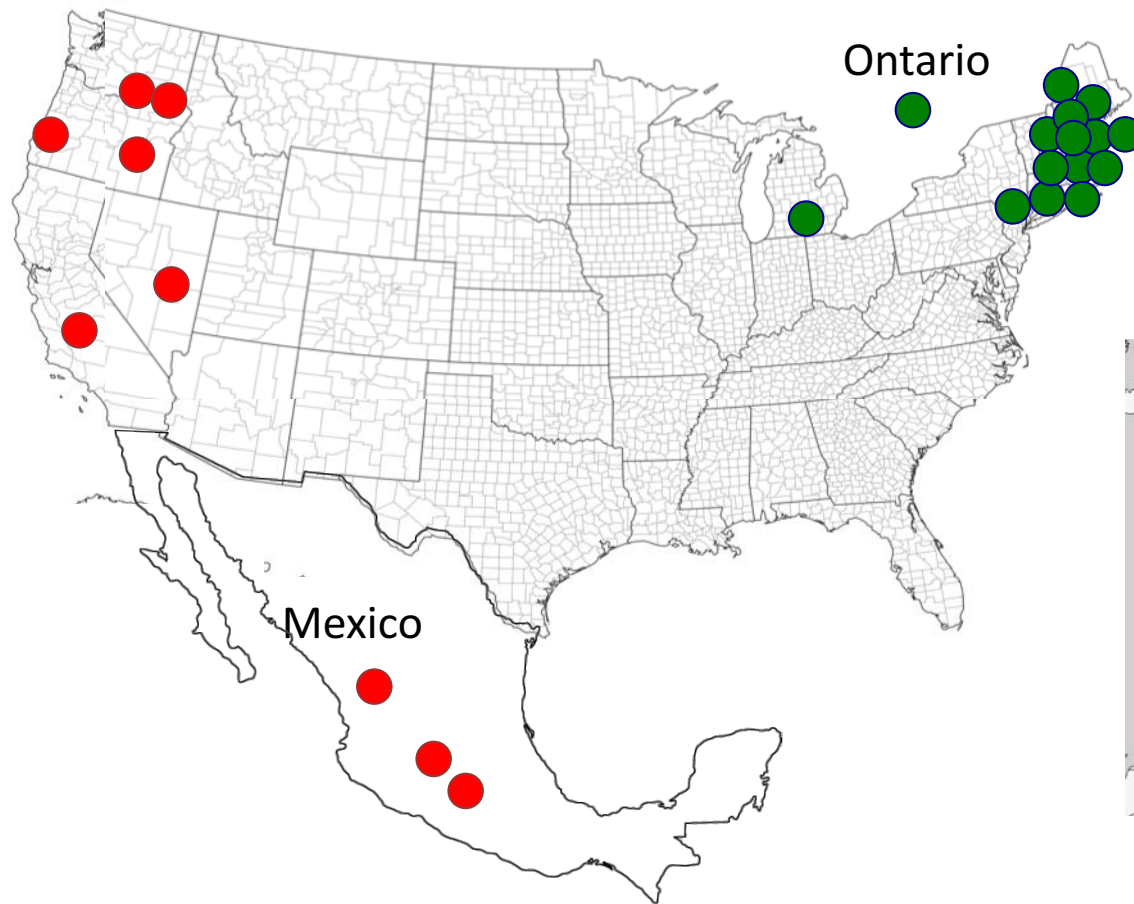
- Collect *E. amylovora* strains in New England.



Acknowledgement:

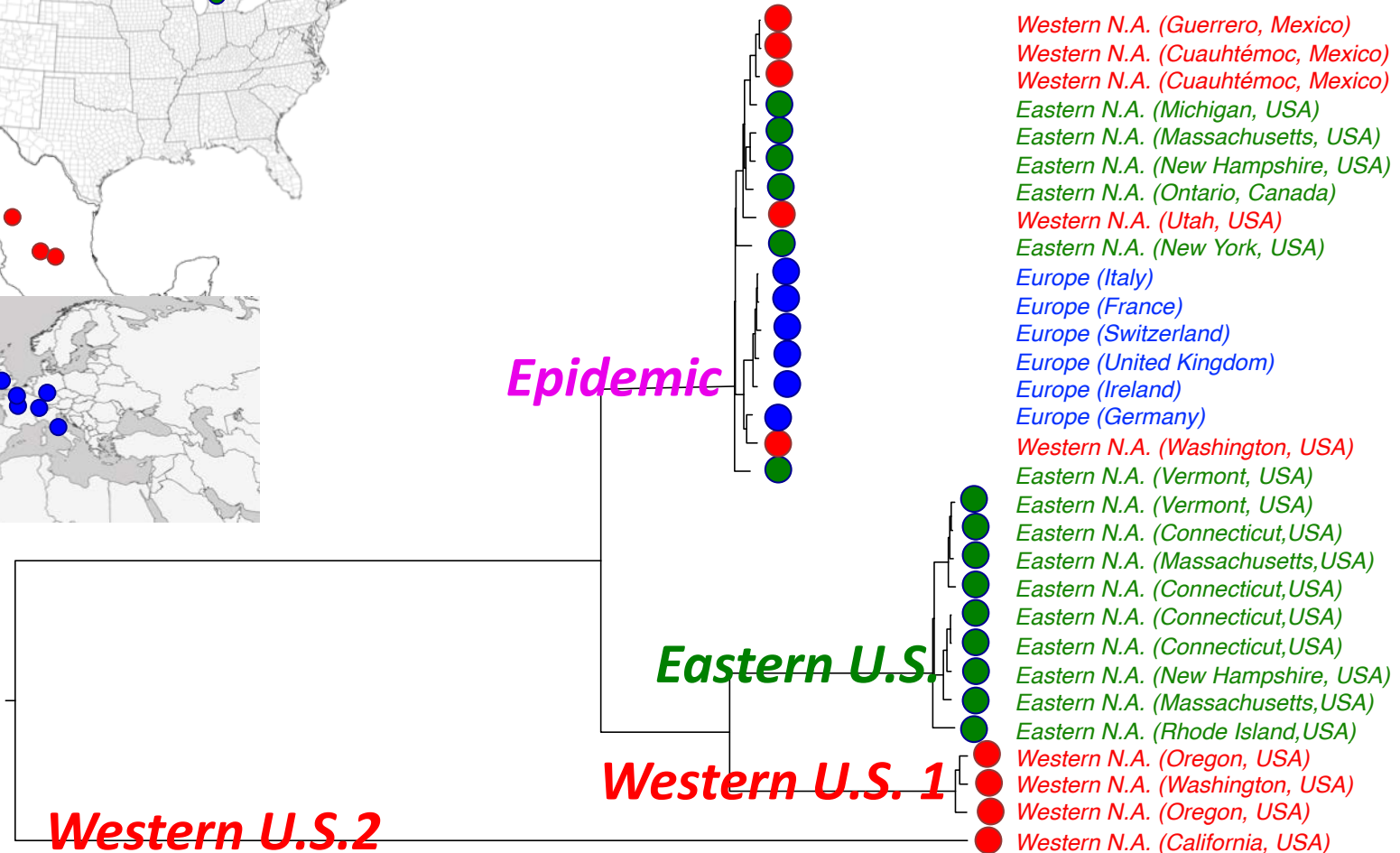
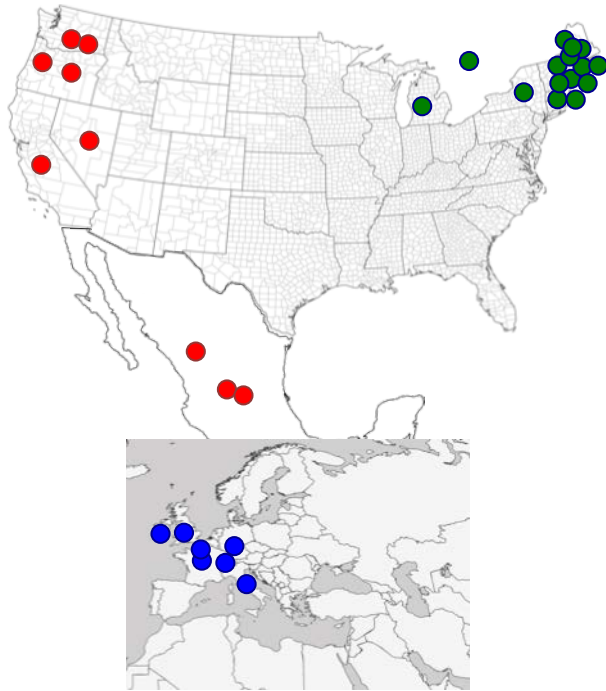


