Exploring the Matrix of Organisms in which Invasive Plants Thrive

- Parker and Swope
  - Plant-microbe interactions and plant invasions.
- Wojcik
  - Native pollinators and invasive plants: Implications for agriculture and restoration.
- Aslan
  - Mutualisms between native and non-native species: Global trends and Californian case studies.

Plant-Microbe Interactions and Plant Invasions

Ingrid Parker

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Sarah Swope

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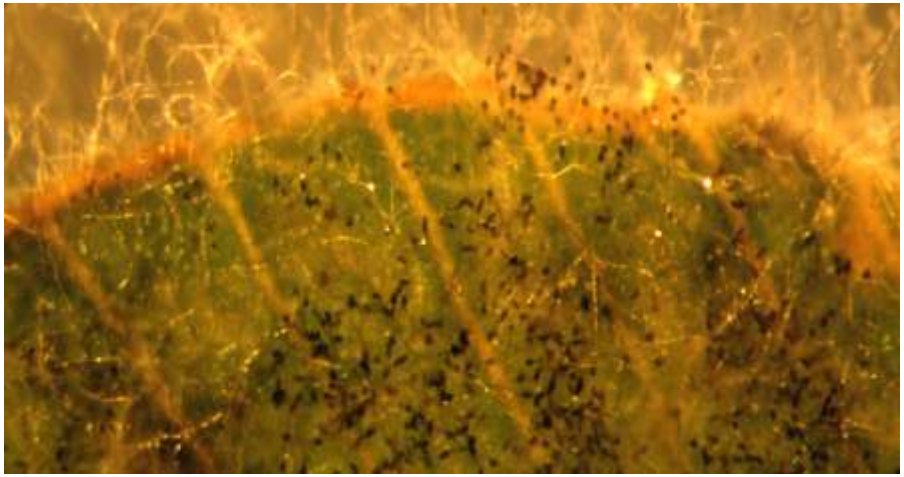
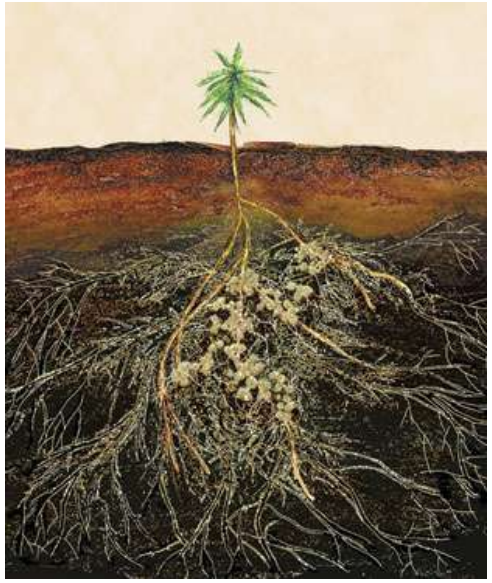


Microbes are everywhere

Southern corn leaf blight

Potato blight

Sudden oak death



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Mycorrhizae!

Pathogen

Host	Native	Novel
Native	**[Native interaction]**	**Novel epidemic**
Novel	**Introduced plant**	**Biological control**

Parker & Gilbert 2004 AREES, Gilbert & Parker 2005 in Cadotte et al.

Pathogen

Host	Native	Novel
	Native	**[Native interaction]**
	Novel	**Introduced plant**

Novel epidemic

Biological control

Do introduced species always "leave natural enemies behind"?

- Do pathogens explain or constrain invasion success?

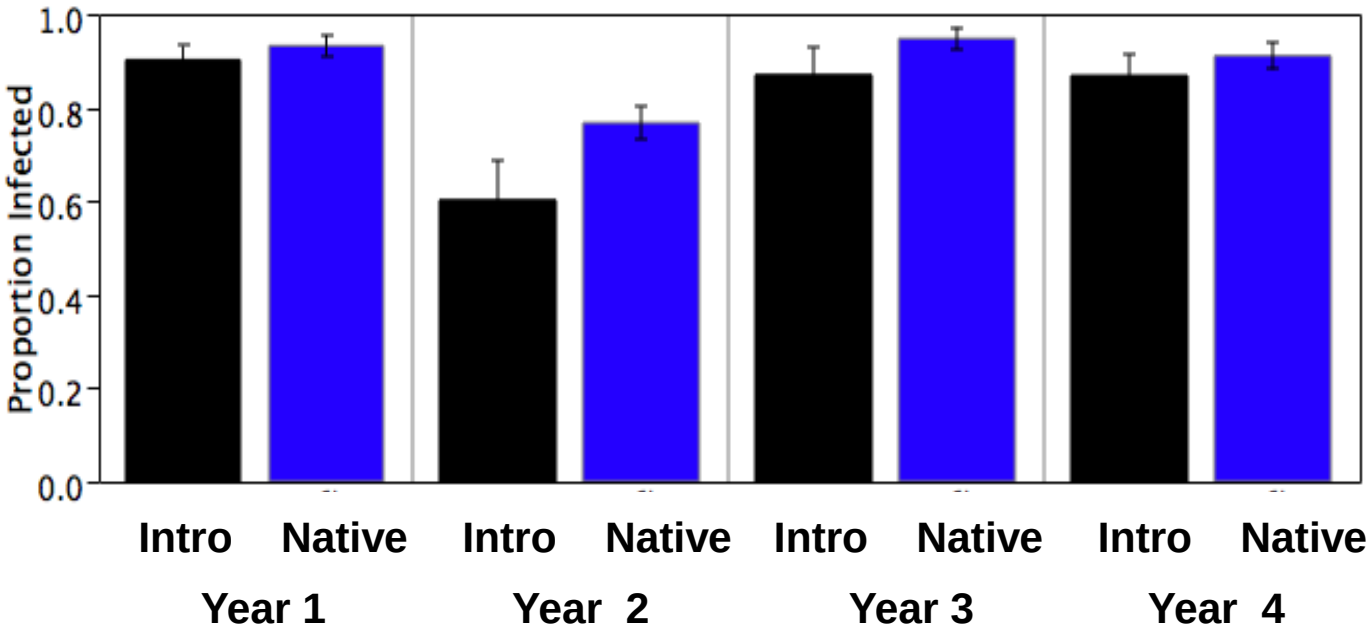
ECOLOGY

- How will these interactions change over time?

