





Flower Biology and Biologically-based Integrated Fire Blight Management

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USDA-ARS, Wenatchee, WA**

WSHA Annual Meeting, Dec. 6, 2011

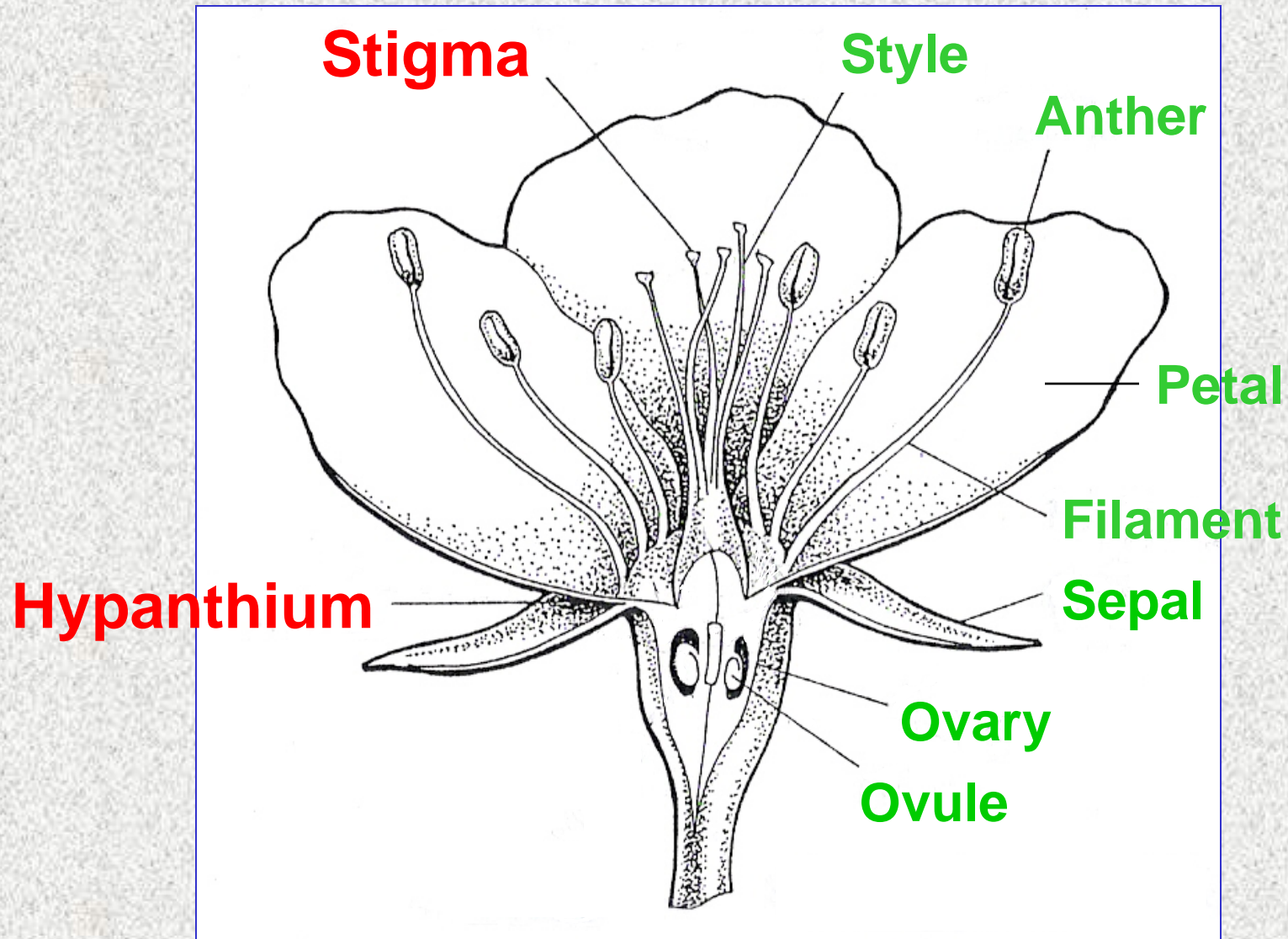
Notes on slides can be viewed by holding the cursor over the icon in the upper left corner.



Why biological control?

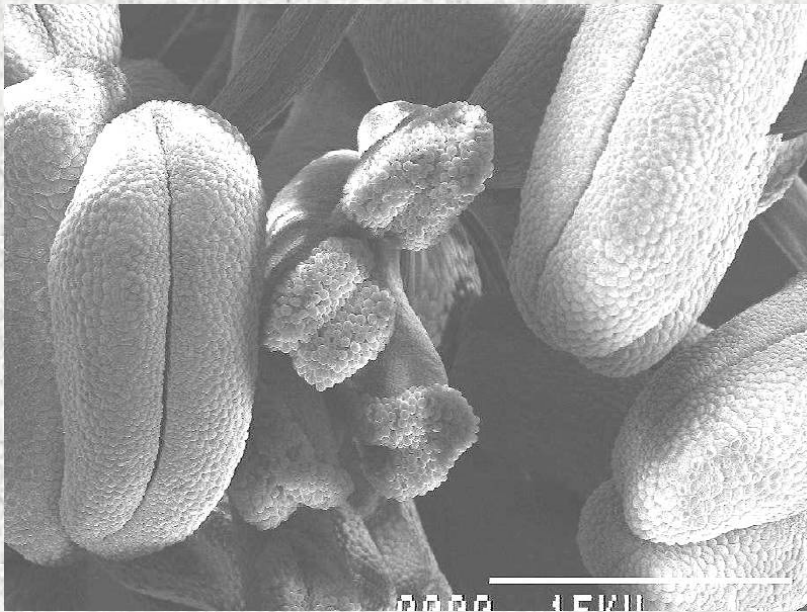
- Replace antibiotics
- Complement other approaches
- Advantage of multiplication and spread

