Pierce's disease in the US
- History, biology and ecology -

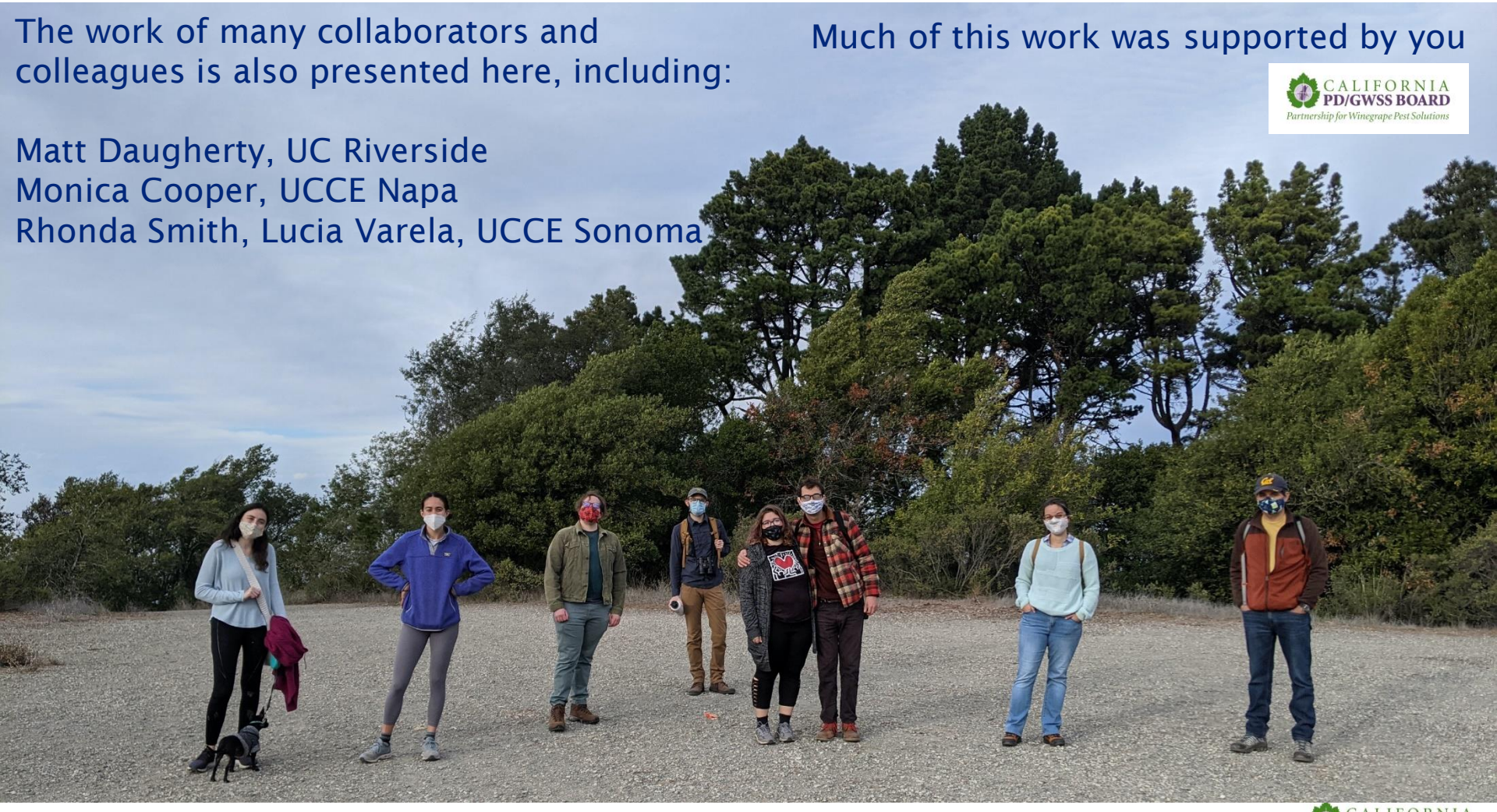
Rodrigo Almeida
University of California, Berkeley

Berkeley Rausser
College of Natural Resources

The work of many collaborators and colleagues is also presented here, including:

Matt Daugherty, UC Riverside
Monica Cooper, UCCE Napa
Rhonda Smith, Lucia Varela, UCCE Sonoma

Much of this work was supported by you



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CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

XF ACTORS
Xylella Fastidiosa Active Containment Through a multidisciplinary-Oriented Research Strategy

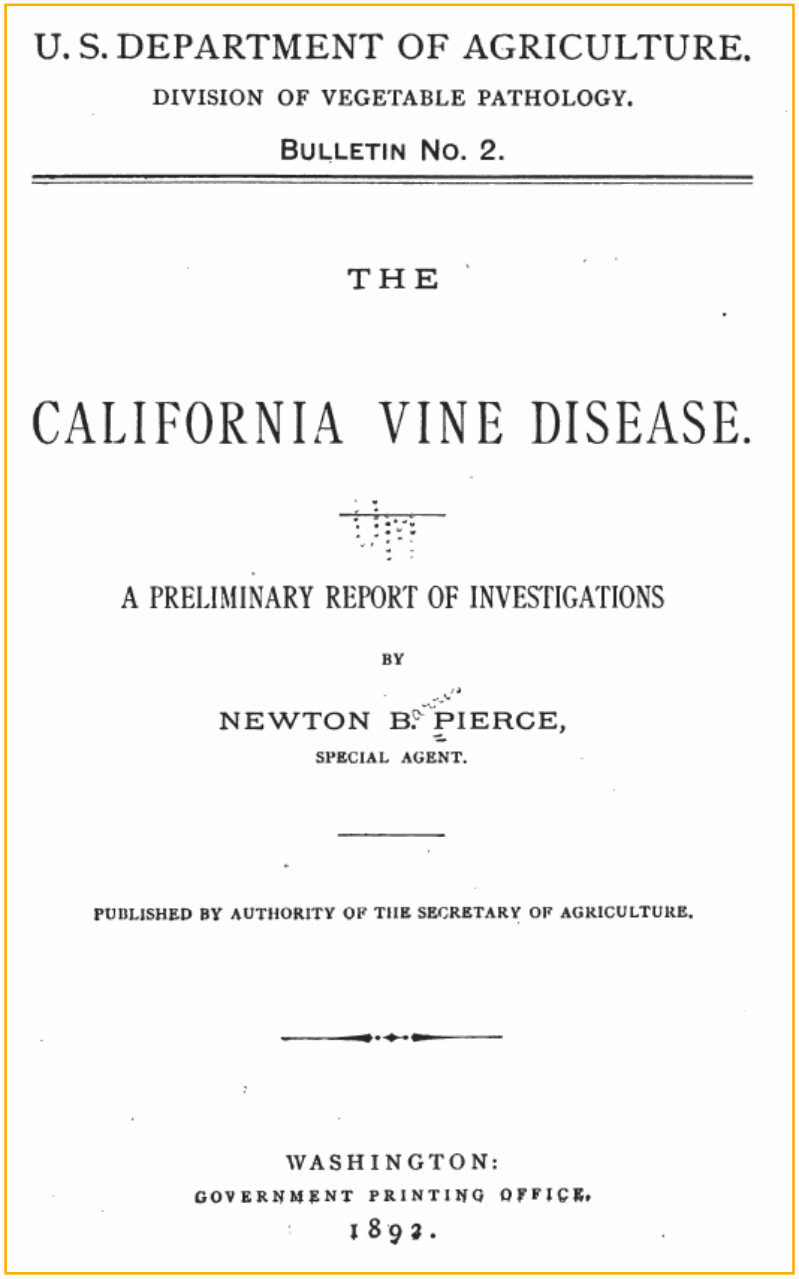
USDA

AMERICAN VINEYARD FOUNDATION

NSF

MARIE CURIE ACTIONS

History



U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

BULLETIN NO. 2.