EVOLUTION


Trifolium/Medicago
9 native species
8 introduced species
[species as replicate]
Greg Gilbert, UCSC

FUNGAL INFECTION



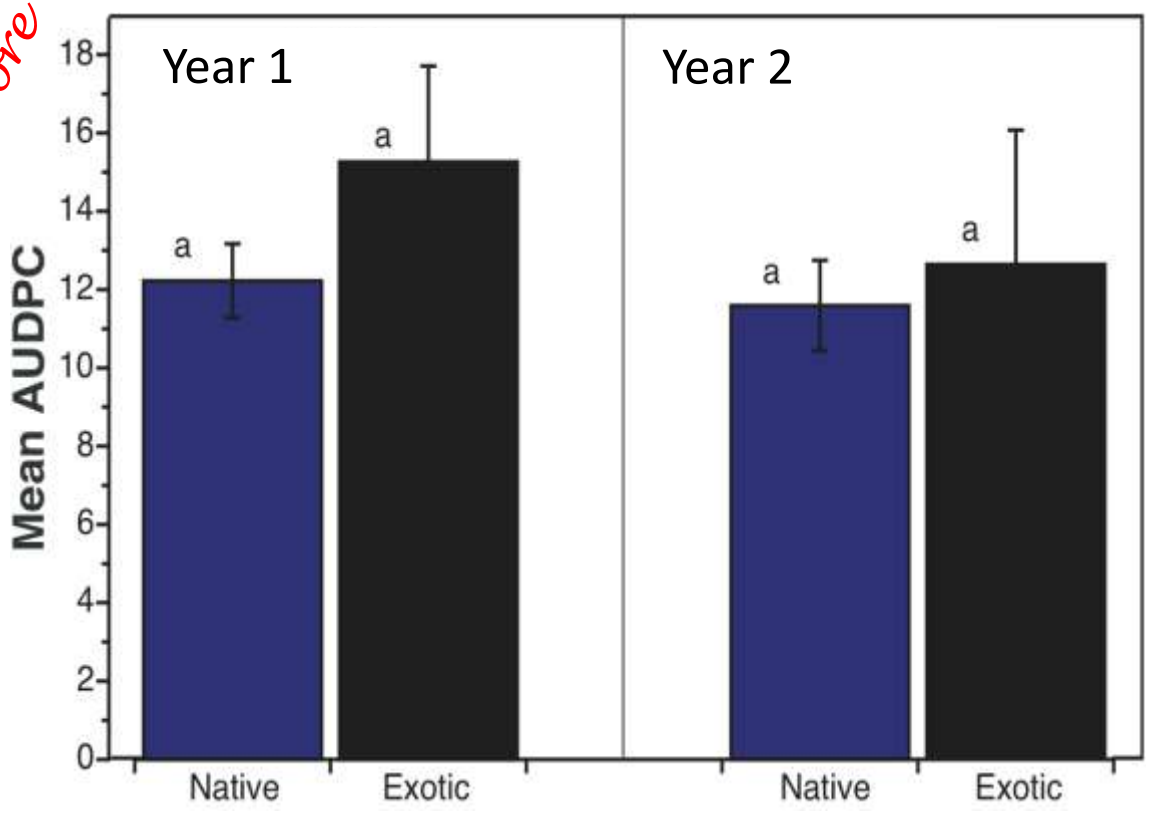
Infection is extremely common

Introduced ≈ Native

Parker & Gilbert 2007 Ecology

DISEASE PREVALENCE

Integrative disease score



Introduced ≈ Native

Same for disease severity.

Same for fitness cost.

Parker & Gilbert 2007 Ecology

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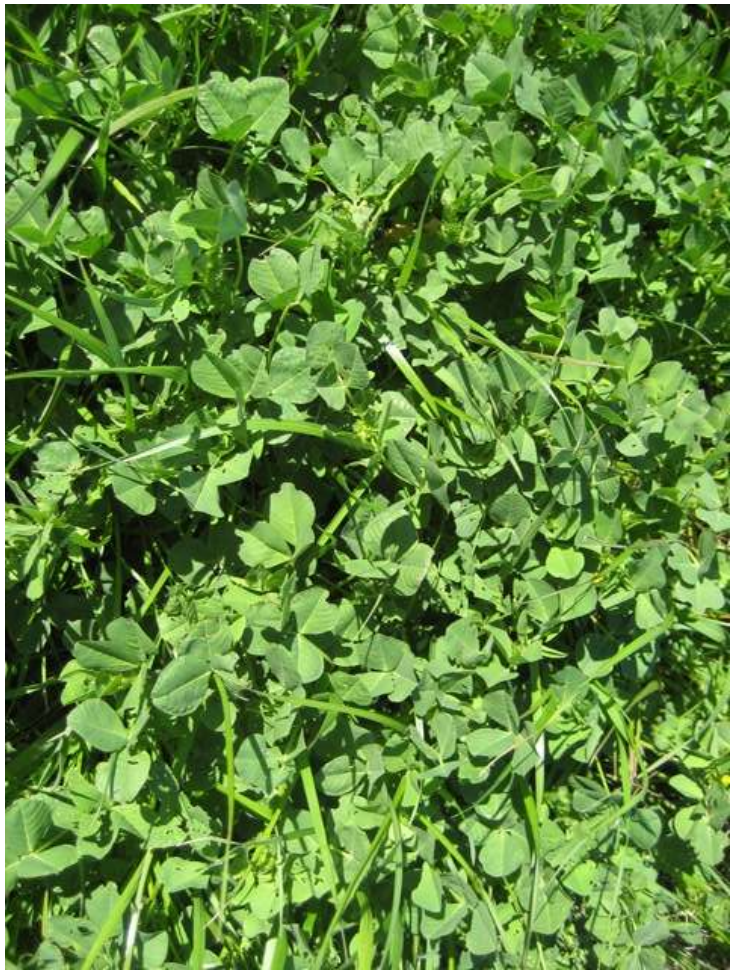
Vs.