Diagram of apple flower

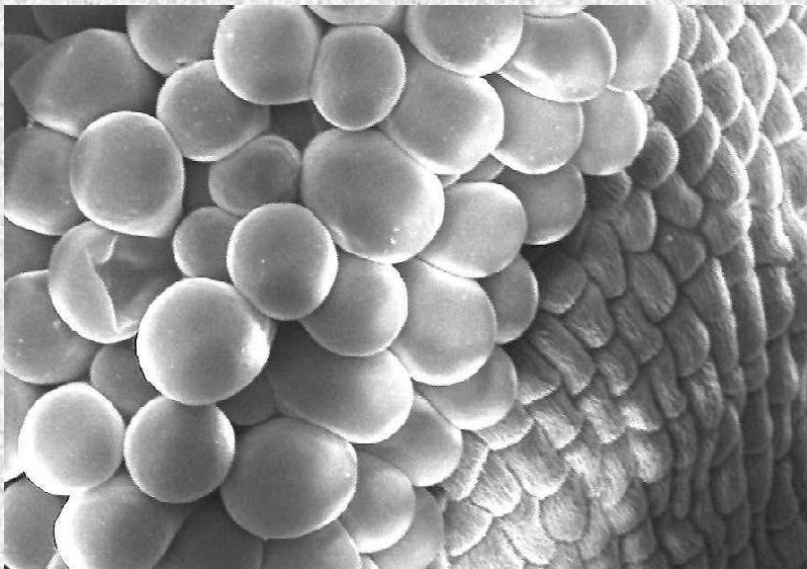
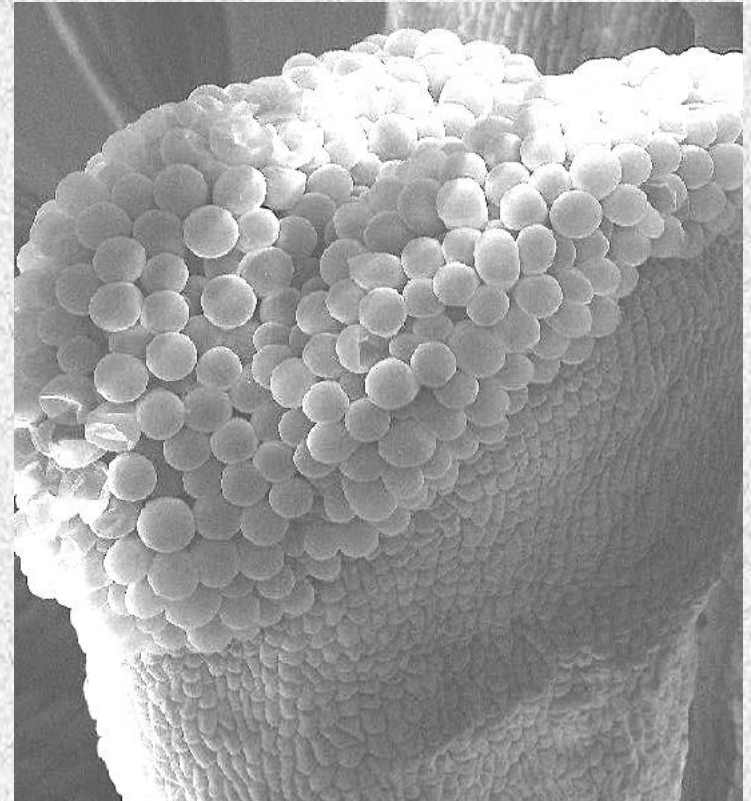