THE

CALIFORNIA VINE DISEASE.

A PRELIMINARY REPORT OF INVESTIGATIONS

BY

NEWTON B. PIERCE,

SPECIAL AGENT.

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WASHINGTON:

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1892.

"California Vine Disease": First detected in Anaheim in 1884

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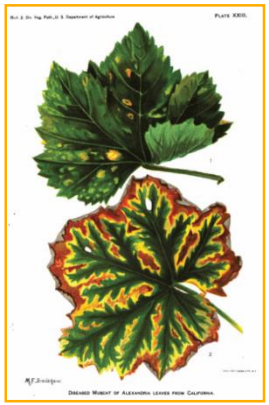
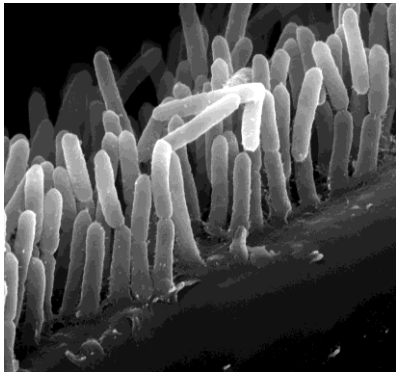
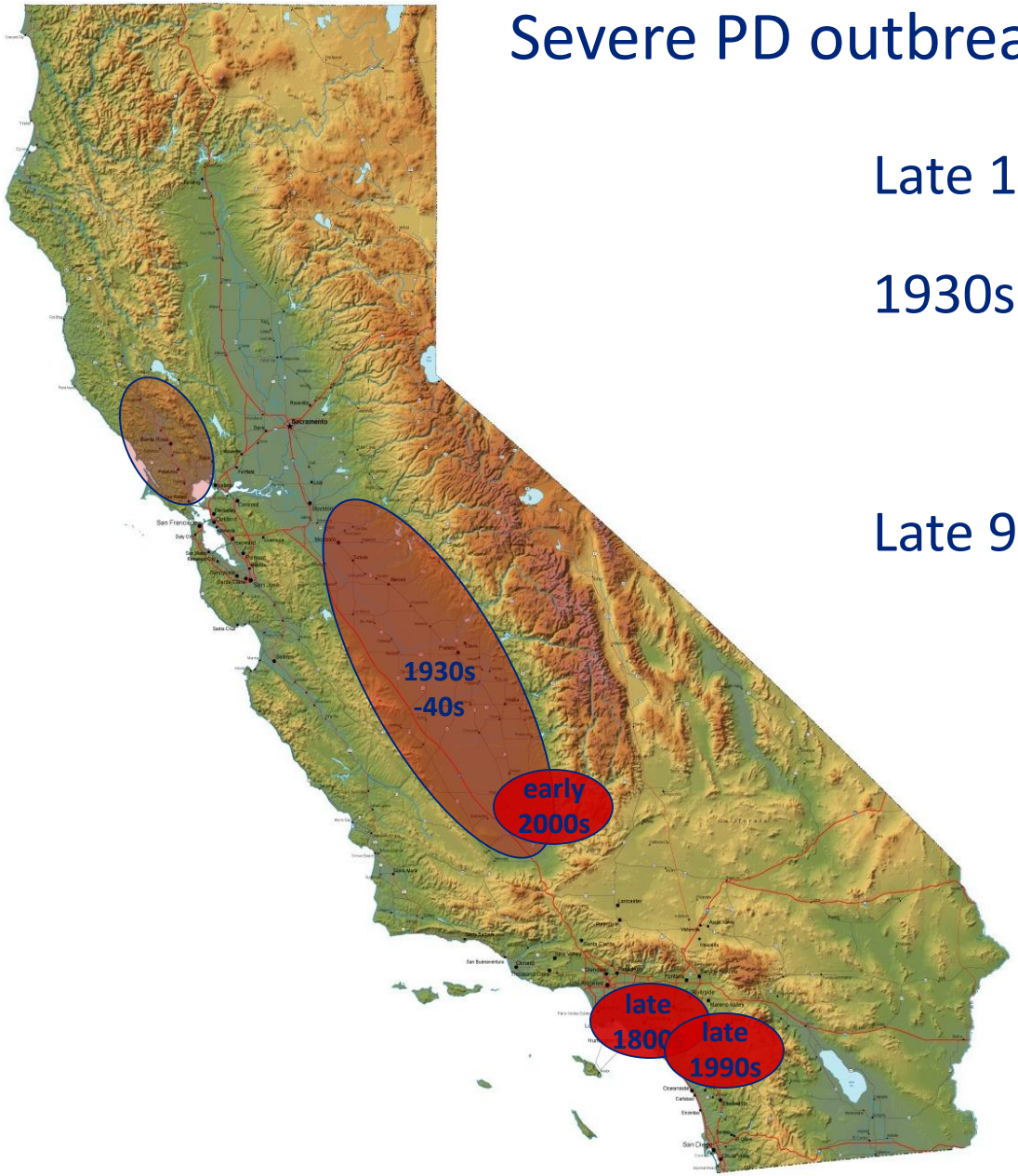
Newton B. Pierce



Pierce's disease of grapevines



Severe PD outbreaks are unusual



Late 1800s: Anaheim vine disease

1930s and 40s: Central Valley

-alfalfa

Late 90s - early 2000s: Temecula Valley and Kern County

-invasive GWSS

North coast: usually moderate, episodic

-native BGSS

HILGARDIA

A Journal of Agricultural Science Published by the California Agricultural Experiment Station