© trnerr.org

NON-INVASIVE

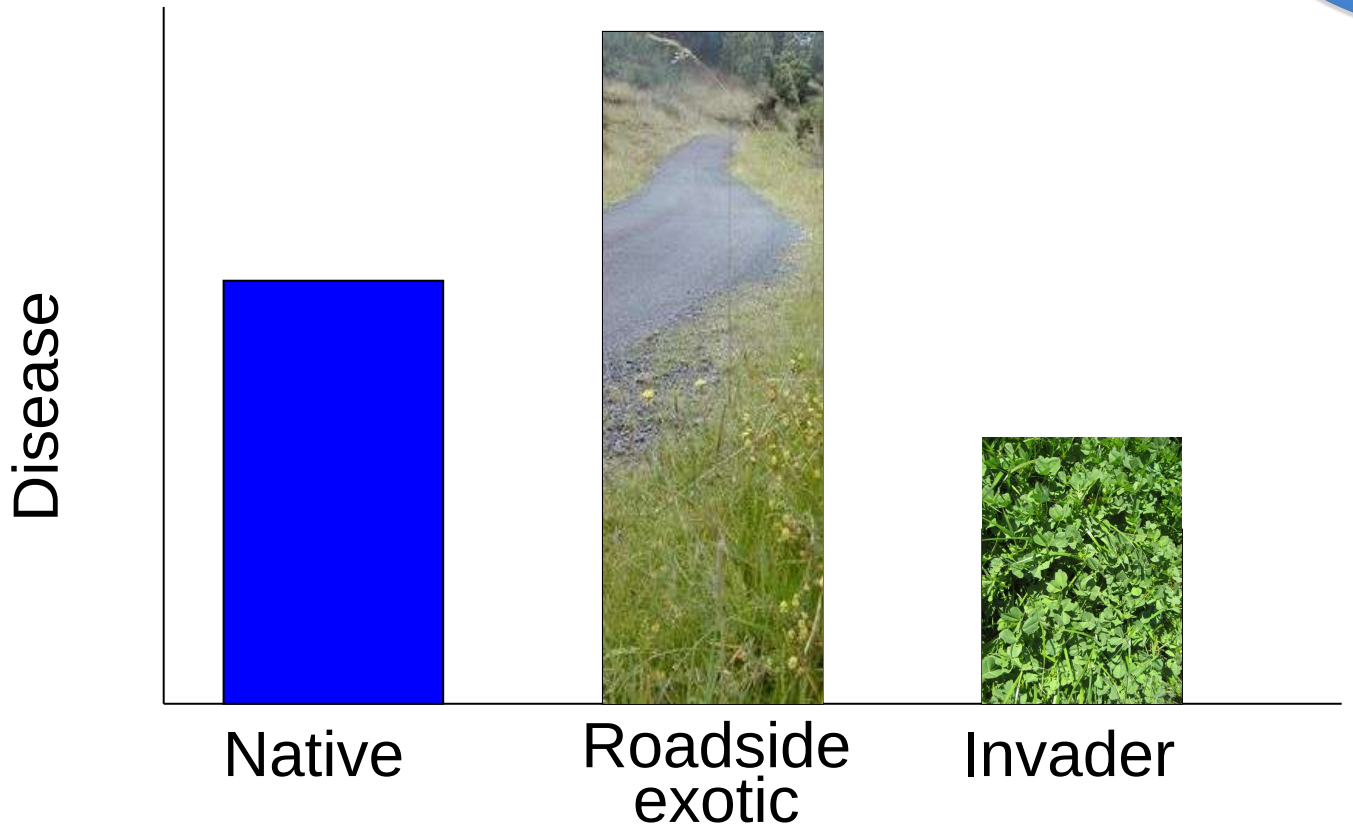
T. glomeratum
T. campestre
T. Subterraneum
T. repens
T. dubium
M. lupulina