Apple stigma





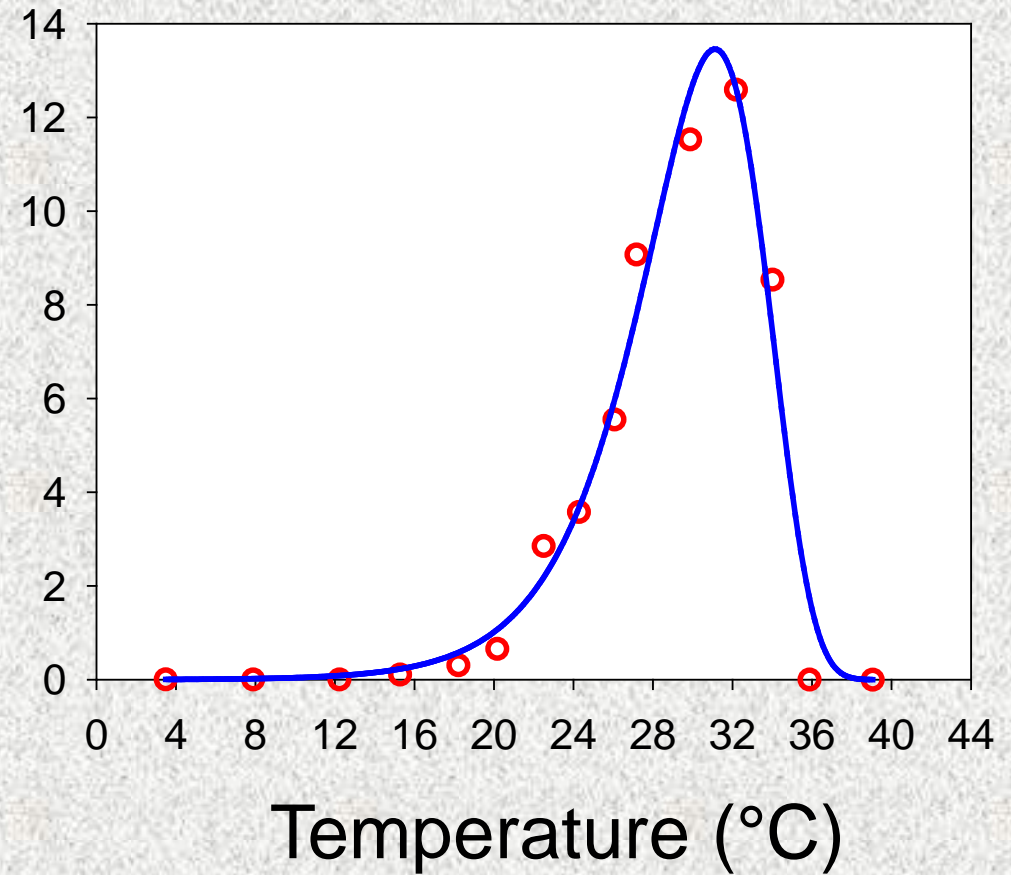
Stigma



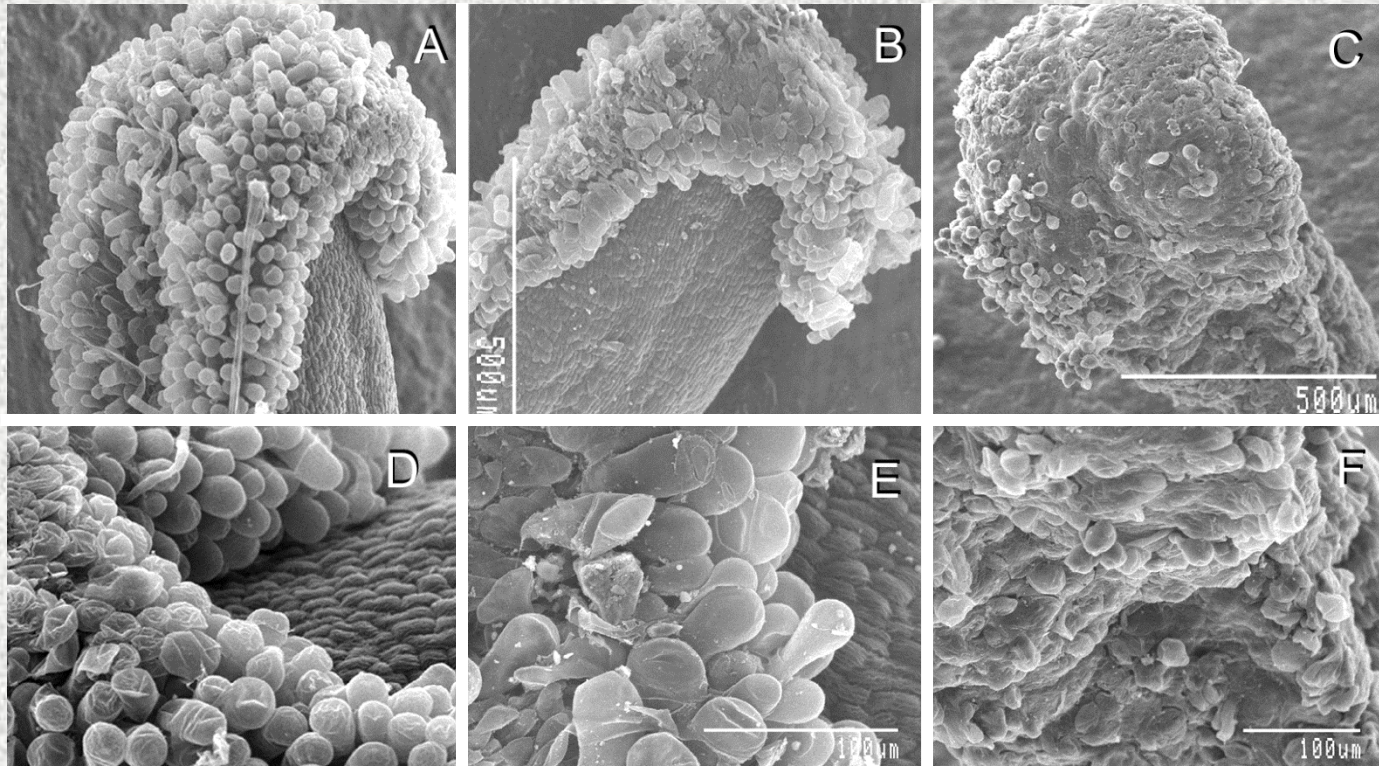


Erwinia amylovora (Ea) on flower stigma

CFU per day
(x 100,000)