Extension researchers and orchard owners



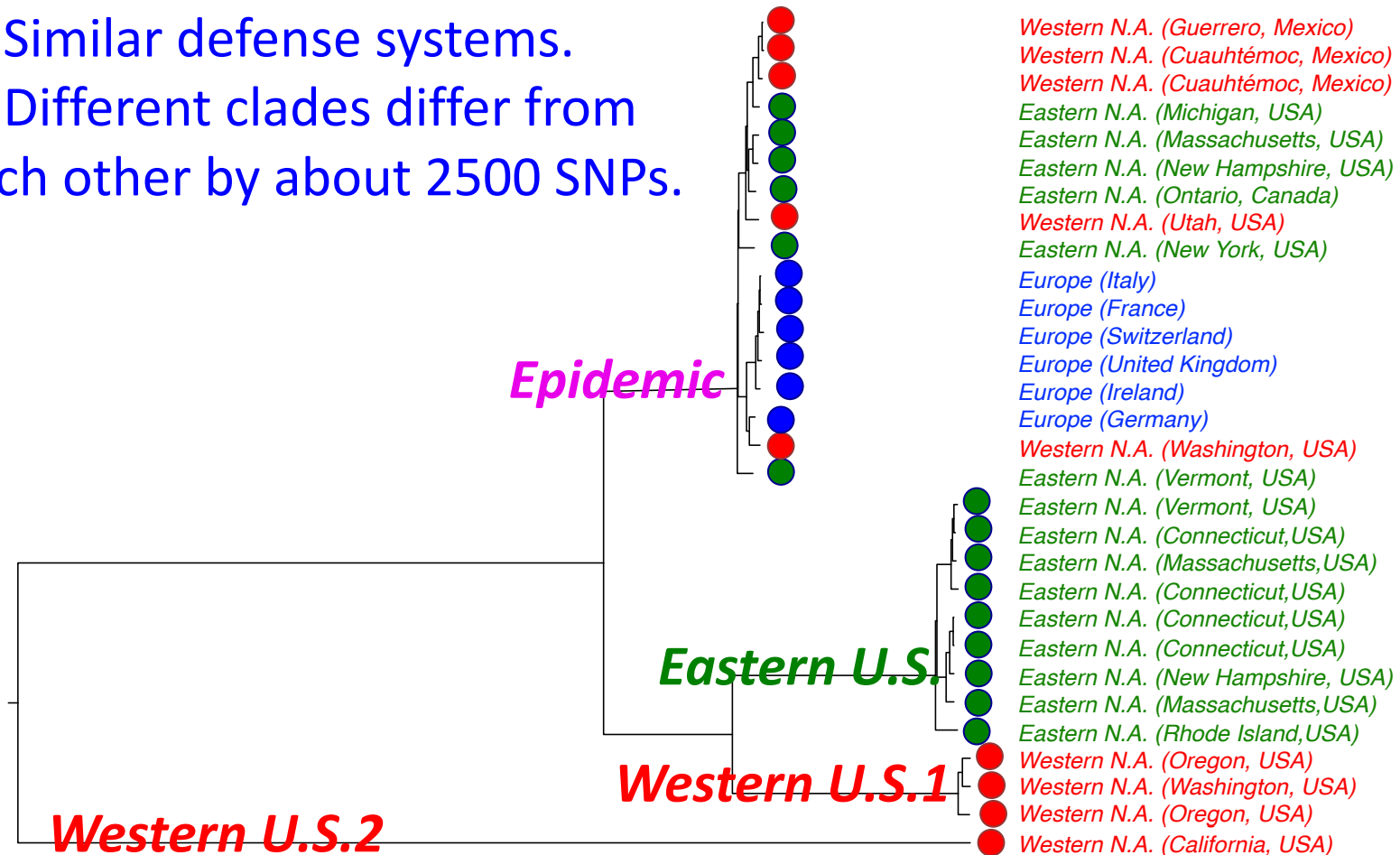
- Sequenced 12 strains isolated from New England
- Also sequenced 7 genomes from other parts of U.S.
- Performed genomes comparison using these 19 strains along with 11 existing *E. amylovora*.

E. amylovora strains in North America and Europe belong to 4 phylogroups.

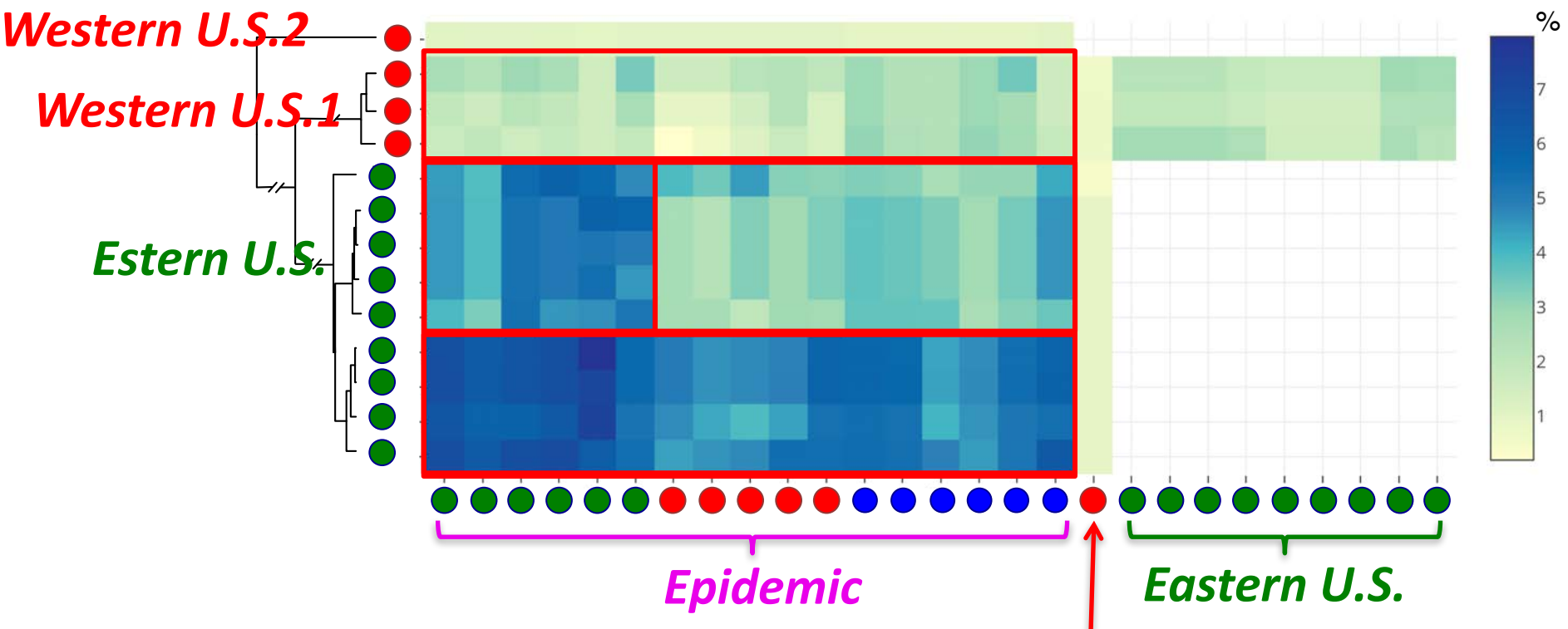


E. amylovora strains are highly homogeneous.

- Pairwise identity determined as 99.7%
- Watterson's theta = 8.18×10^{-4}
- Minimum genome rearrangement.
- Similar defense systems.
- Different clades differ from each other by about 2500 SNPs.