INVASIVE

M. polymorpha
M. arabica

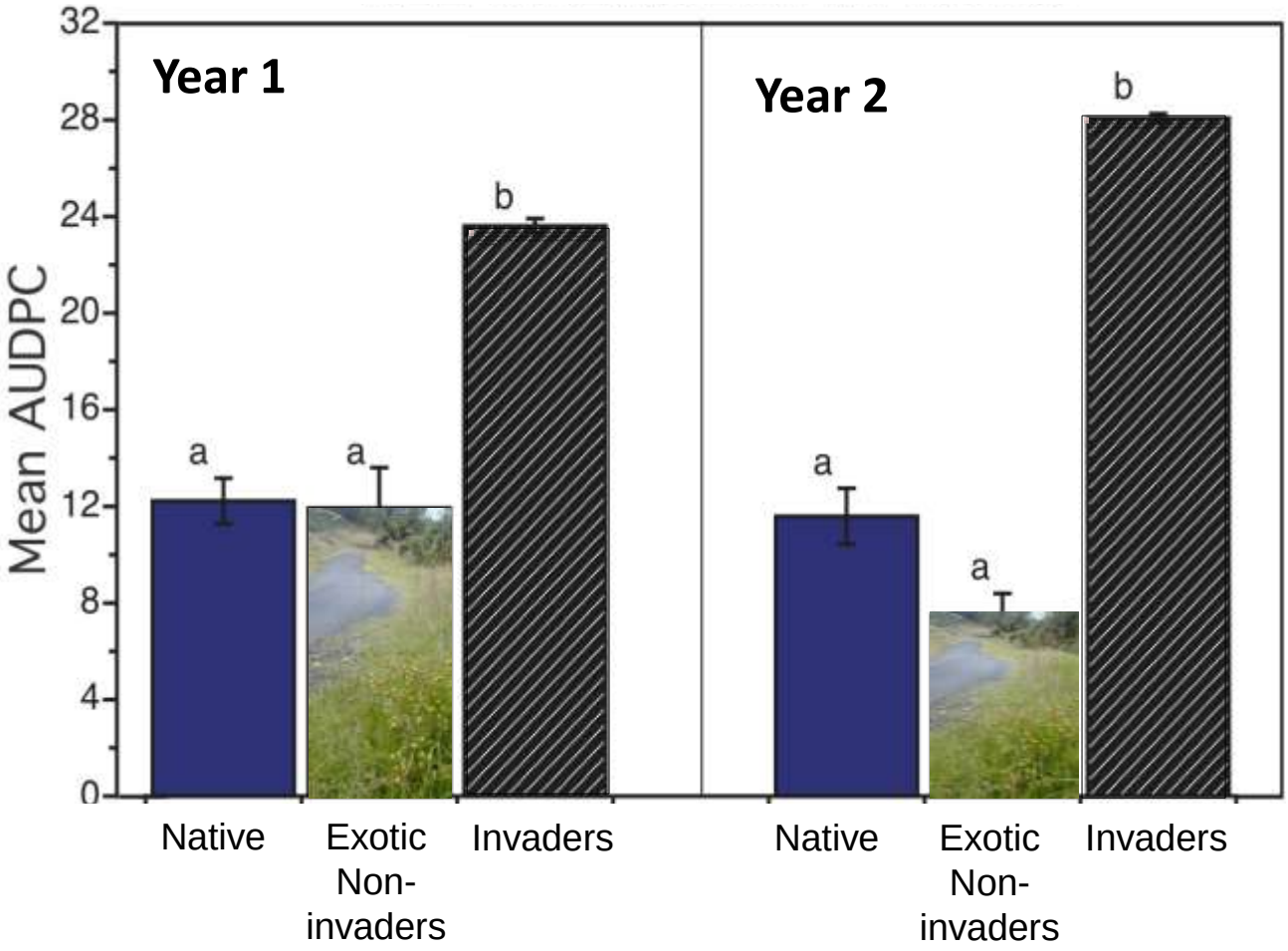
Does BIOTIC RESISTANCE limit some introduced clovers to roadsides?

Predicted Results



NO:
The more invasive species experienced MORE disease.

Actual Results



CONCLUSIONS:
Clovers and Their Pathogens

Introduced & native plants experienced similar rates of infection by pathogens.

Introduced & native plants suffered similar disease.

Of the introduced plants, the more invasive ones experienced more disease, not less.

No support for "escape from enemies"

WHY

No support for "escape from pathogens"?

Bodega clover pathogens are dominated by:

- Host-generalists (> 95% of 1178 fungi cultured)

FUNGI RECORDED

Fungus	Native hosts										Introduced hosts								
	T. barbigerum	T. bifidum	T. fucatum	T. gracilentum	T. macraei	T. microcephalum	T. microdon	T. willdenovii	T. wormskjoldii	M. arabica	M. lupulina	M. polymorpha	T. campestre	T. dubium	T. glomeratum	T. repens	T. subterraneum
Stemphylium spp.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Alternaria sp.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cladosporium sp.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Colletotrichum trifolii	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Phoma sp.	■	■	■	■				■	■	■		■	■	■	■	■	
Cochliobolus spicifer				■		■	■		■	■	■		■		■	■	
Cylindrocarpon sp.	■							■	■	■					■	■	
Leptosphaerulina trifolii				■						■		■			■	■	
Uromyces minor													■	■		■	
Pseudopeziza trifolii									■						■	■	
Epicoccum nigrum				■	■											■	
Trichurus sp.					■								■				
Fusarium cf. *roseum*									■								■
Chaetopsina fulva		■														■	
Idriella sp.						■										■	
Itersonilia sp.	■															■	
Acrodictys sp.		■															
Volutella sp.														■			
Uromyces striatus										■							
Ulocladium atrum									■								
Cercospora sp.										■							
Arthrinium sp.									■								

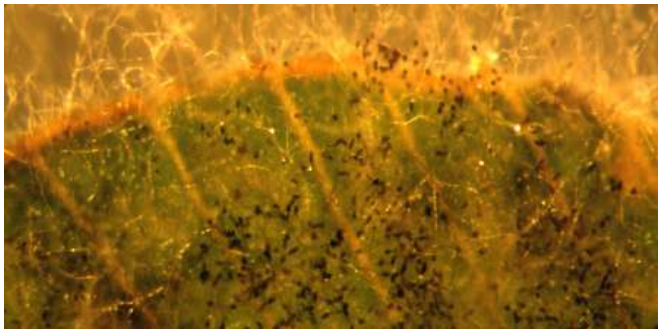
WHY

No support for "escape from pathogens"?

Bodega clover pathogens are dominated by:

- Host-generalists (> 95% of 1178 fungi cultured)
- Taxa that have pathogenic conspecifics or congenerics in the native range

- **Evolution of native pathogens to utilize non-native hosts?**



Evolution of native pathogens to utilize non-native hosts?