Flower stigma age and bacterial colonization



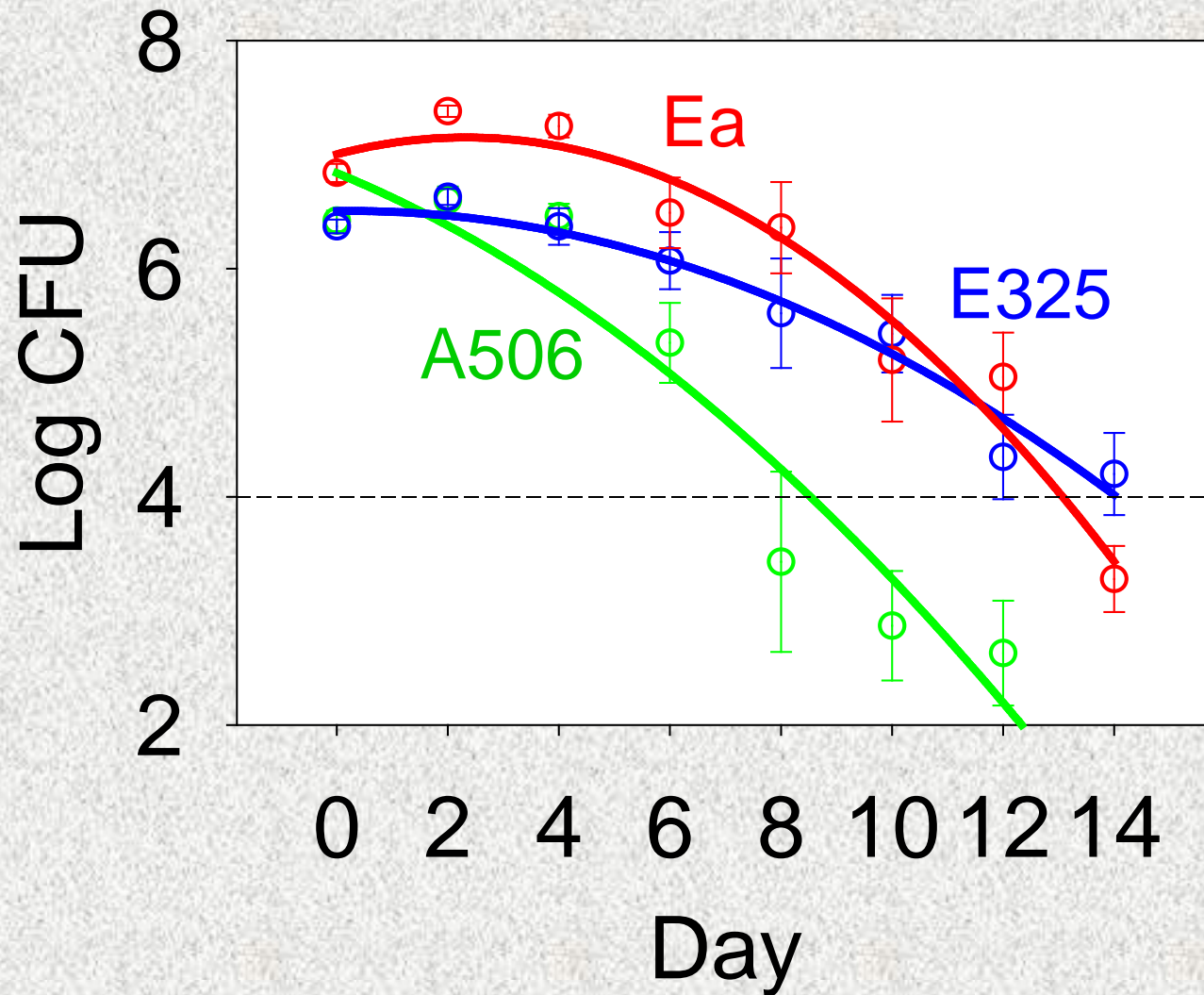
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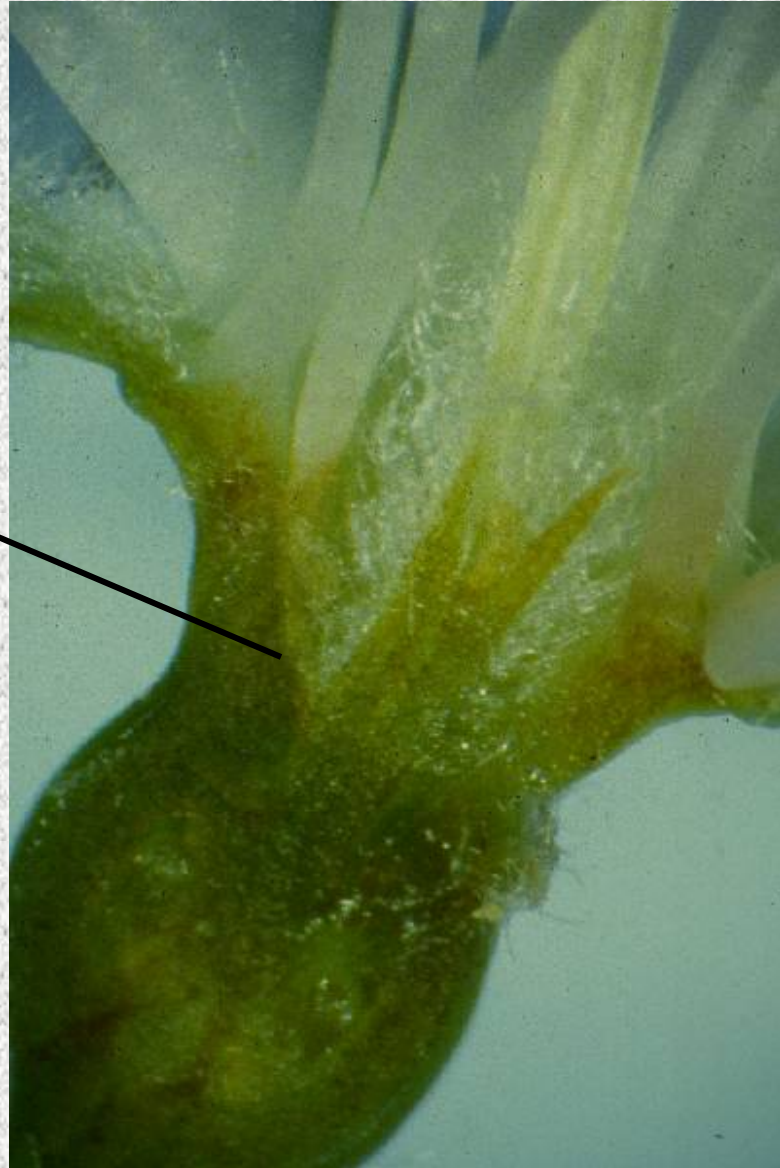
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Days