VOLUME 19 JANUARY, 1950 NUMBER 11

SPITTLE-INSECT VECTORS OF PIERCE'S DISEASE VIRUS

I. CHARACTERS, DISTRIBUTION, AND FOOD PLANTS

DWIGHT M. DELONG and HENRY H. P. SEVERIN

II. LIFE HISTORY AND VIRUS TRANSMISSION

HENRY H. P. SEVERIN

UNIVERSITY OF CALIFORNIA · BERKELEY, CALIFORNIA

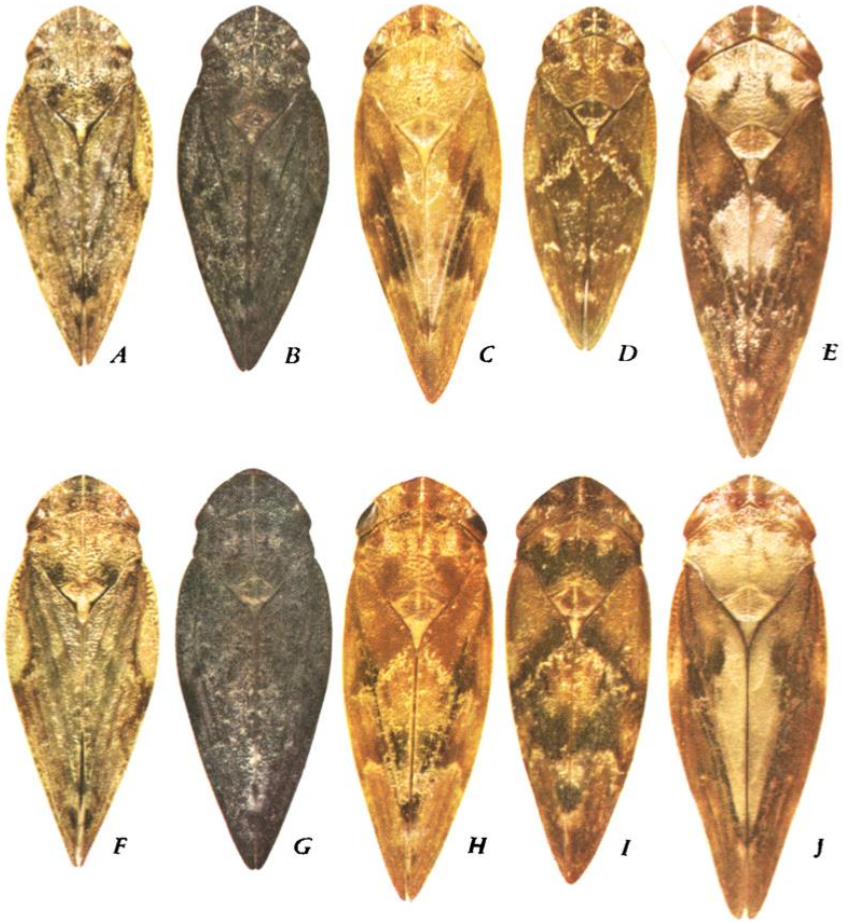
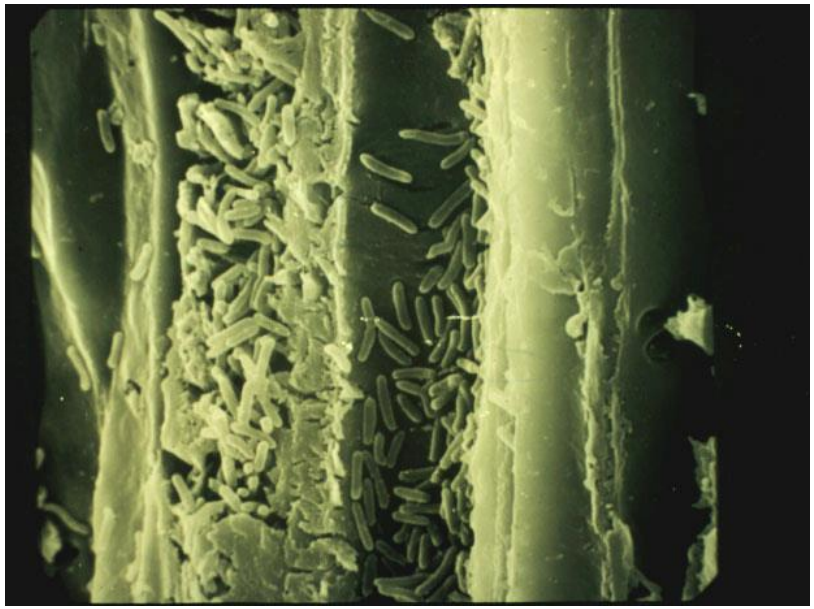
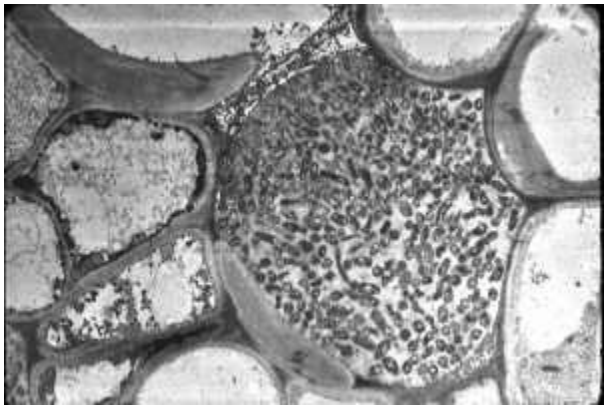


Plate 1. Color variations of adults of two species of spittle insects, vectors of virus of Pierce's disease of grapevines and alfalfa dwarf: *A*, *B*, males, *F*, *G*, females of annulate spittle insect, *Aphrophora angulata* Ball; *C*, *D*, *E*, males; *H*, *I*, *J*, females of western pine spittle insect, *Aphrophora permutata* Uhler.

Insect vectors were identified in the 1940s

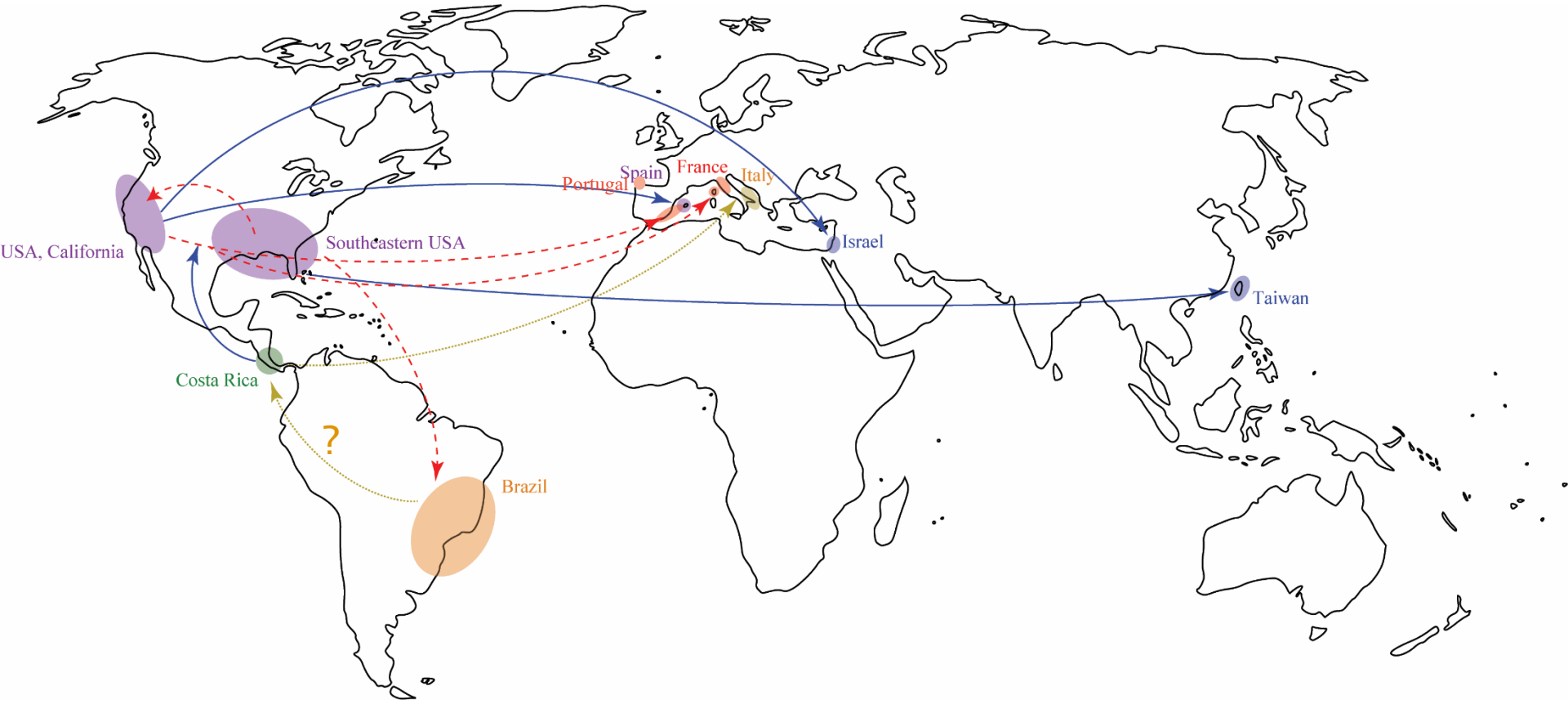
Xylem-limited bacteria were shown to cause PD in the 1970s, *Xylella fastidiosa* was named in 1987