In 5 generations in the lab:

Infection rates ↑↑

CA genotypes compared to EU genotypes:

Infection rates ↑

VIRULENCE ↓↓

Rapid evolution
will play a role in modifying interactions between invaders & natural enemies over time.

Gilbert & Parker 2010 Evol Apps

Sarah Swope
USDA-ARS

Pathogen

Host

	Native	Novel
Native	**[Native interaction]**	**Novel epidemic**
Novel	**Introduced plant**	**Biological control**

MICROBES FOR BIOCONTROL:

Puccinia jaceae on *Centaurea solstitialis*

- Introduced 2004
- How will impact depend on the presence of other species?
- How will impact depend on abiotic environment?

Puccinia jaceae f.s. *solstitialis*

Pathogen and seed predators spatially & temporally separated from one another

Eustenopus villosus

Chaetorellia succinea (& *C. australis*)

Established biocontrol insects: predispersal seed predators

Pathogen has a **DIRECT NEGATIVE** impact on the plant (biomass, inflorescences)

Swope & Parker 2010 Ecology

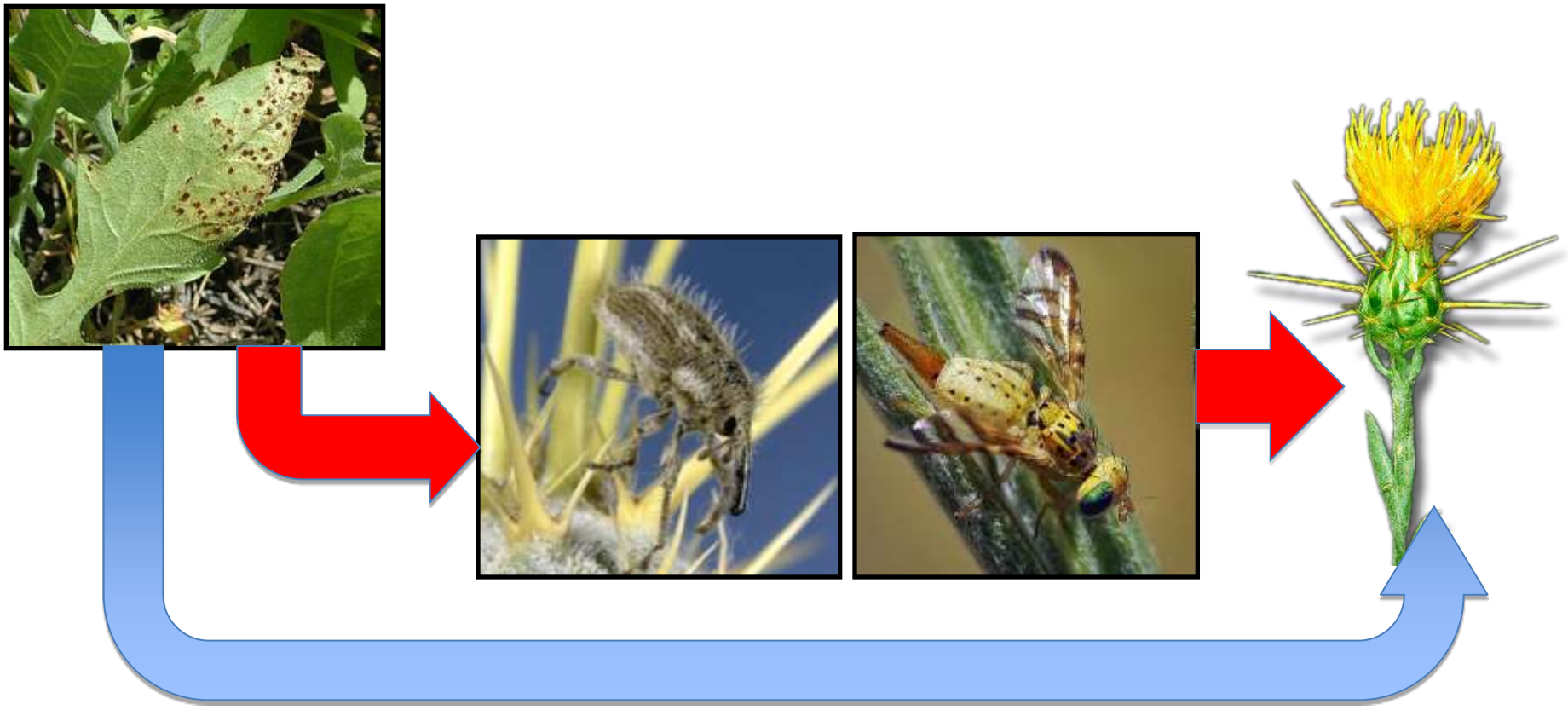
Pathogen has a **DIRECT NEGATIVE** impact on the plant (biomass, inflorescences)

INDIRECT POSITIVE impact on the plant through its seed predators

Swope & Parker 2010 Ecology

MECHANISM for interaction?

- Change in nutrient status?
- SAR response protects the plant against herbivores?