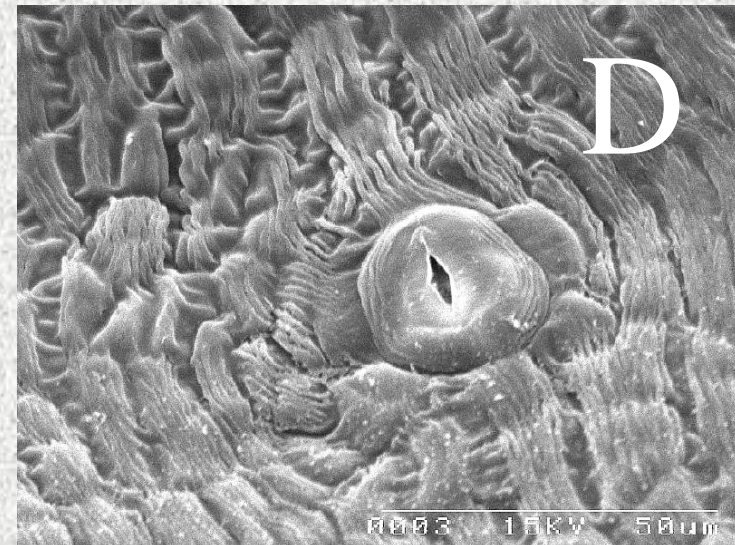
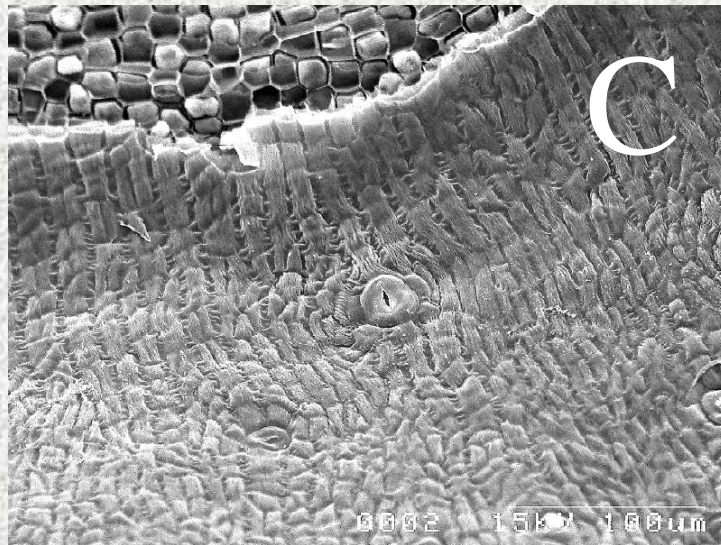
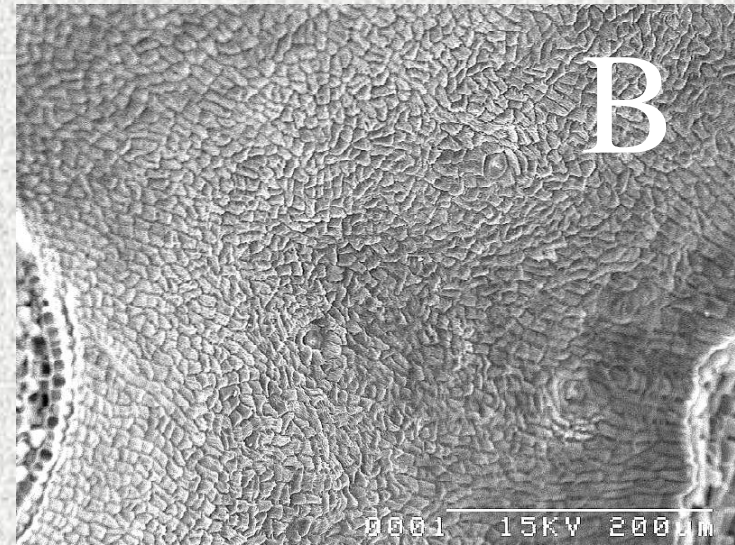
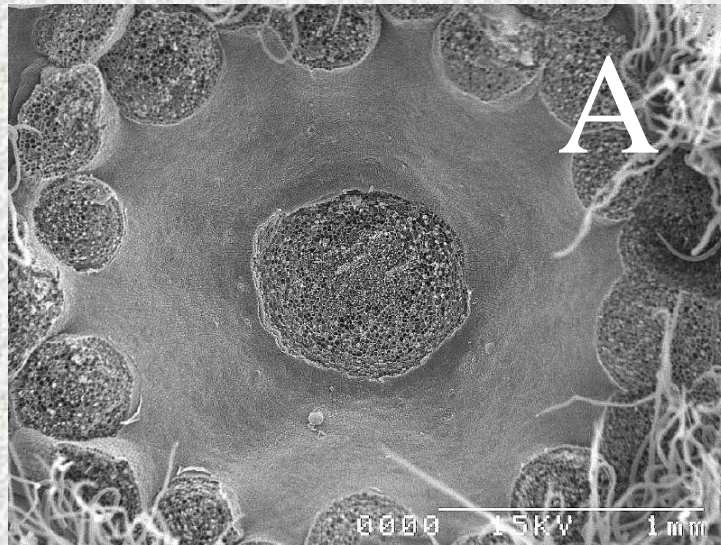
Ea and beneficial bacteria on 'Gala' stigmas related to flower age