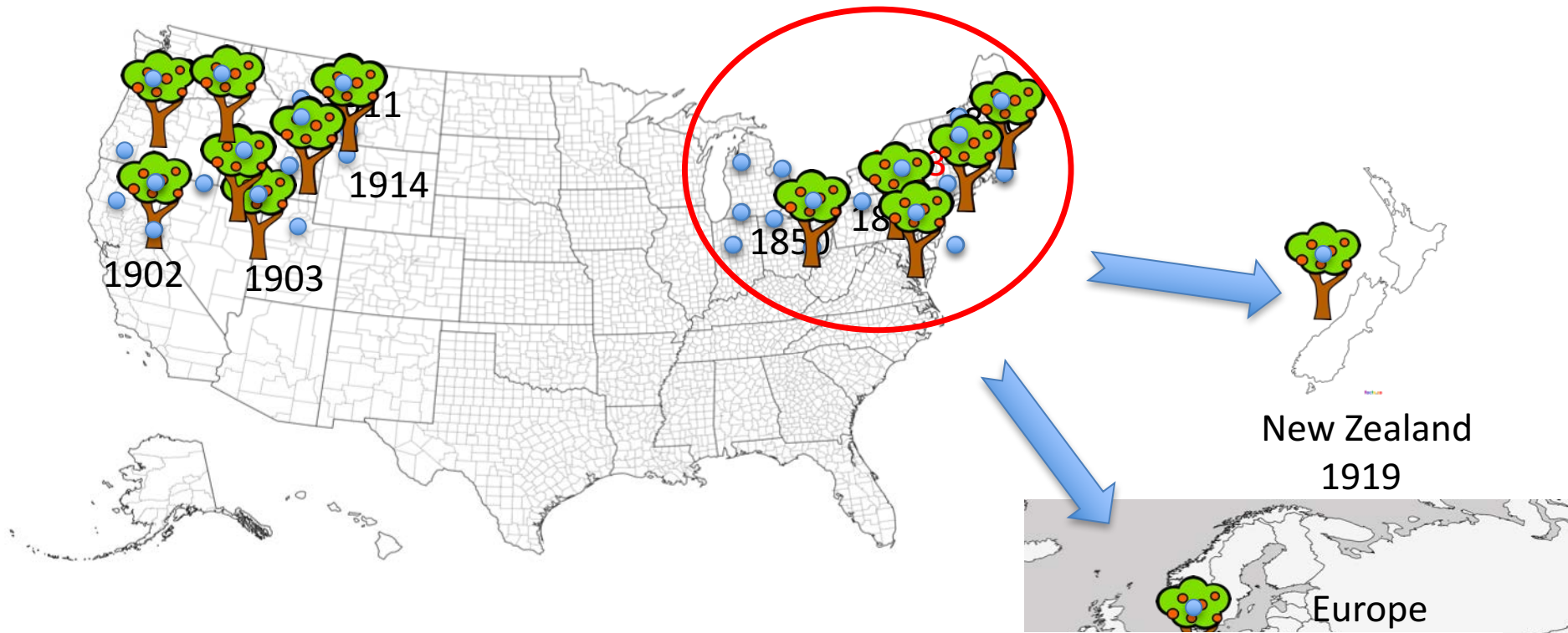


Recombination detected at the genome level.

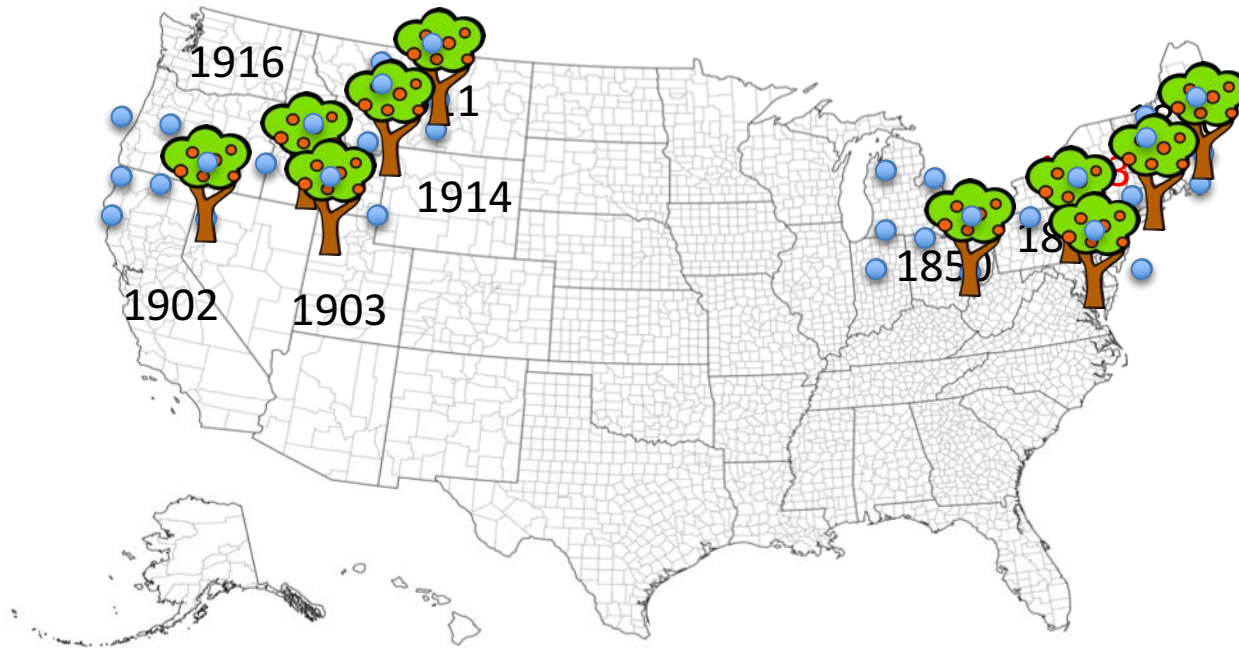


1. Epidemic group originate in the Eastern U.S.
2. Recombination occurred at two sequential stages.

Early Reports of Fire blight

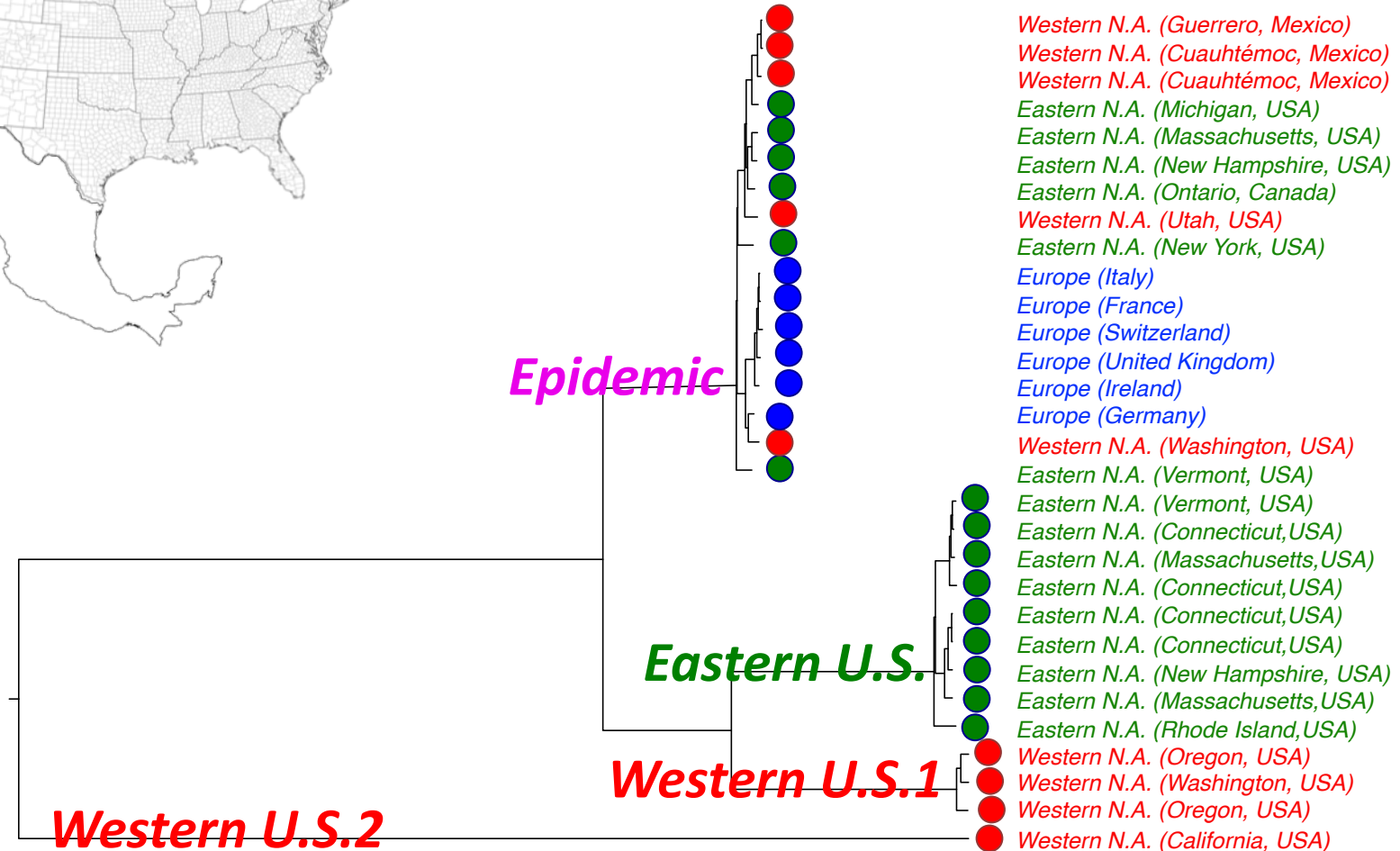
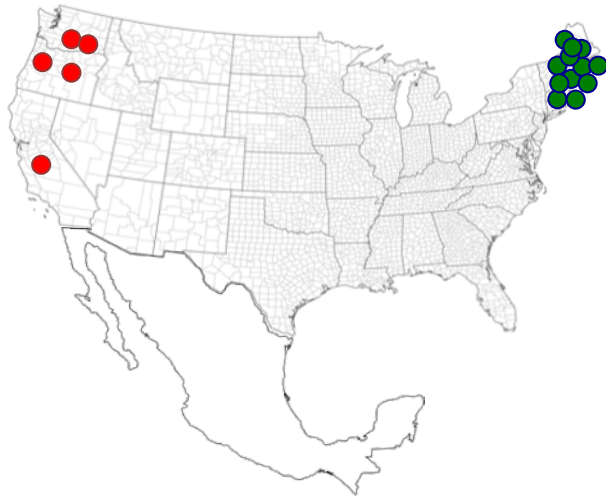