Swope & Parker 2010 Ecology

MICROBES FOR BIOCONTROL:

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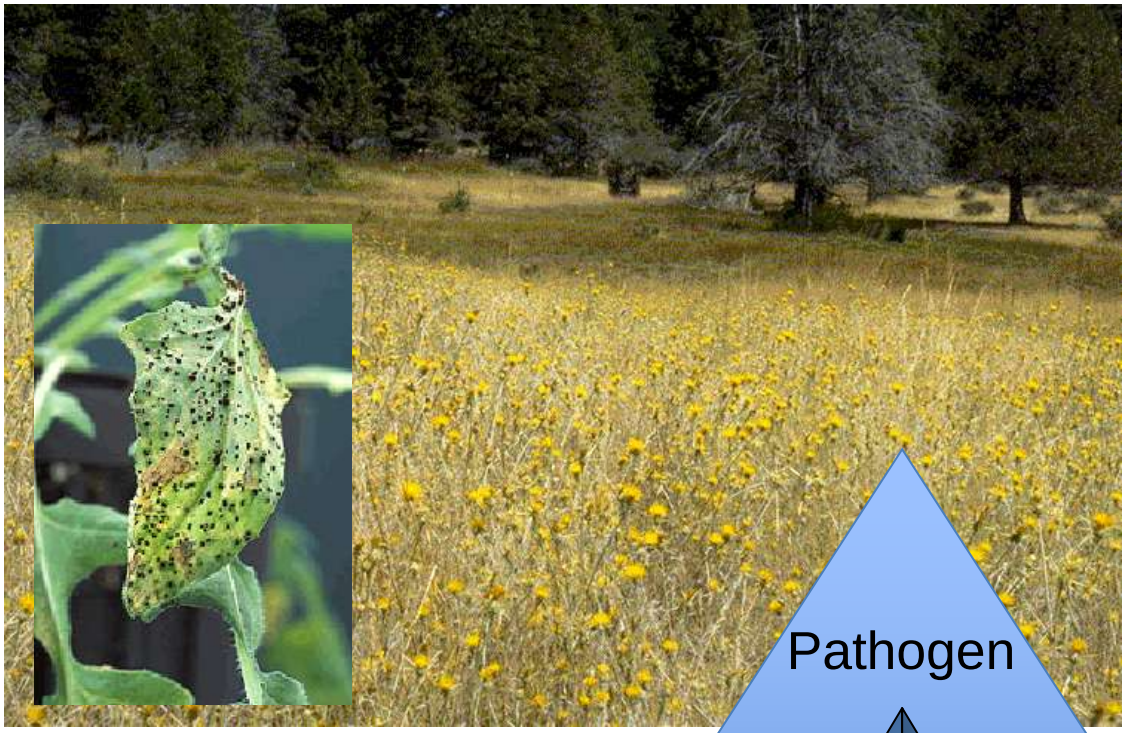
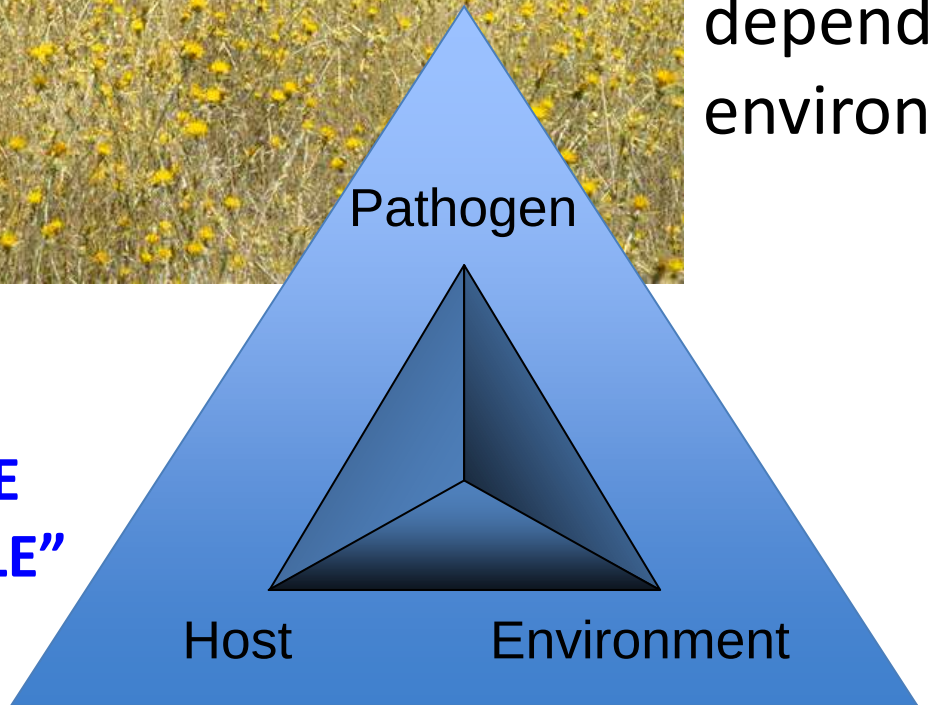
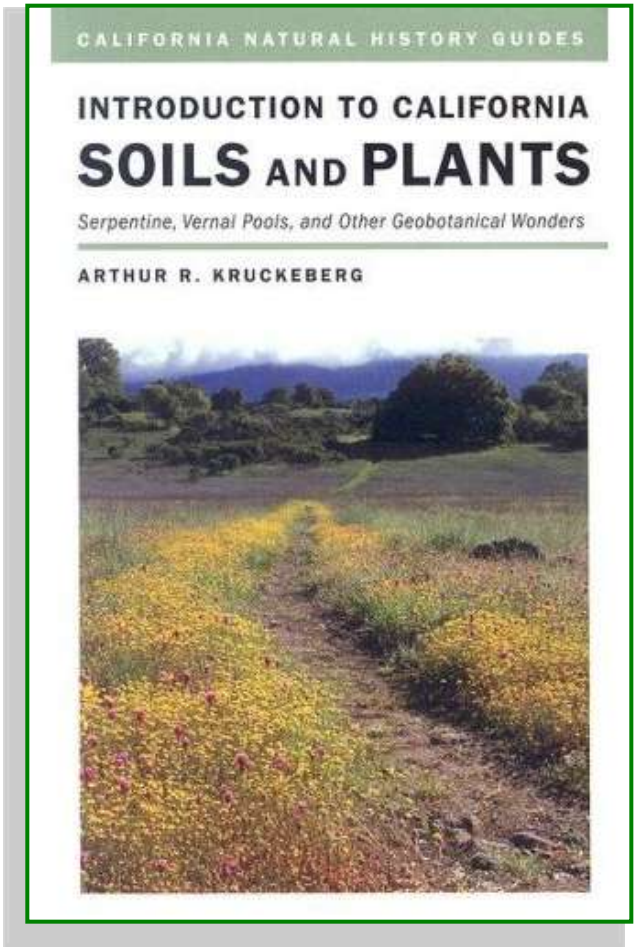


- How will impact depend on the presence of other species?
- How will impact depend on abiotic environment?