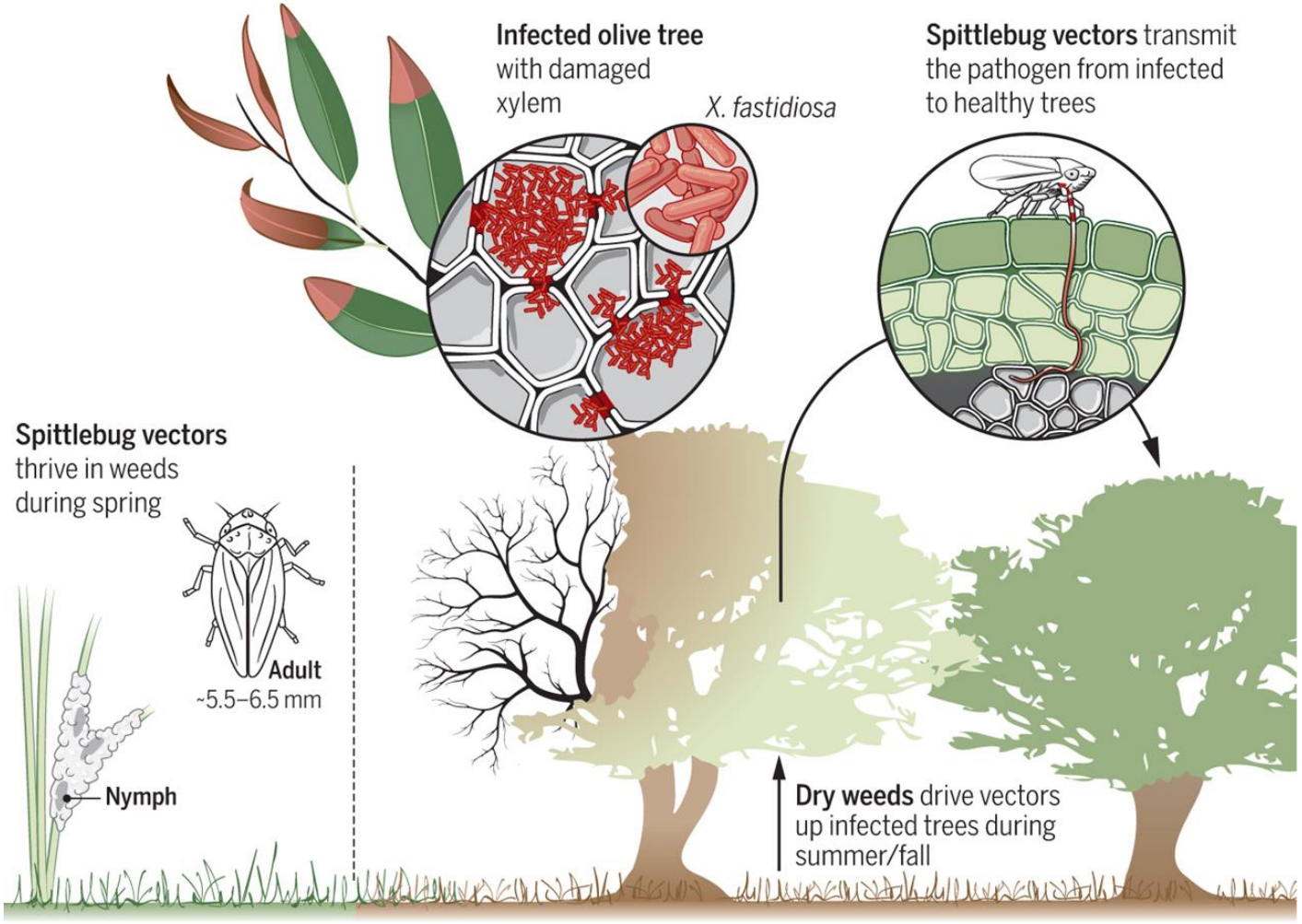


In 2013 *X. fastidiosa* was identified in Italy. That led many countries to look for the pathogen.

Current worldwide phylogeographic distribution of *X. fastidiosa* – and PD



Biology


Infected olive tree
with damaged
xylem
X. fastidiosa
Spittlebug vectors transmit
the pathogen from infected
to healthy trees
Spittlebug vectors
thrive in weeds
during spring
Adult
~5.5–6.5 mm
Nymph
Dry weeds drive vectors
up infected trees during
summer/fall



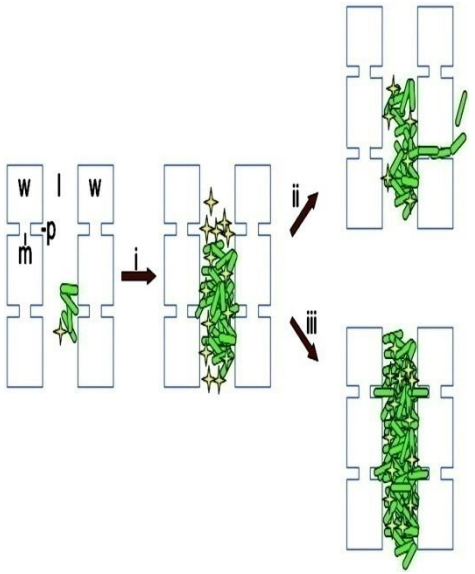


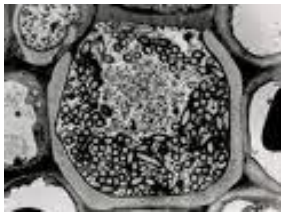



- Pierce's disease of grapevines
- Olive quick decline syndrome
- Almond leaf scorch
- Phony peach disease
- Plum leaf scald
- Citrus variegated chlorosis
- Elm, oak, sycamore leaf scorch

Oleander leaf scorch

* and a very large list of new emerging diseases of crops and ornamentals



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Pierce's disease: typical leaf symptoms