- Which part of the North America were the fire blight pathogens in Europe and other parts of the world originally from?

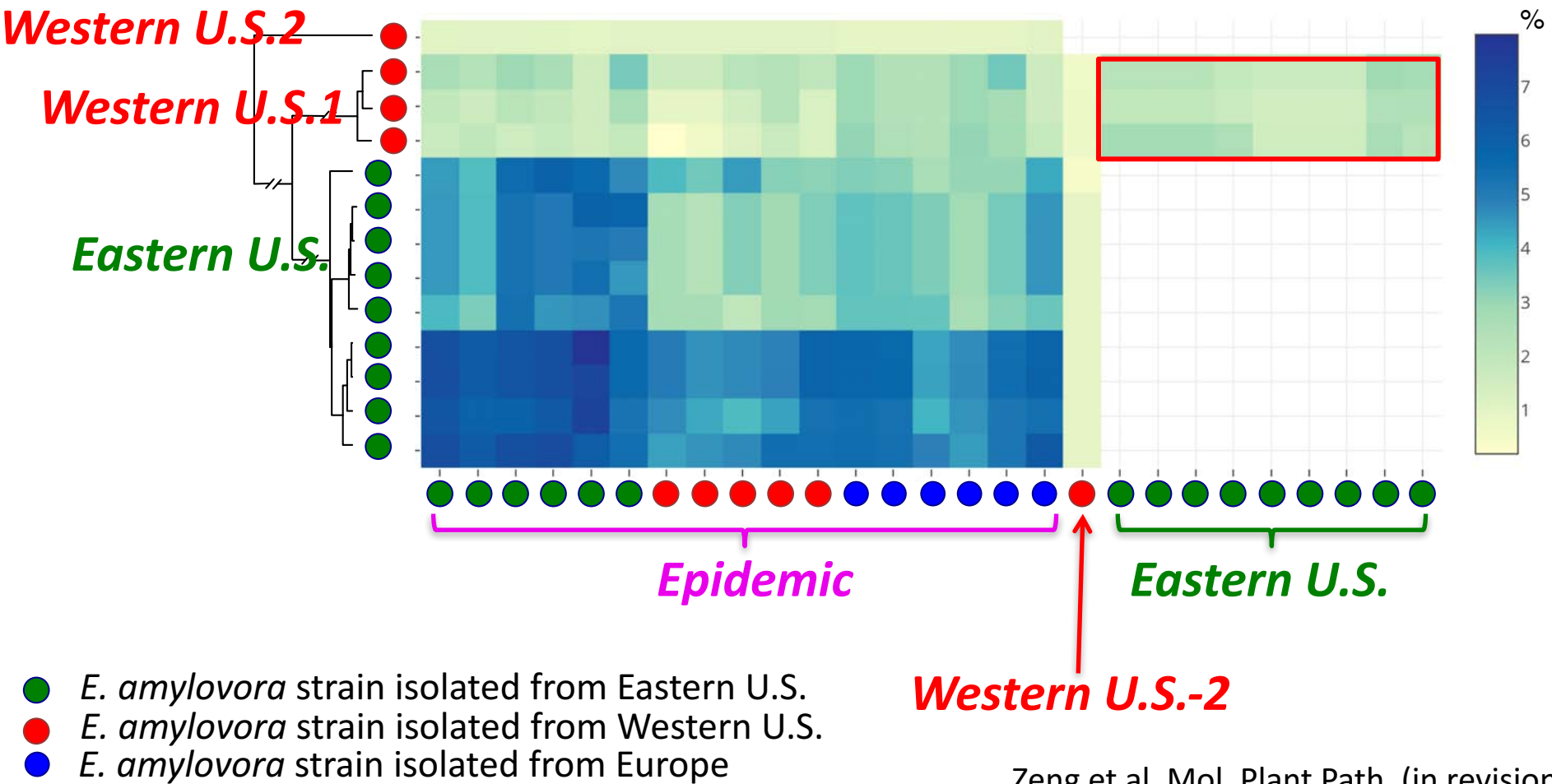


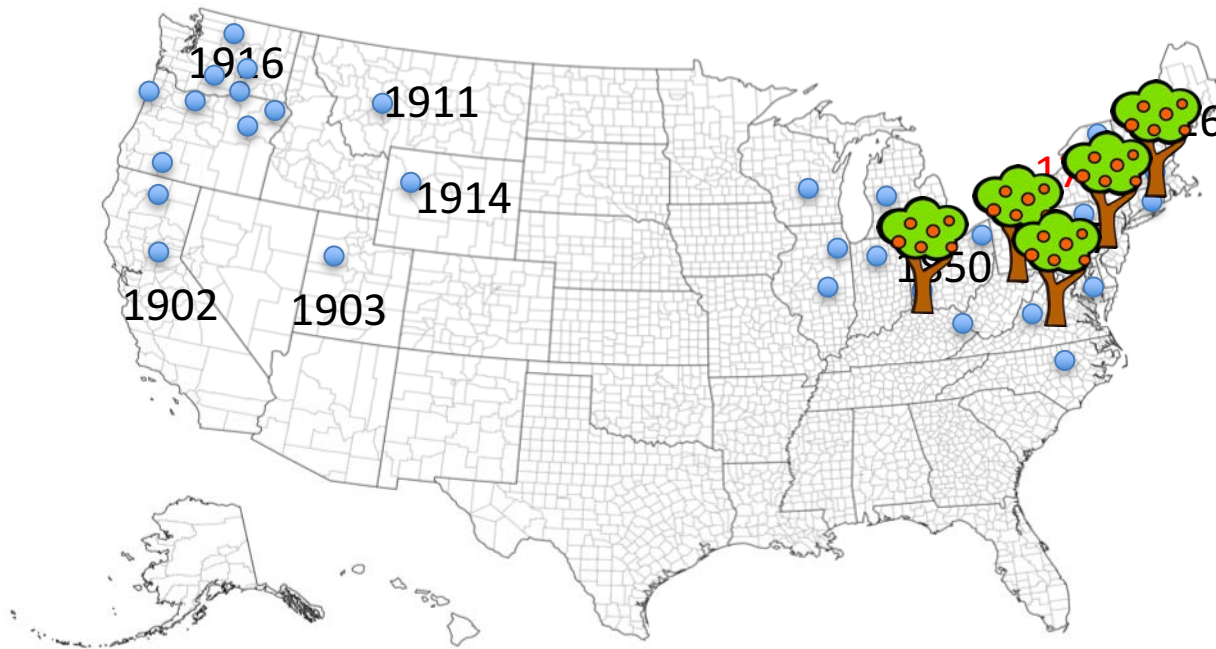
- Where are fire blight pathogens originally present in North America?