"DISEASE TRIANGLE"





Serpentine =
high conservation value

Unique properties: low Ca^{++}/Mg^{++}
can be stressful for plants

Ca^{++} role in response to infection

Is biocontrol more effective on serpentine?
Does interaction between agents change on serpentine?

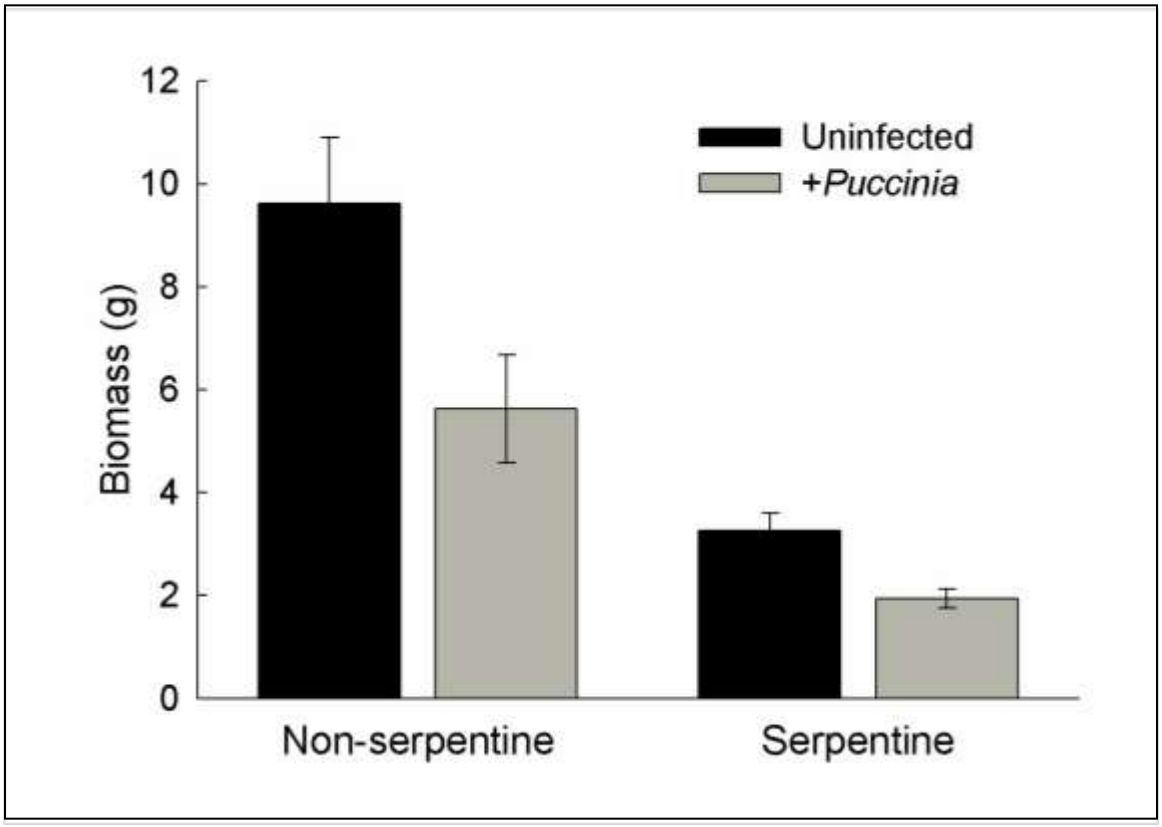
Adjacent patches of serpentine and non-serpentine (McLaughlin NR)

N = 400 naturally recruiting seedlings

+/- *Puccinia inoculation*

Exposed to natural levels of attack by the seed predators

Direct impact of pathogen on plant:

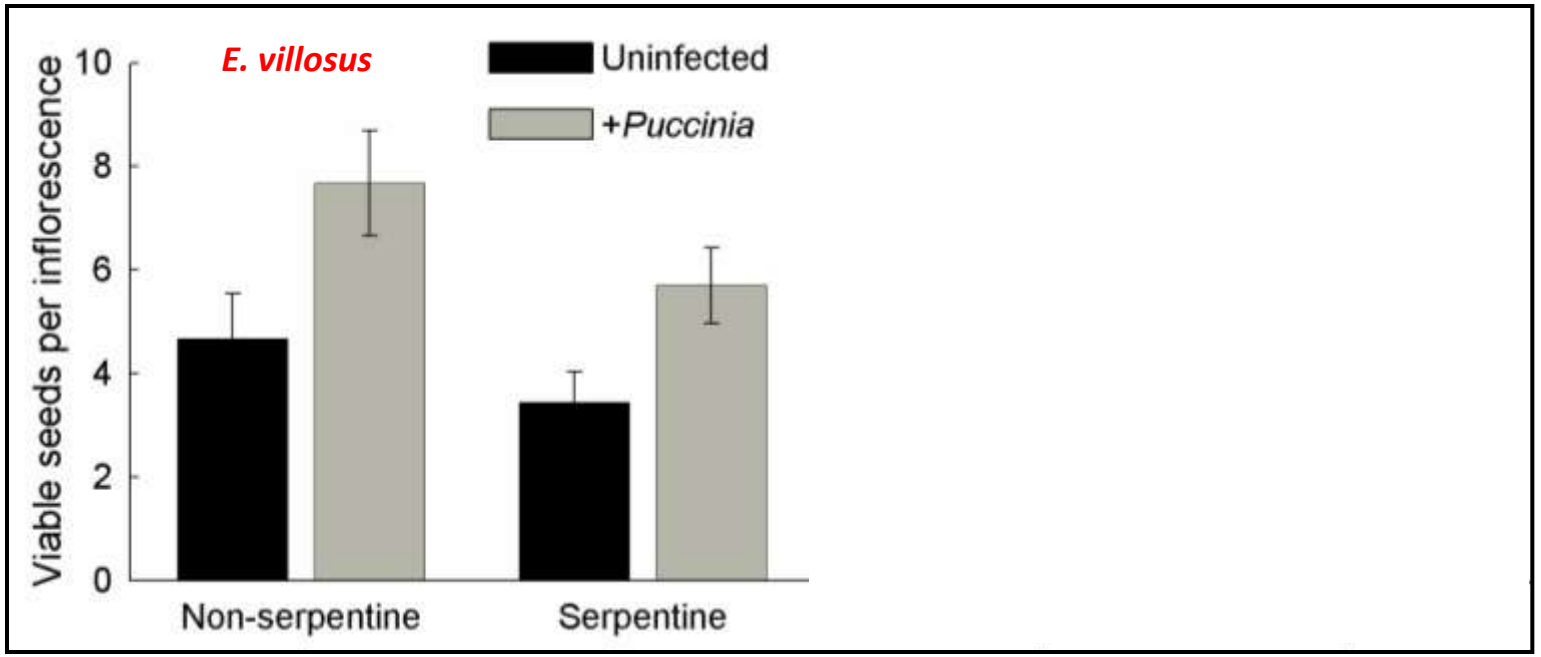


Soil type: p=0.0001
Pathogen: p=0.0001
Soil × Pathogen: p=0.57

Same pattern for infl #
No effect on # viable seeds / inflorescence

Indirect impact of pathogen via seed predators:

Data for attacked inflorescences

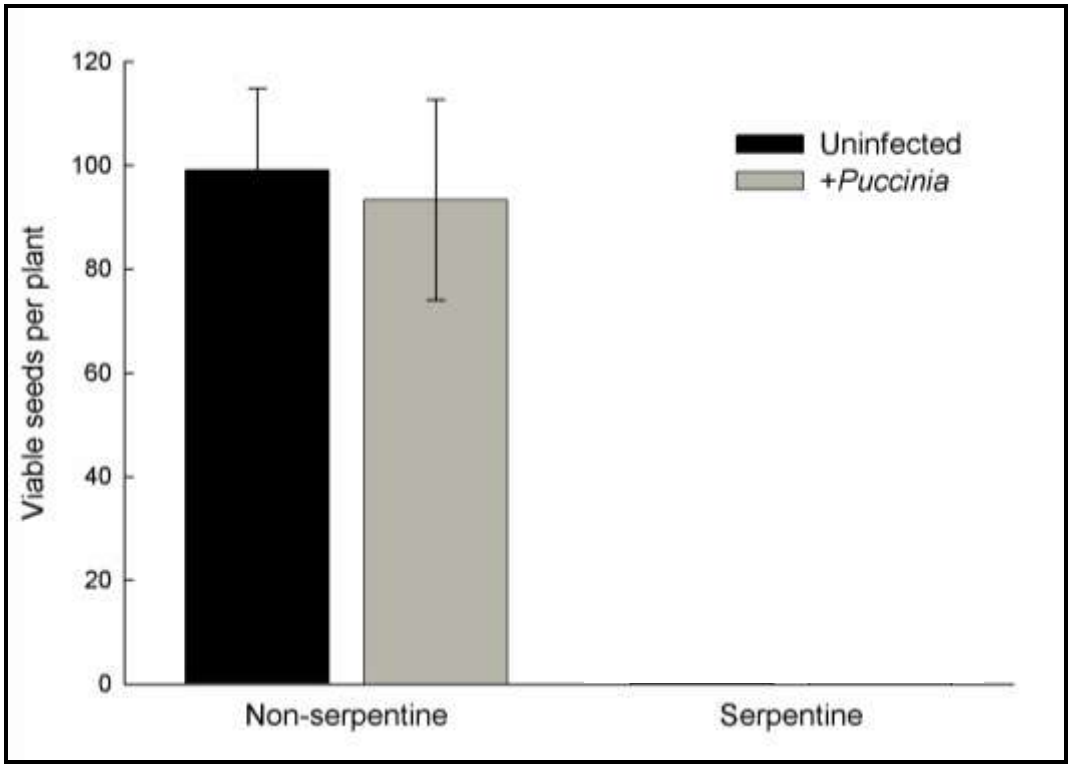


Soil type: p=0.04
Pathogen: p=0.0001
Soil × Pathogen: p=0.78

Soil type: p=0.0001
Pathogen: p=0.0001
Soil × Pathogen: p=0.01

Swope & Stein 2012 Biol Invasions

Net impact of direct and indirect interactions:



Soil type: p=0.0001
Pathogen: p=0.005
Soil × Pathogen: p=0.009

Non-serp soil: pathogen strongly protects the plant from seed predation = No net increase in control.

Serpentine: Adding pathogen increases control.

CONCLUSIONS:

- Microbial biological control agents can be effective…at least in some environments
- Plant-mediated interactions between biocontrol agents may affect success
- Impact of a biocontrol agent may depend on other key interactors …

  and may depend on abiotic conditions

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