Hypanthium

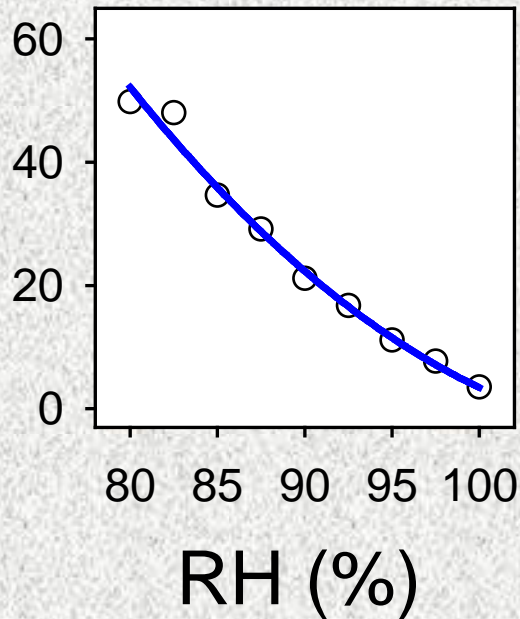


Hypanthium

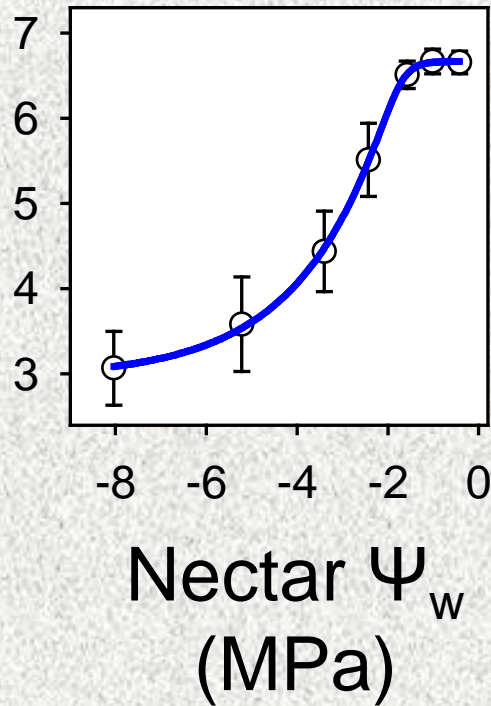


Water relations and Ea in hypanthium

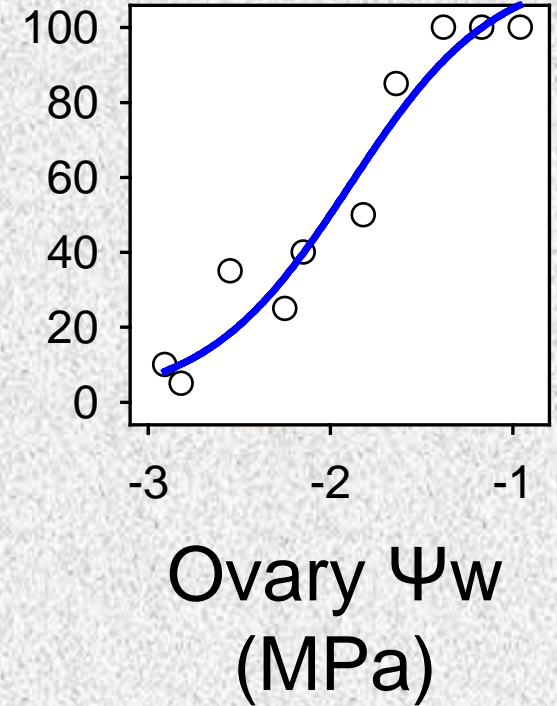
Nectar
Sugar (%)



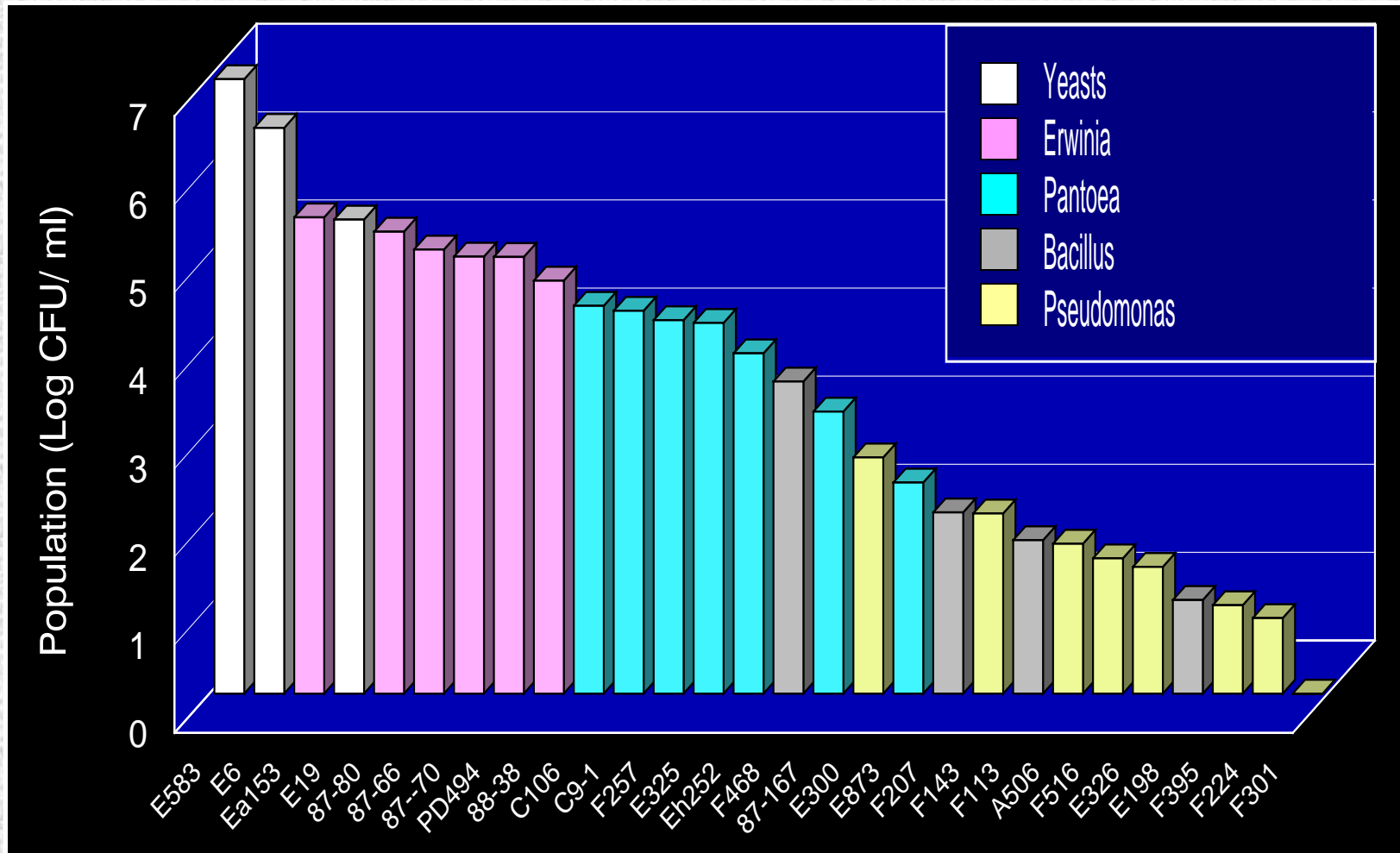
Population
(Log CFU)