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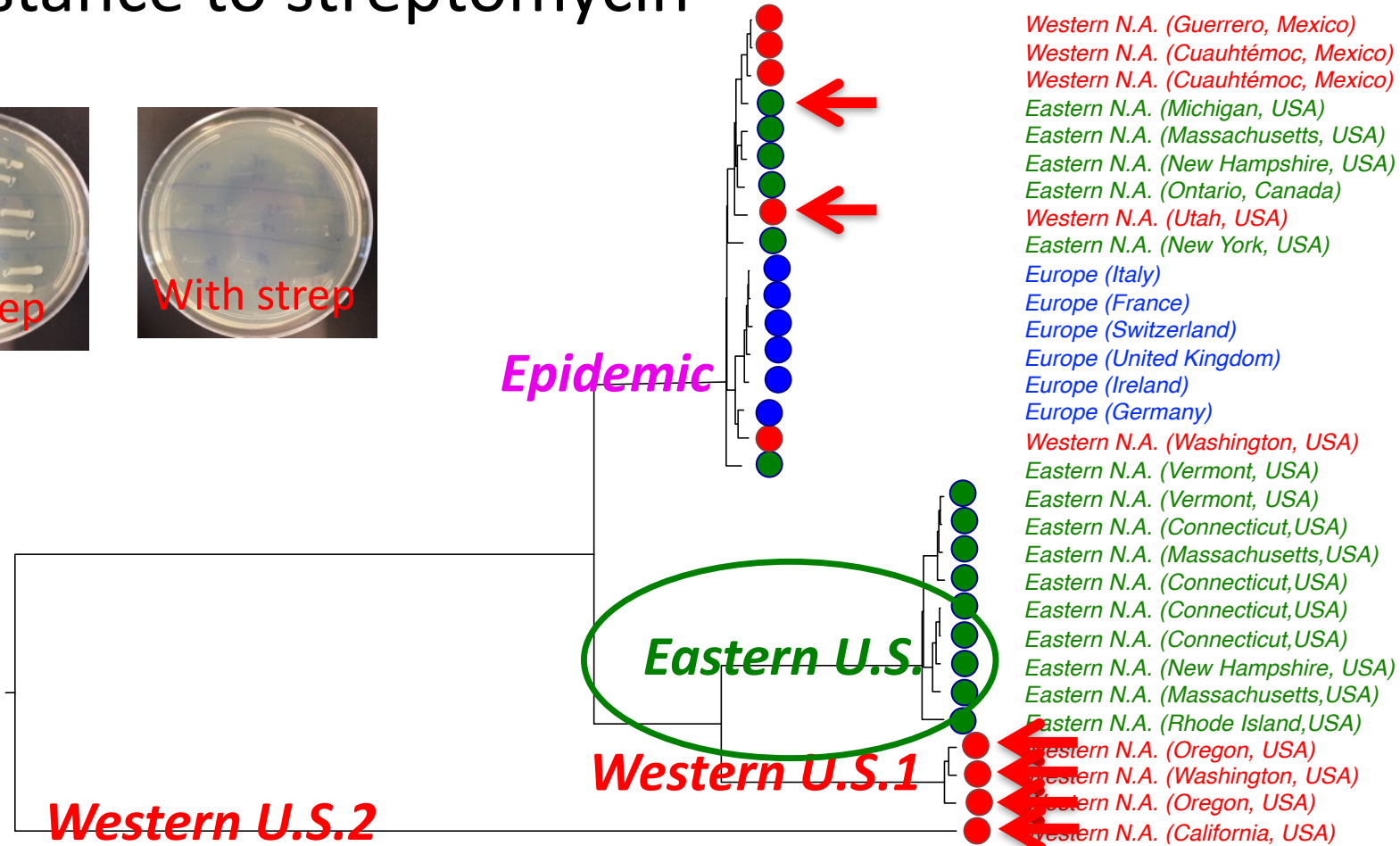




- Question 1: Where are fire blight pathogens originally present in North America?