Pierce's disease: other typical symptoms

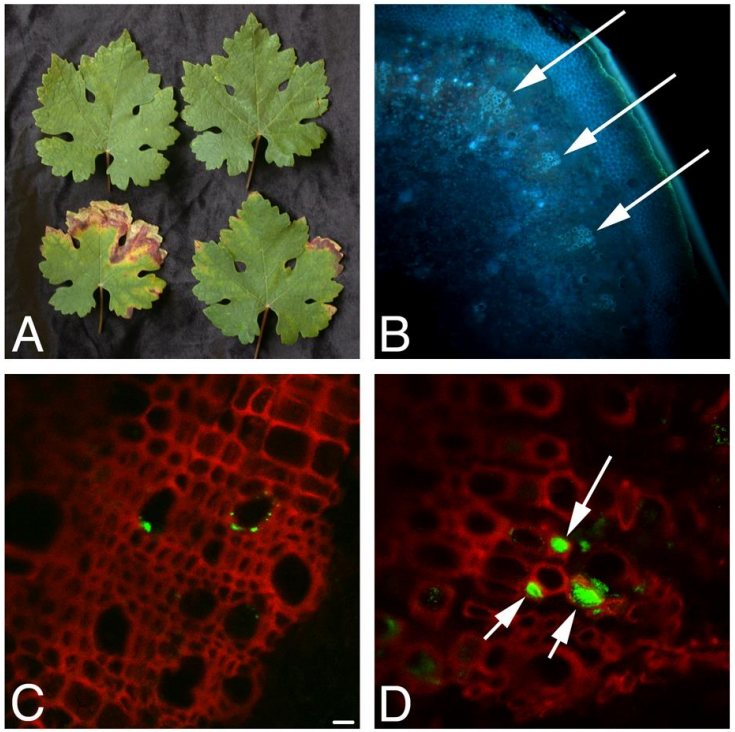
Matchstick petioles

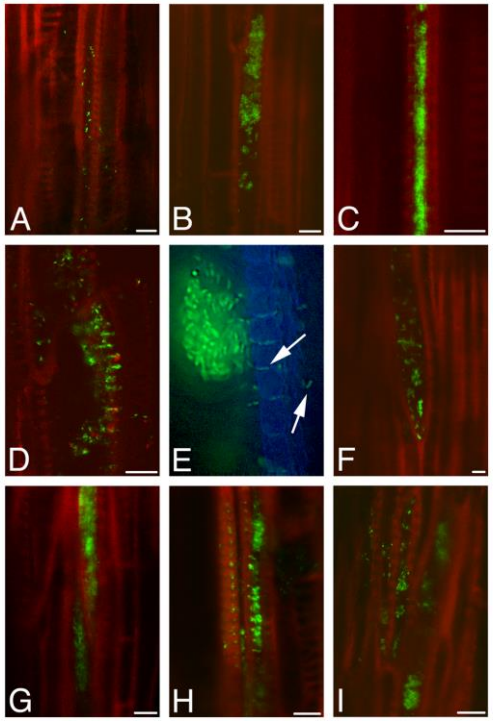
Uneven lignification

Shriveled berries

Chronic infections: Stunting, decline & vine death

Plant colonization





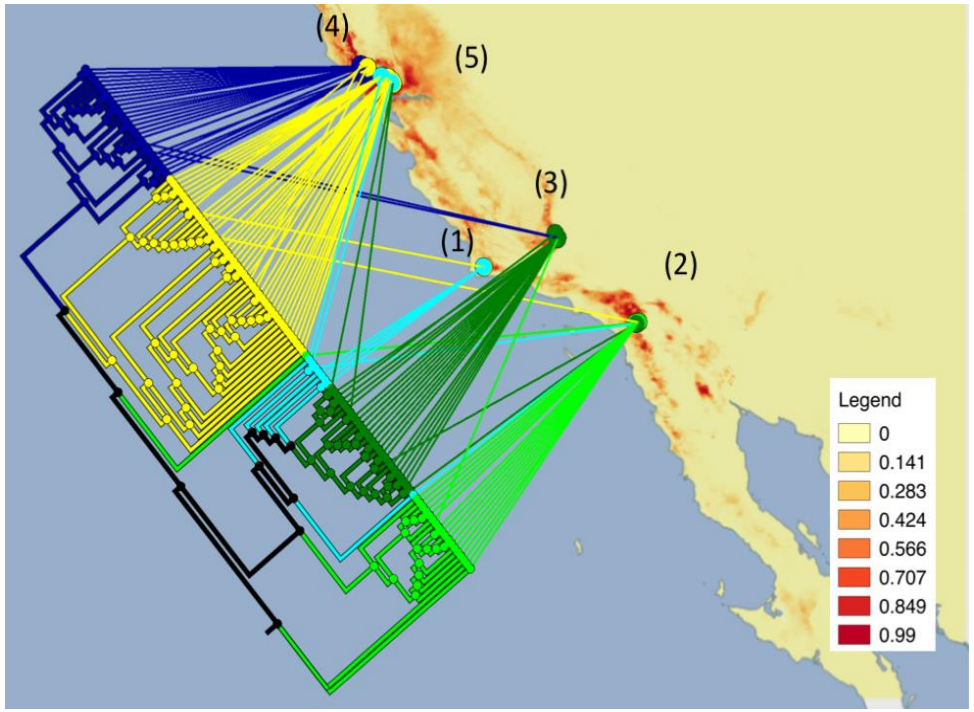
Newman et al. 2003 Appl. Env. Microbiol.

Are all *X. fastidiosa* causing PD in California the same?

No. Local pathogen populations are geographically and genetically structured.

That means PD is caused by very closely related but distinct pathogen populations in California.

We now know these little differences matter.



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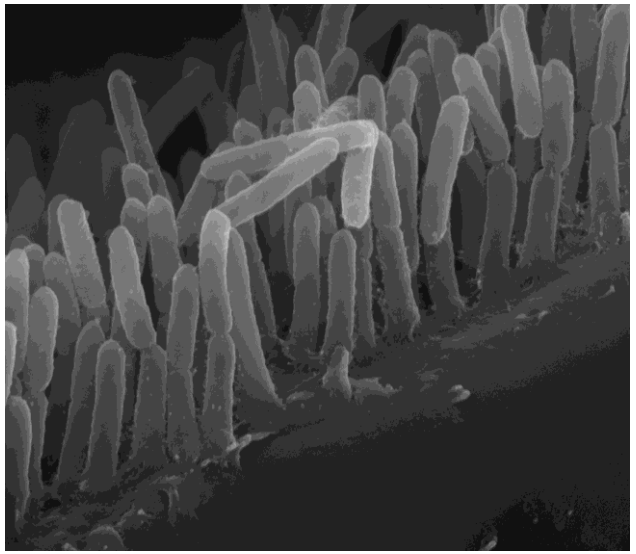
Vanhove et al. 2020
Environ Microbiol

Vector transmission of *X. fastidiosa*

- ✓No vector species – pathogen strain specificity
- ✓Nymphs and adults transmit *X. fastidiosa*
- ✓No latent period
- ✓No transmission after molting
- ✓No transovarial transmission
- ✓Persistent in adults