Disease (%)



Growth of microbial strains in synthetic nectar (25% sugar)



Survey of natural microbial populations on 'Gala' flowers





Bacteria and yeast genera on apple flowers

Bacteria

Acinetobacter	Micrococcus
Actinobacterium	Pantoea
Aeromicrobium	Paenibacillus
Arthrobacter	Pectobacterium
Bacillus	Pseudomonas
Cellulomonas	Ralstonia
Clavibacter	Rhodococcus
Curtobacterium	Rhizobium
Erwinia	Stenotrophomonas
Kocuria	Variovorax
Microbacterium	

Yeasts

(or yeast-like)

Aureobasidium
Cryptococcus
Pichia
Rhodotorula
Starmerella



Crab apple laboratory model





Screening microorganisms for potential use in biological control



Bacteria and yeast genera on apple flowers

Bacteria


Acinetobacter	Micrococcus
Actinobacterium	Pantoea (1)
Aeromicrobium	Paenibacillus
Arthrobacter	Pectobacterium
Bacillus	Pseudomonas (2)
Cellulomonas	Ralstonia
Clavibacter	Rhodococcus
Curtobacterium	Rhizobium
Erwinia	Stenotrophomonas
Kocuria	Variovorax
Microbacterium	

Yeasts

(or yeast-like)

Aureobasidium (2)
Cryptococcus (1)
Pichia
Rhodotorula
Starmerella

***Red indicates highest ranked groups in screening assays**



Adaptability of bacteria and yeasts on flower tissues

Bacteria

- Stigma
- Young flowers

Yeasts

- Hypanthium
- Old flowers

Practical implication

- Bacterial biocontrol agents should be applied beginning in early bloom
- Application of yeasts may be delayed



Proposed future strategies

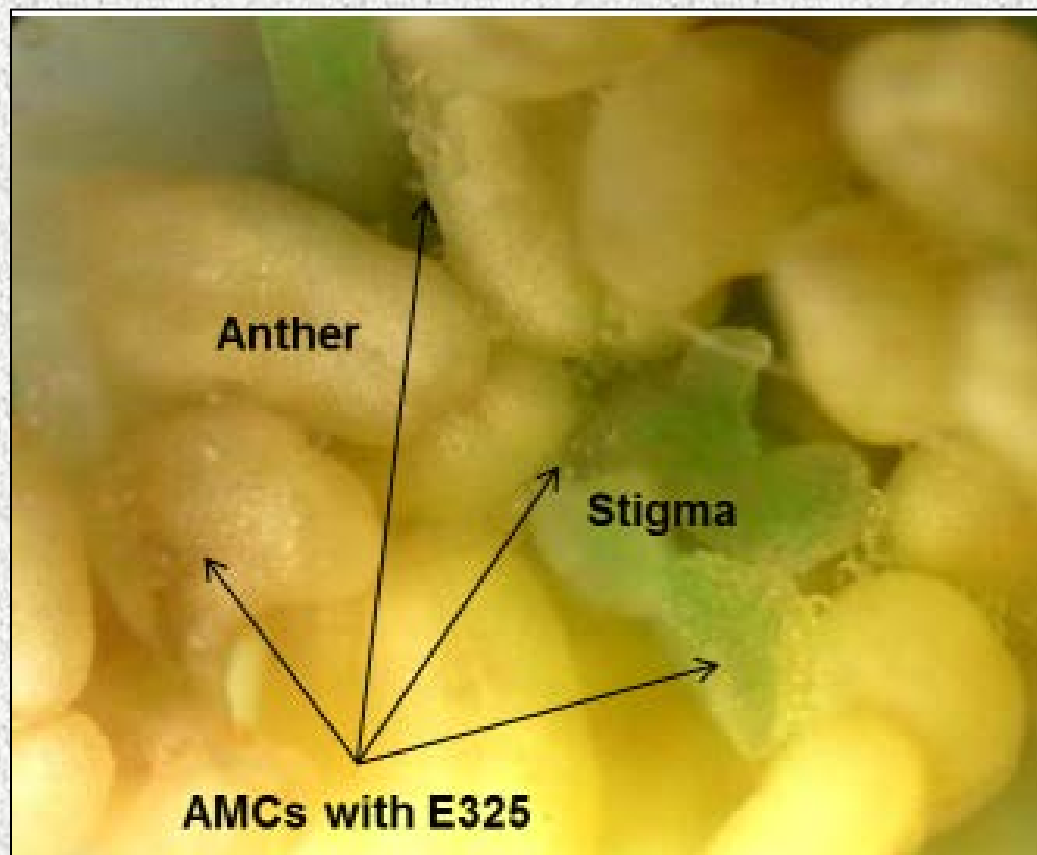
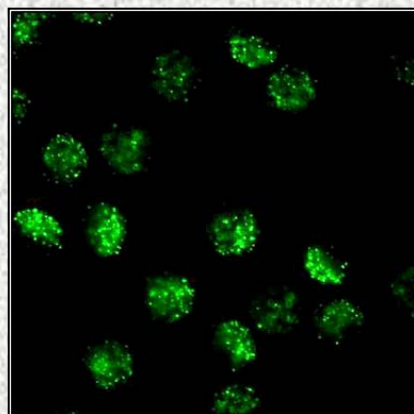
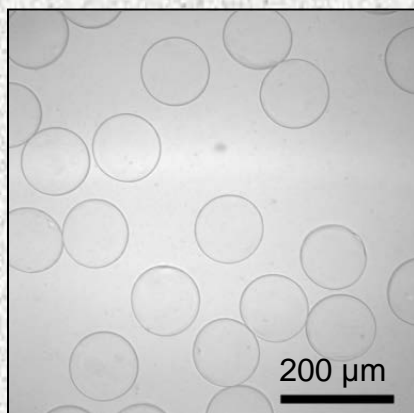
- I. Bacterial biocontrol
- II. Yeast biocontrol
- III. Integrated management