Phenotypical variations

- Resistance to streptomycin

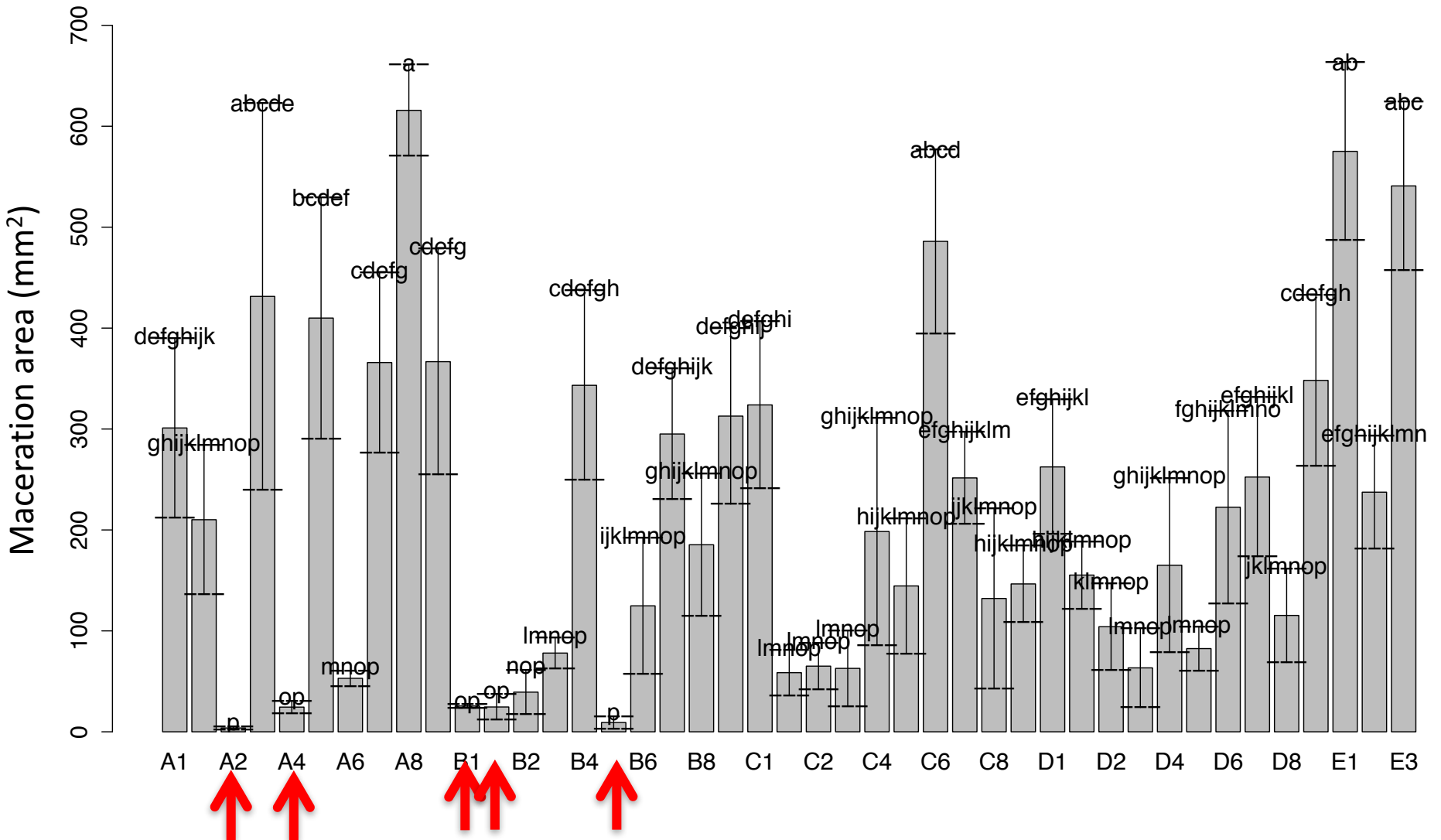


Phenotypical variation

- Bacterial virulence



Variation in virulence



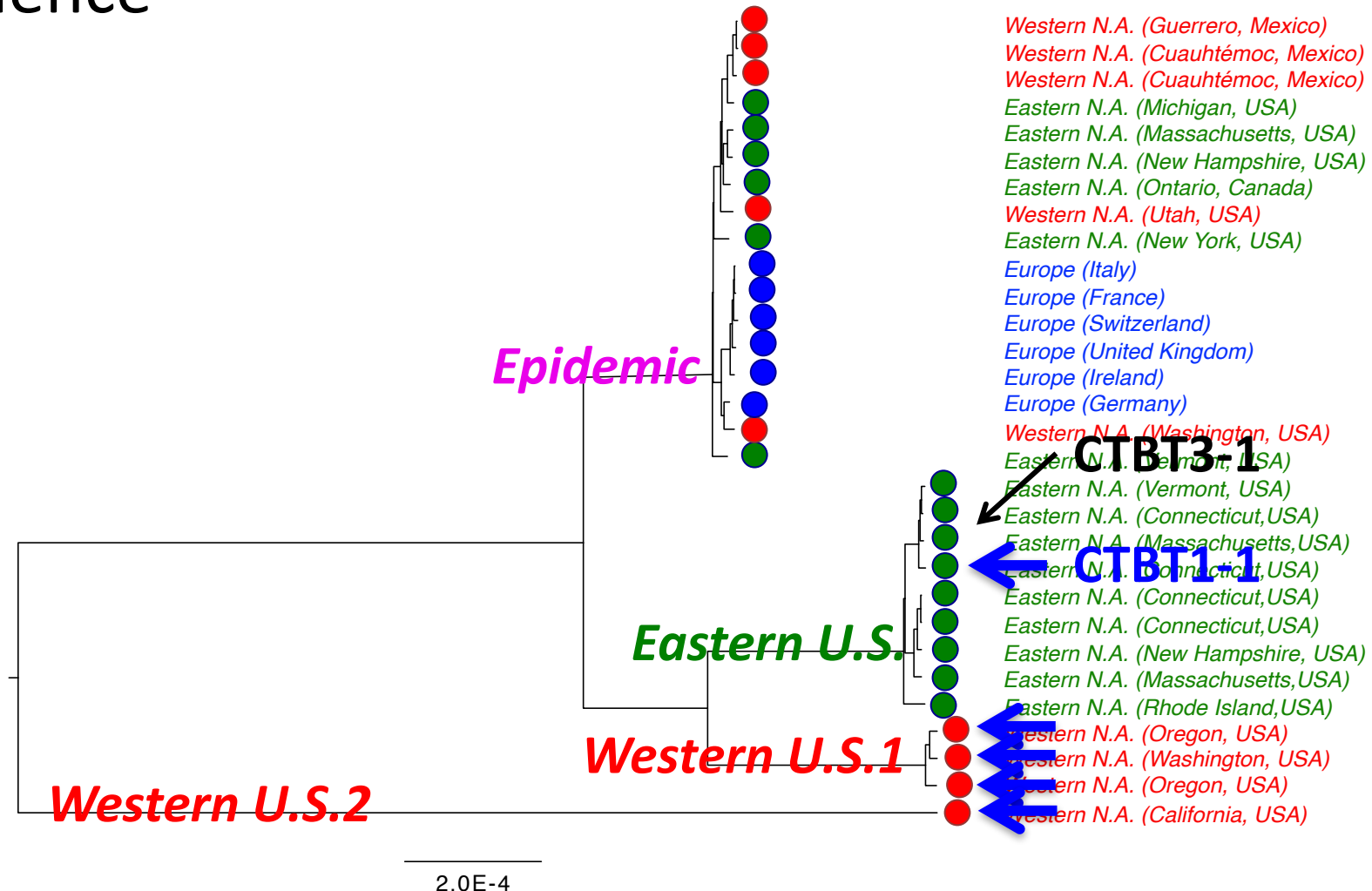
Phenotypical variation

- Bacterial virulence

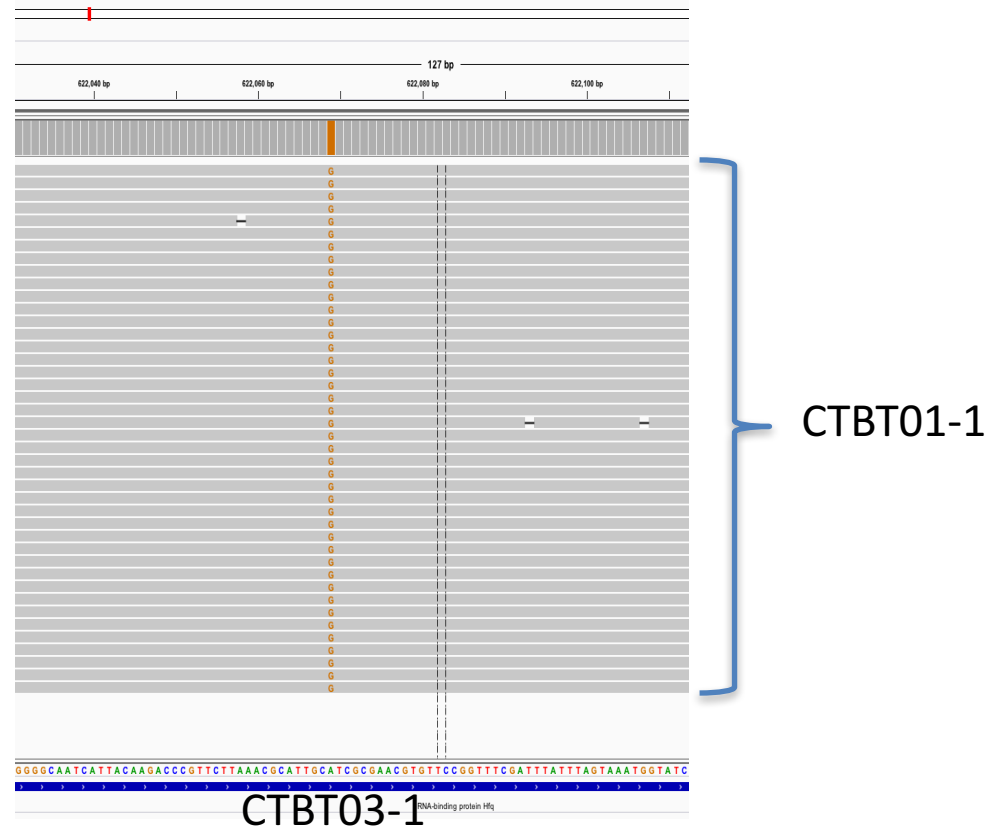
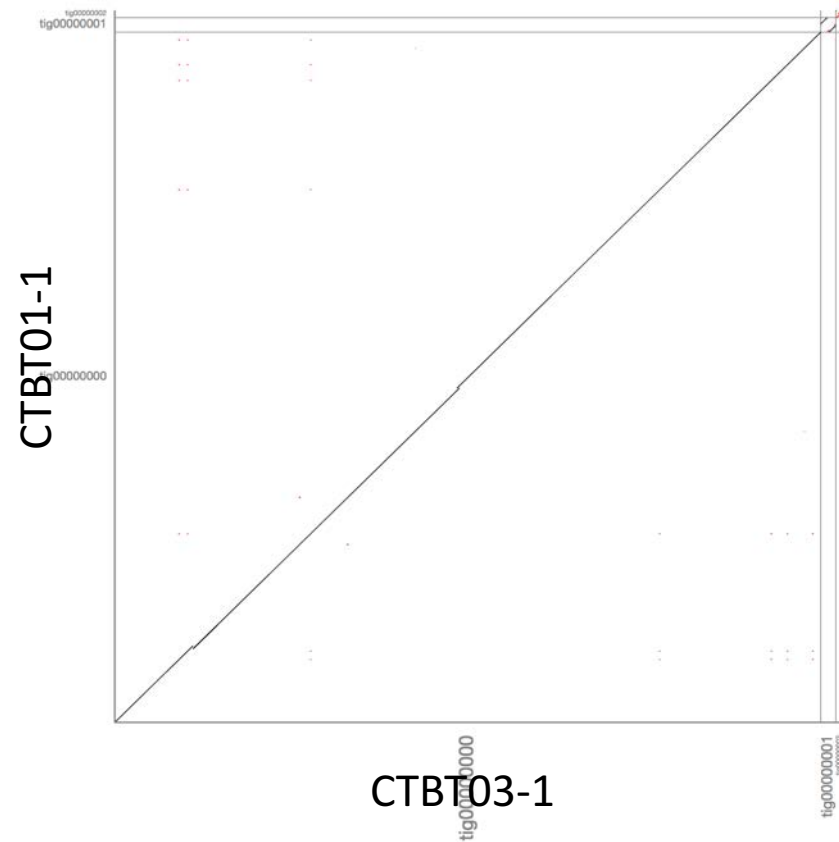