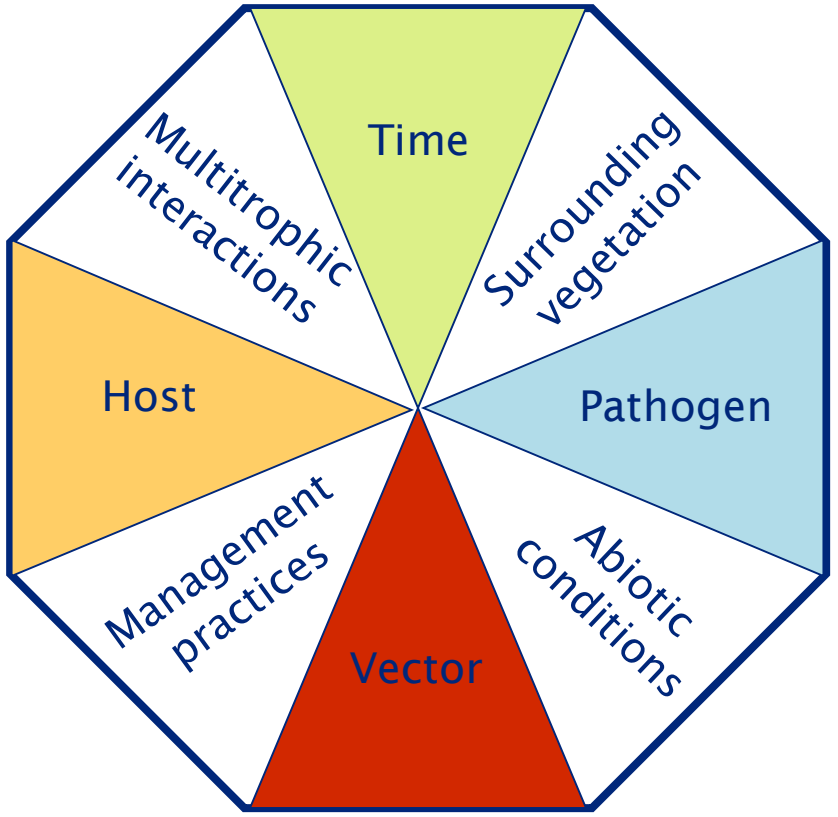


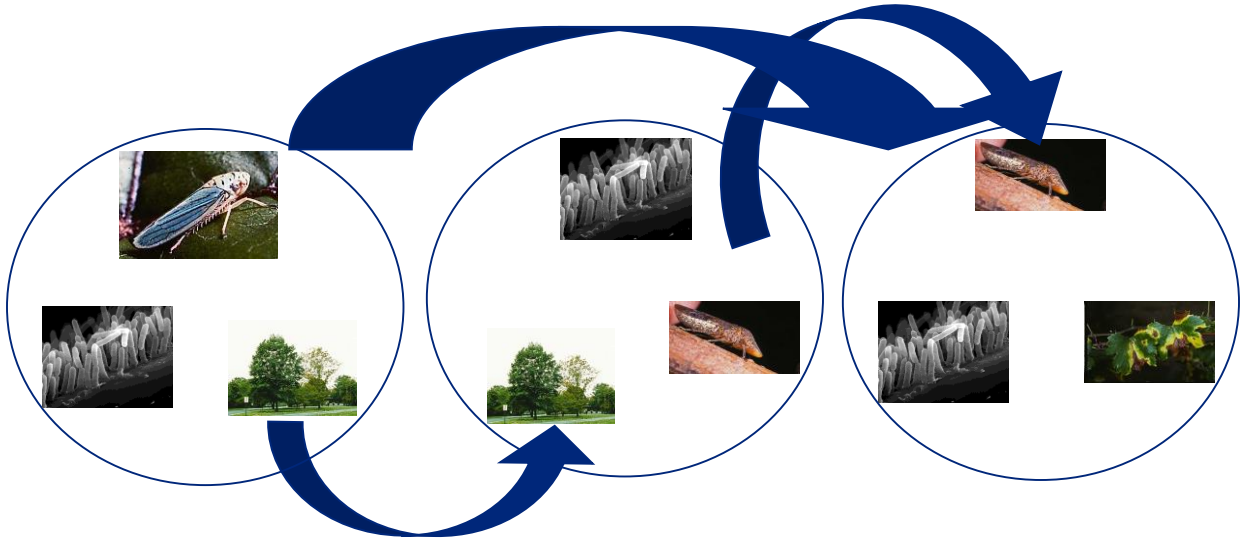
Important vectors in California

Also a vector in California, but important in Europe

Ecology

What factors affect Pierce's disease ecology?





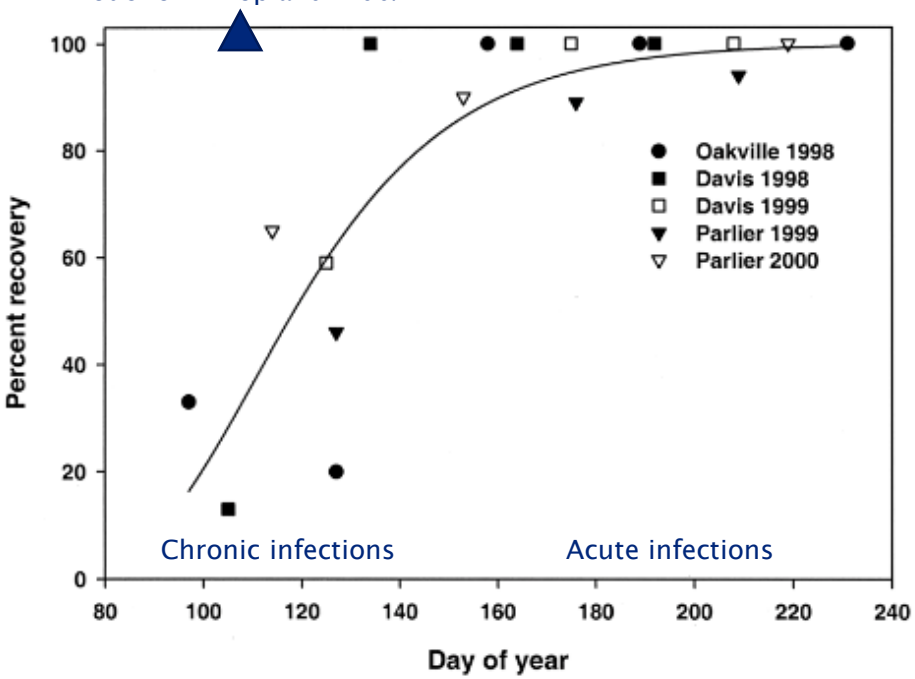
X. fastidiosa diseases have very complex ecology

- ✓ environment (e.g. temperature)
- ✓ vector ecology
- ✓ pathogen ecology
- ✓ host plant ecology
- ✓ outcome of various interactions
- ✓ disease management

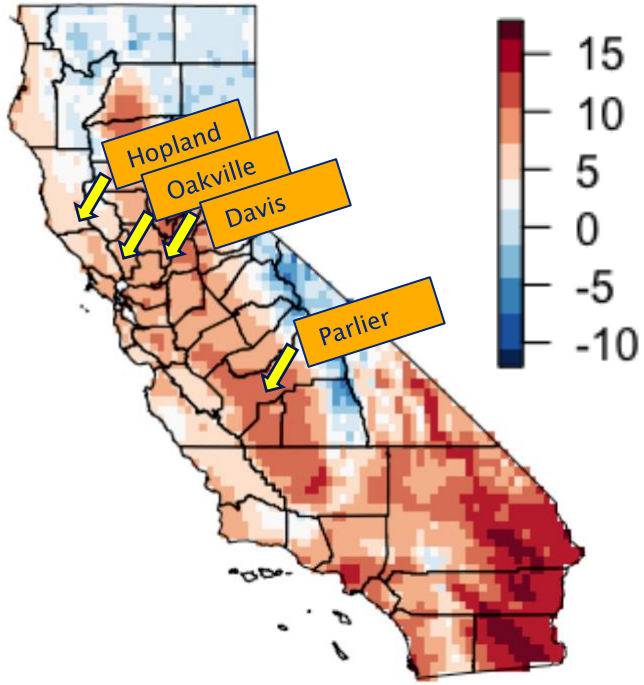
Winter curing of PD infection

Vines with PD can be cured over the winter, particularly late season infections

Not shown Hopland: 100%



Feil & Purcell, 2003

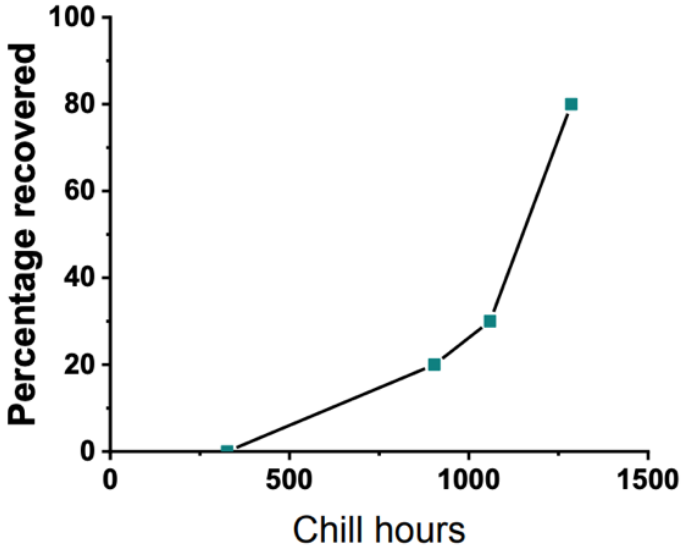


Minimum Annual Temperature, 2021

What causes curing: freezing or chill hours?