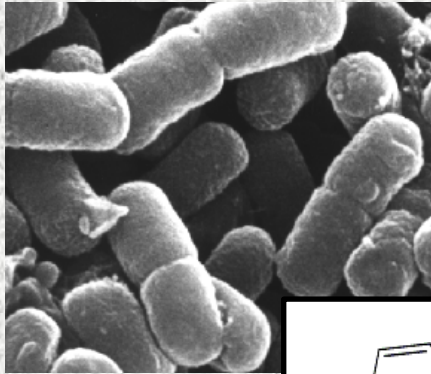


I. Bacterial biocontrol

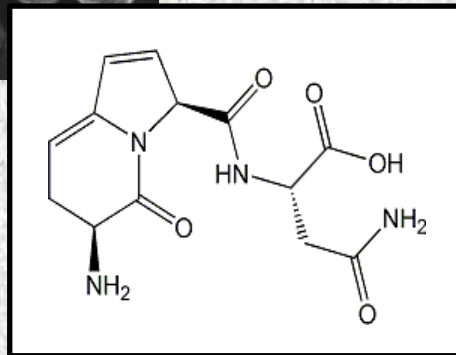
Microencapsulation to improve survival and dispersal

Collaborators: K. Kim & H. Choi, Univ. Illinois



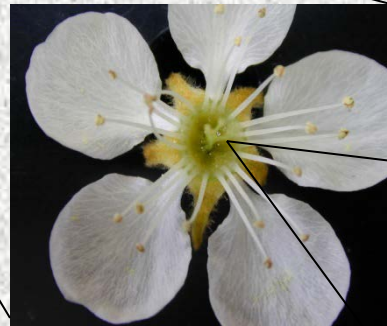


Exploit metabolites

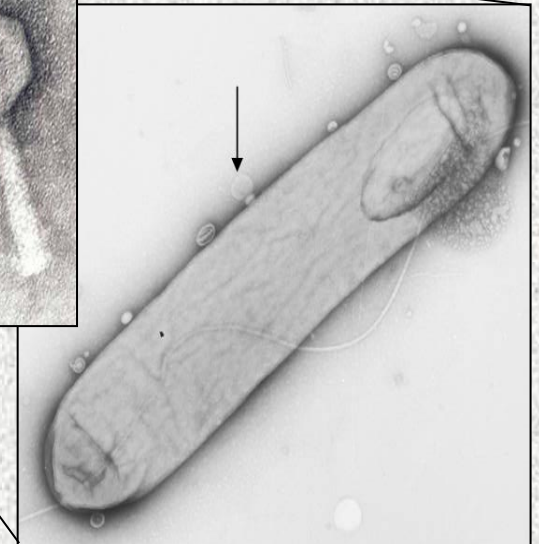


Exploit bacteriophages

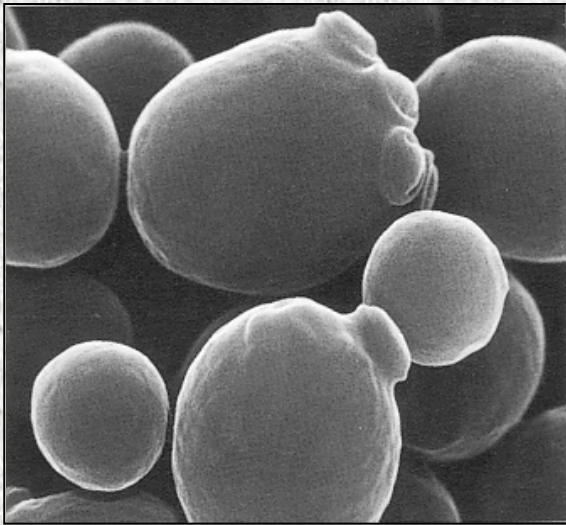
Collaborator: A. Svircev, AAFC, Ontario



Phage + carrier

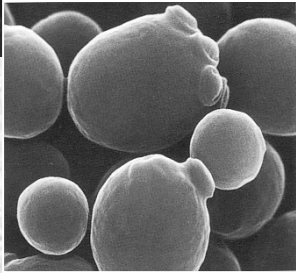
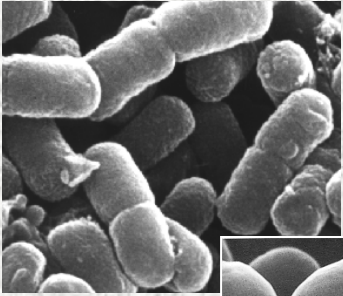


Carrier
bacterium is
Pantoea
agglomerans



II. Yeast biocontrol

- Hypanthium screening
- Assess osmotolerance
- pH consideration



III. Integrated management

- Complementary biocontrol
- Agents with antibiotic-like activity (e.g., AMPs)
- Plant resistance inducers