Phenotypical variation

- Virulence



Comparing CTBT03-1 and CTBT01-1



A

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	M	A	K	G	Q	S	L	Q	D	P	F	L	N	A	L	R	R	E
CTBT3-1:	ATG	GCT	AAG	GGG	CAA	TCA	TTA	CAA	GAC	CCG	TTC	TTA	AAC	GCA	TTG	CGT	CGC	GAA
CTBT1-1:	ATG	GCT	AAG	GGG	CAA	TCA	TTA	CAA	GAC	CCG	TTC	TTA	AAC	GCA	TTG	CAT	CGC	GAA
	M	A	K	G	Q	S	L	Q	D	P	F	L	N	A	L	H	R	E

B

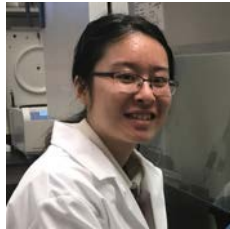


Summary

- *E. amylovora* in North America and Europe belong to four clades.
- Eastern and Western North America both were inhabited by *E. amylovora*.
- Strains causing current global disease epidemic were from Eastern U.S.
- The genetic cause of a low virulence strain in the natural *E. amylovora* populations was identified.

Acknowledgments

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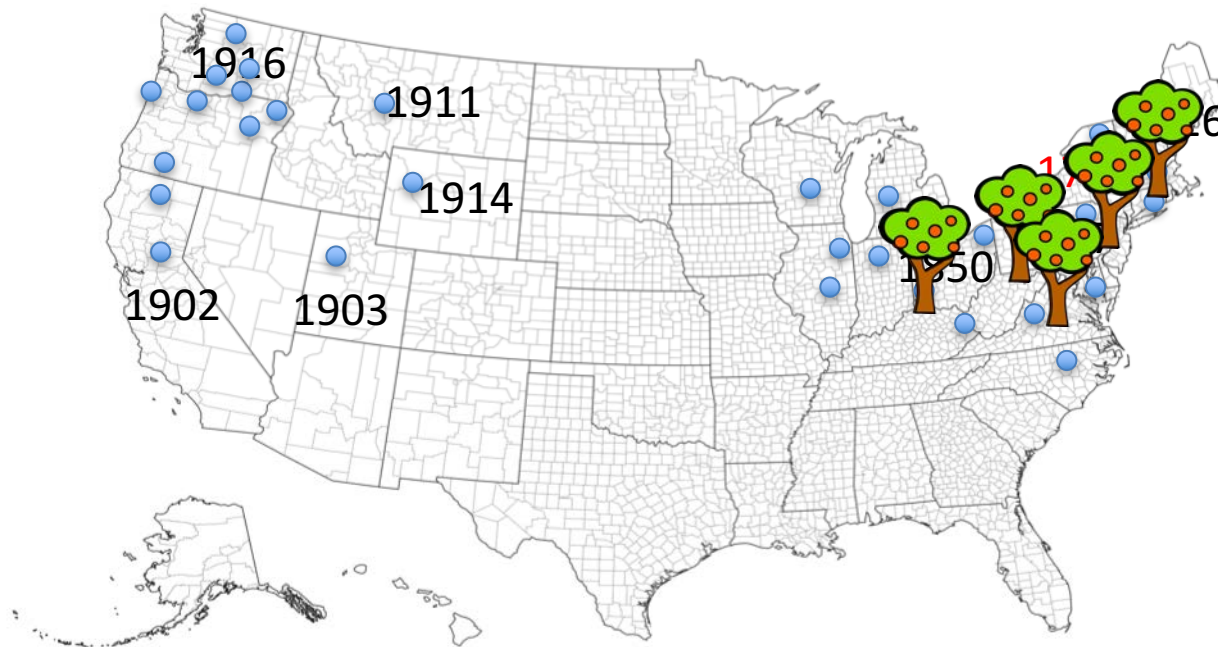
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Questions?