Table 2. Effects of multiple cold treatments on the survival and recovery of grapevines with Pierce's disease (PD).

Initial chamber temperature (°C)	Time[a] of exposure(s) (hours)	No. days preconditioning 2° to 4°C	Survival[b] of plants with PD	Survival[b] of check plants	Recovery[c] from PD (no.)
B. Multiple cold treatments					
-8	1.5, 21.5	70	3/4	-	0/3
-8	2.0, 6.0	57	6/8	3/3	2/6
-8	2.0, 6.0, 19.5	151(bare root)	3/9	3/5	3/3
-8	2.8, 7.0, 15.5	7	2/4	2/2	0/2
-8	6.0, 20.3	151(bare root)	0/5	7/7	-
-8	4.5, 3.5, 24.0	30	6/11	-	6/6
-10	2.0, then to [illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Short exposure to sub-zero temperature resulted in curing (Purcell, 1977)

Longer exposure of infected plants to 40C results in greater curing (Burbank, 2018)

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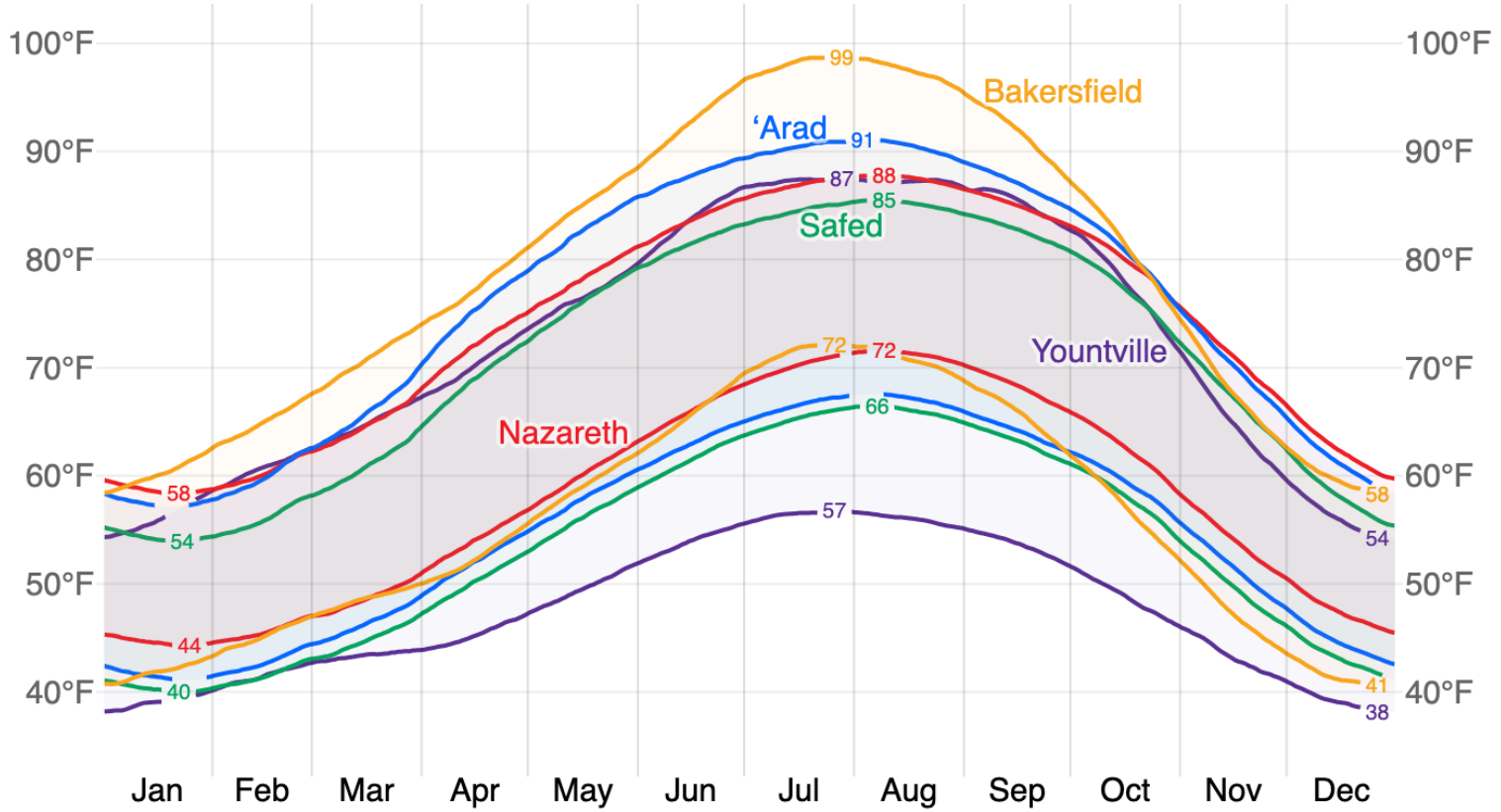
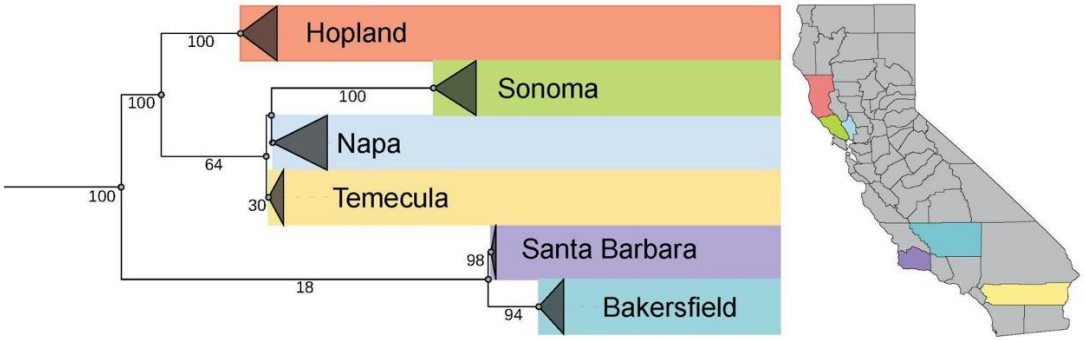
How does it compare with your temperatures?

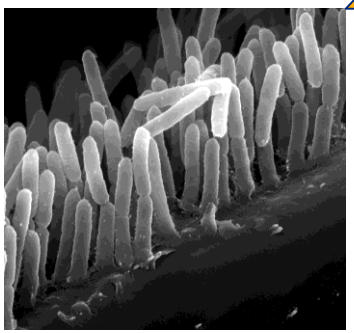


Winter curing is grape variety and *X. fastidiosa* strain dependent



Strain →	Hopland (cold)	Bakersfield (hot)
Recovery	29 (34%)	66 (74%)
No Recovery	57 (66%)	23 (26%)

There are ‘two’ Pierce’s disease in California



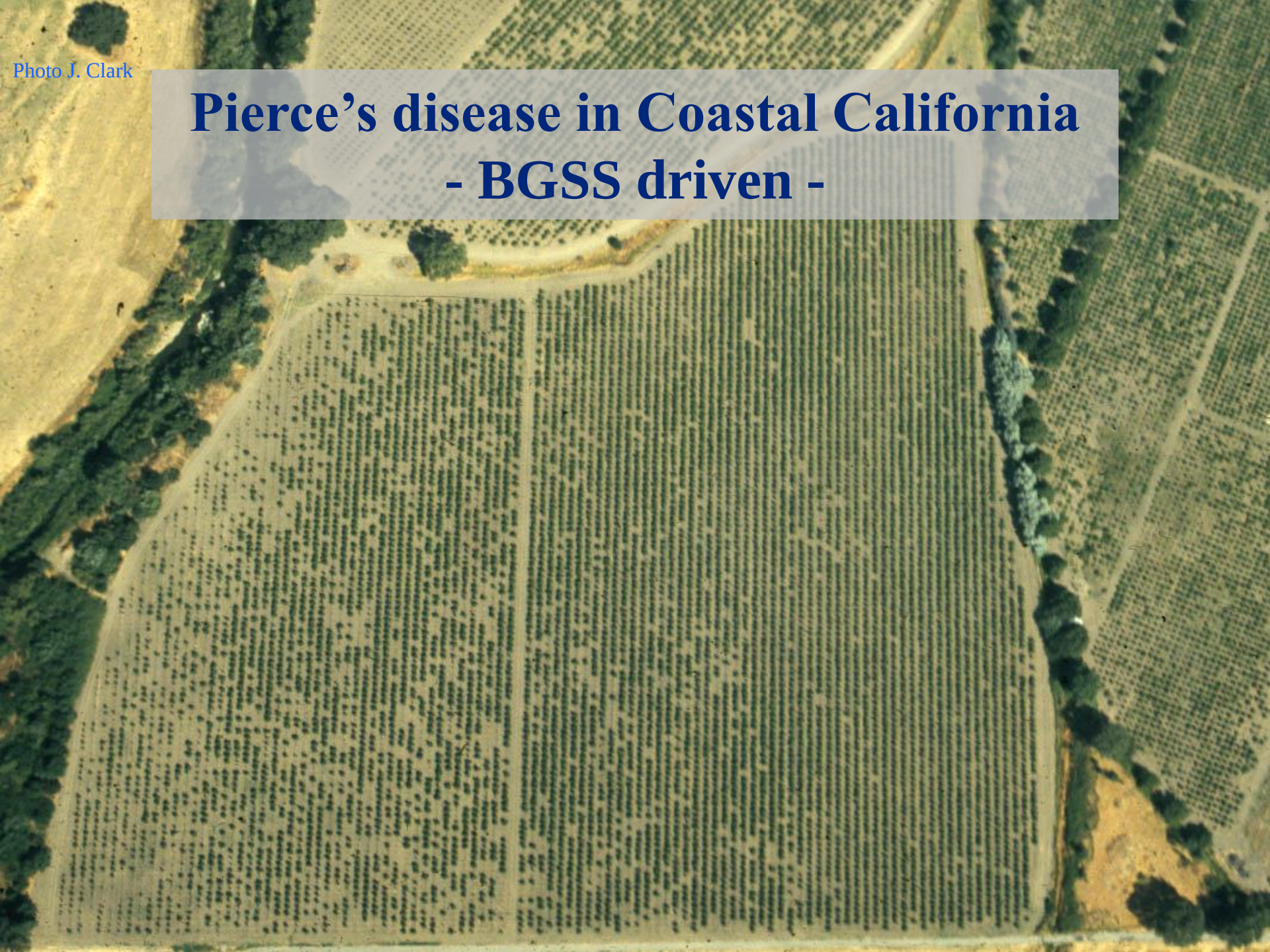
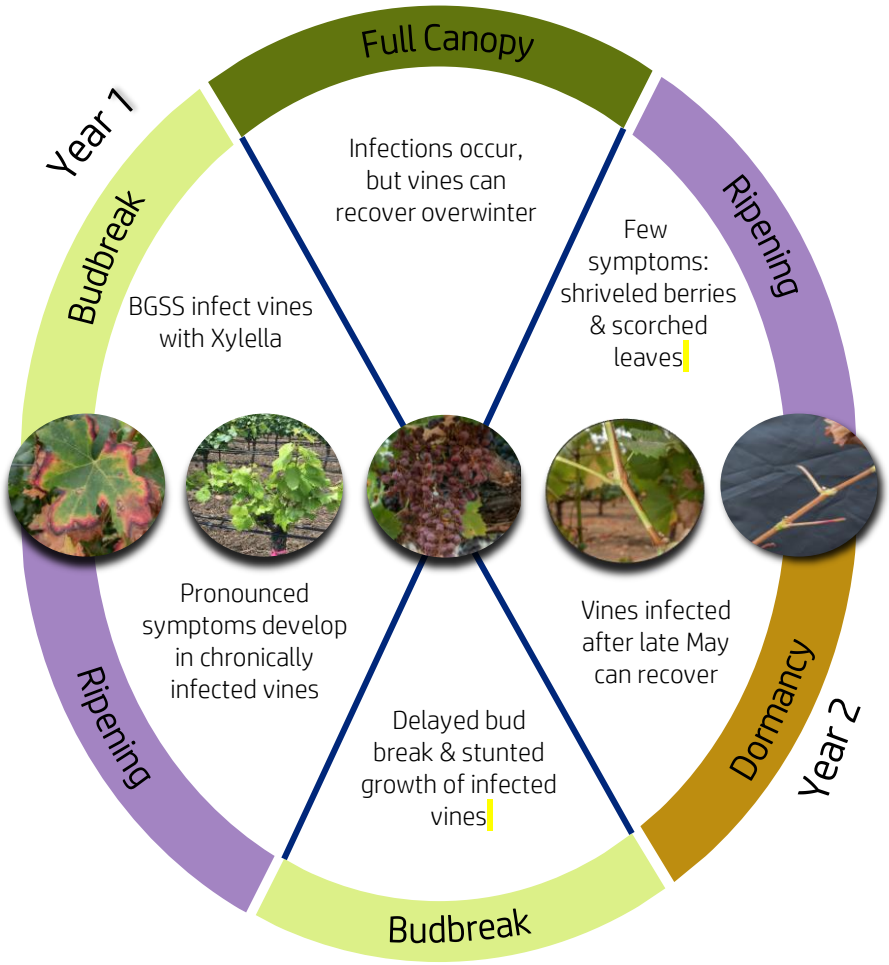


Photo J. Clark

Pierce's disease in Coastal California
- BGSS driven -

Pierce's disease cycle
North Coast, California



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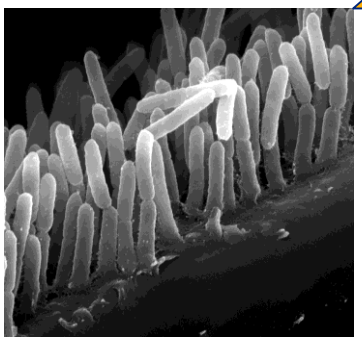
There are ‘two’ Pierce’s disease in California



Pierce's disease in Southern California
- GWSS driven -

To be continued…

CALIFORNIA PD/GWSS BOARD
Partnership for Winegrape Pest Solutions

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