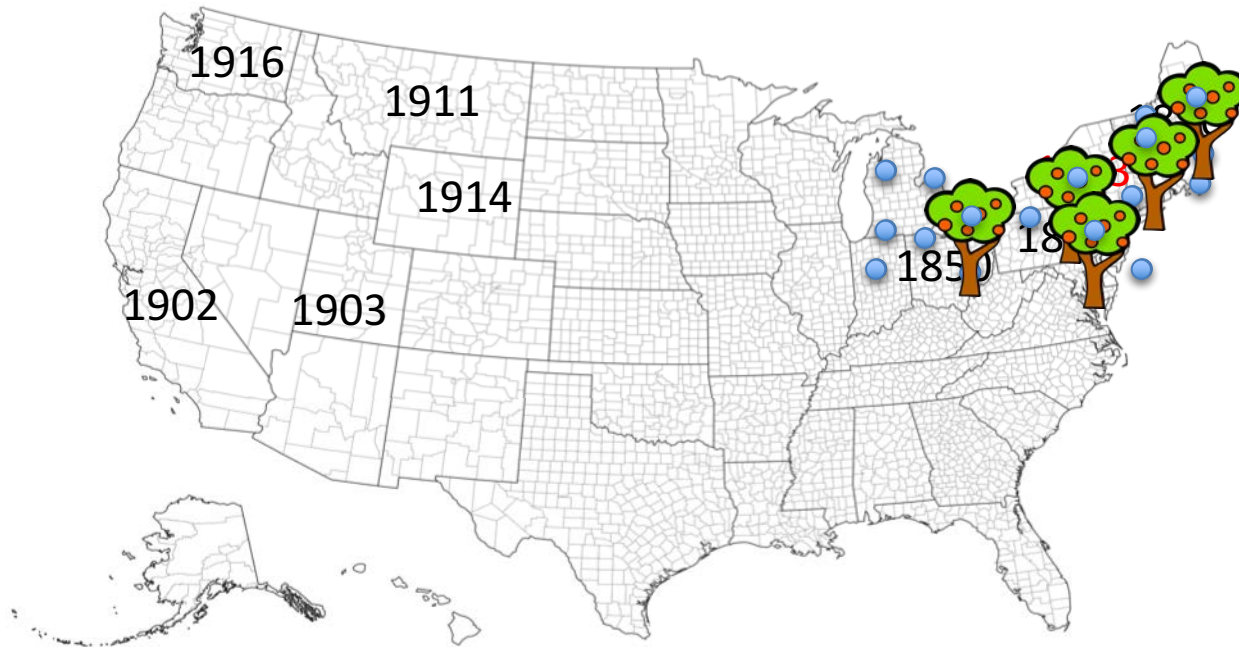


Early Reports of Fire blight



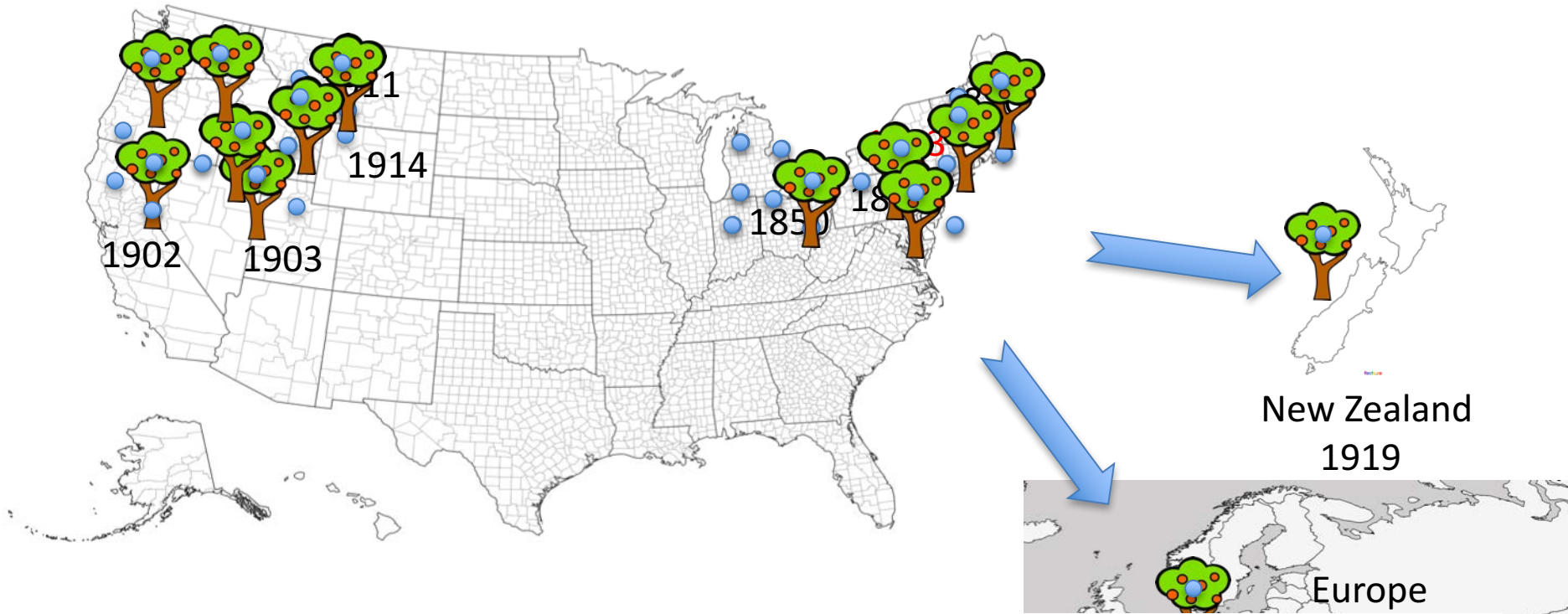
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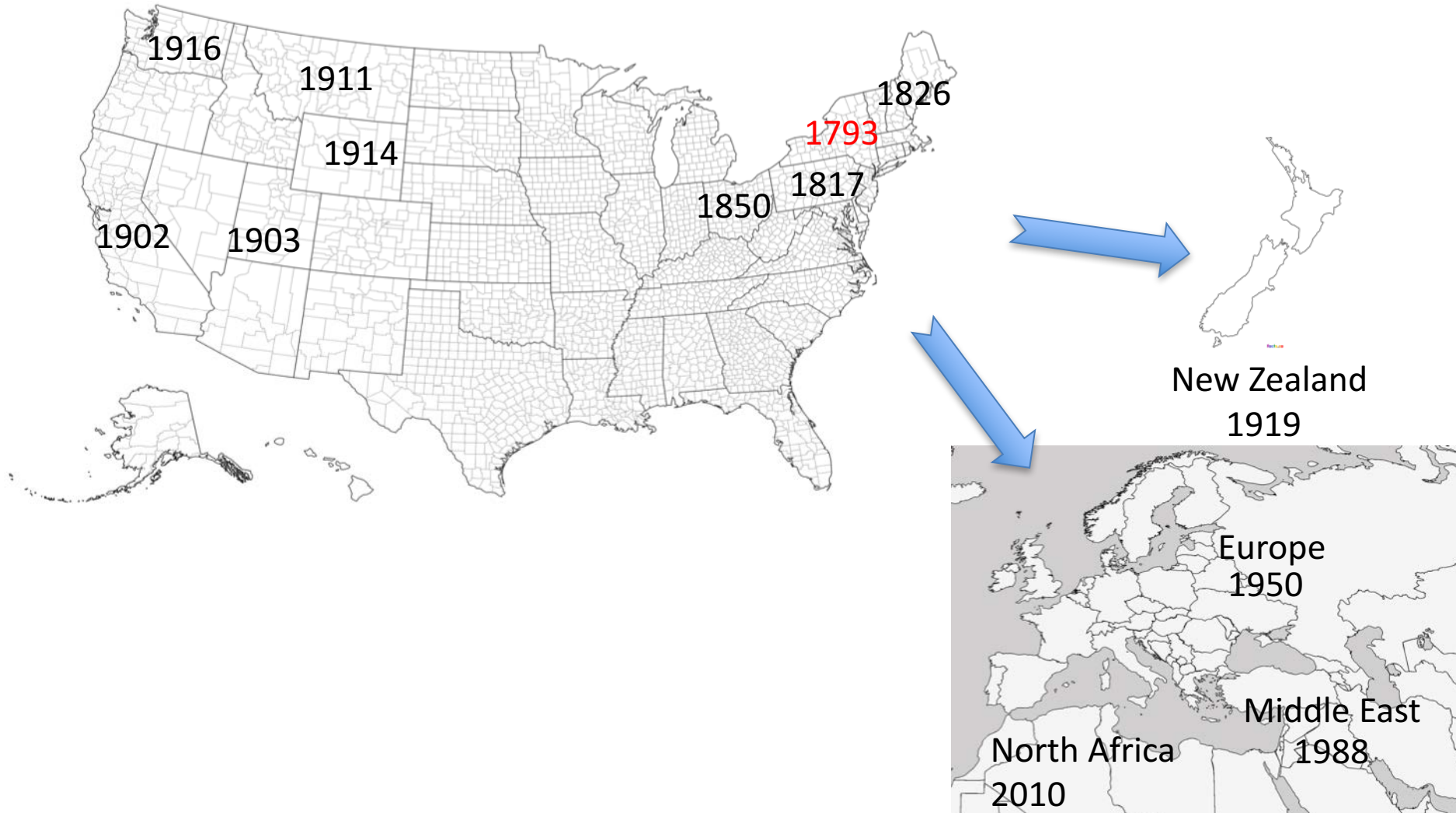
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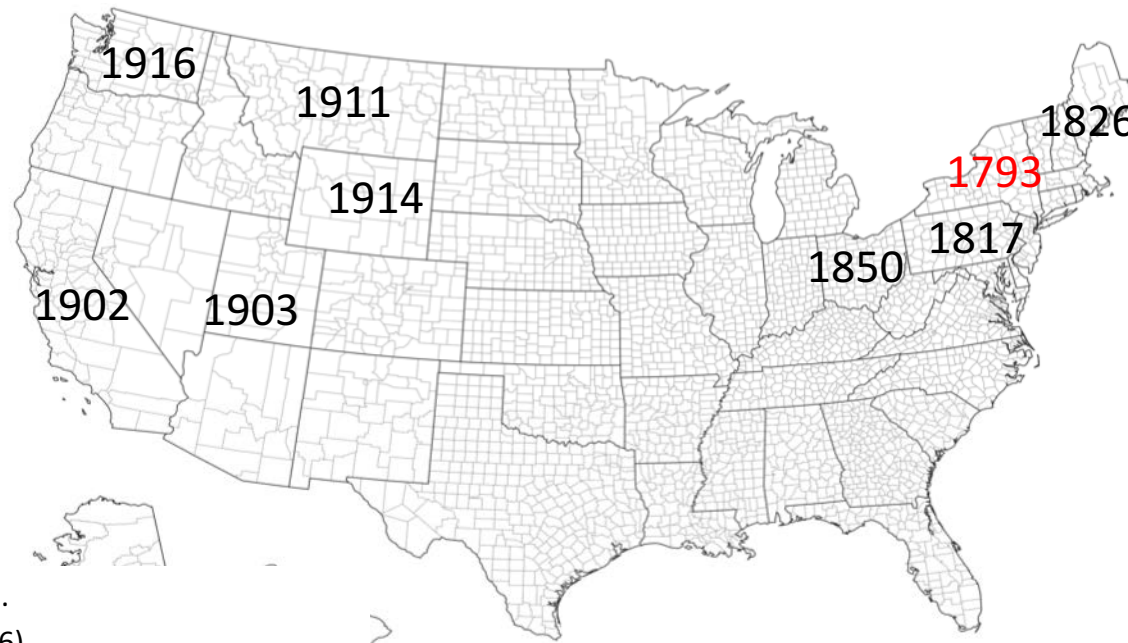


- Question 2: Which part of the North America were the fire blight pathogens in Europe and other parts of the world originally from?

Emergence and spread of Fire blight



Early Reports of Fire blight



New York (Denning 1793).
New England (Lowell 1826)
Pennsylvania (Fletcher 1931-1933)
Colora
Ohio (
Califor
Monta
Wyom
Washi

- Question 1: Where are fire blight pathogens originally present in North America?