




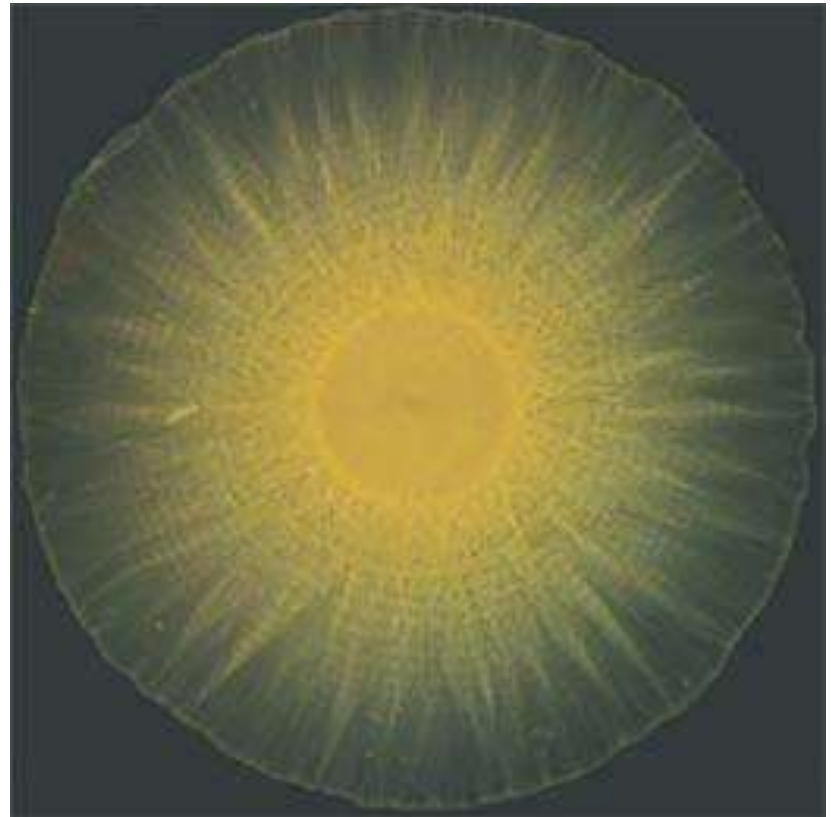
Myxobacteria as Biocontrol Agents of Agricultural Plant Pathogens

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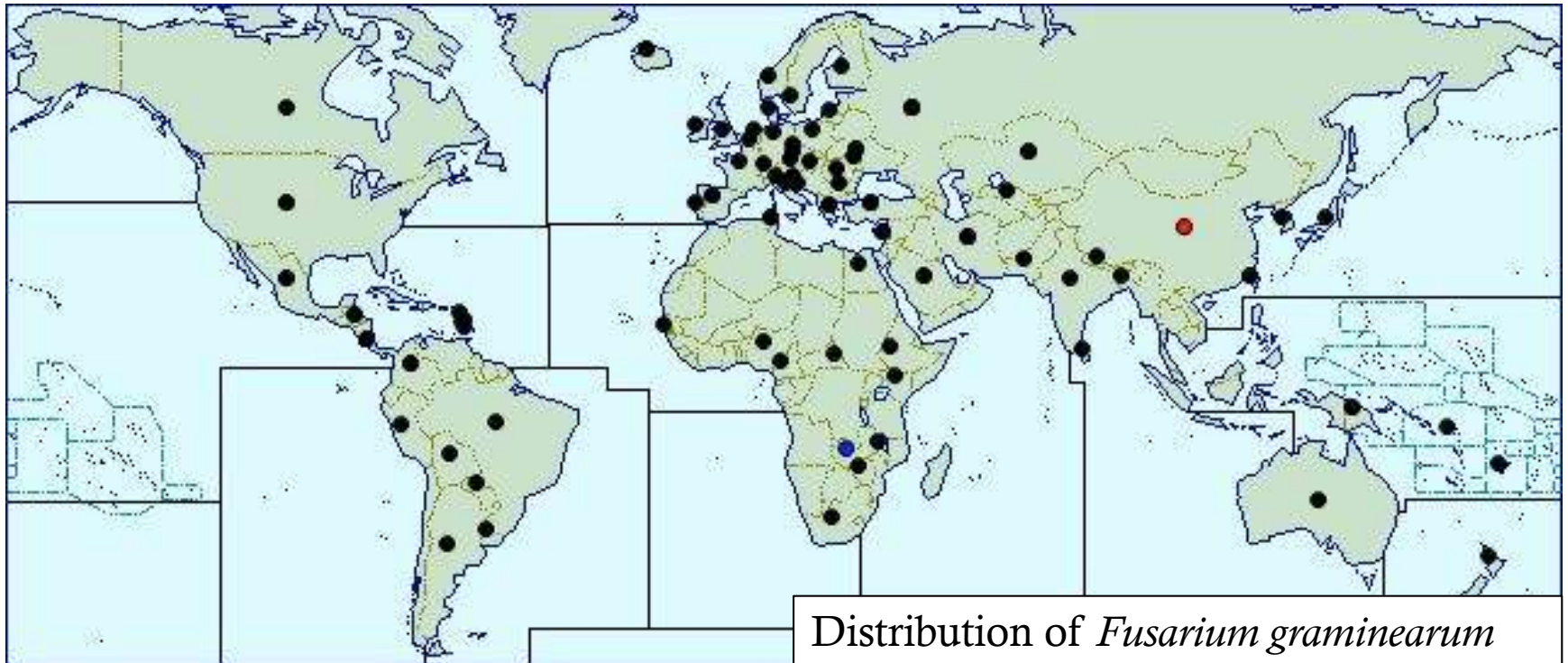
Myxobacteria

- Soil microbes
- Display unique “swarming” motility
- Predate on other microbes
- Produce a wide range of antibiotics and other secondary metabolites



Juergen Berger / Science Photo Library

Plant Pathogens



- Microbial plant pathogens account for approximately \$30 billion in losses per year in the US alone -Pimental, et al. 2000. BioScience 50. 53.

Microbial Consortia Can Protect Plants from Pathogens

- Microbiome plays a role in protecting plants from their pathogens
- Protection occurs in nature and is commercially used (ex. *Coniothyrium minitans*)

PROTECTED



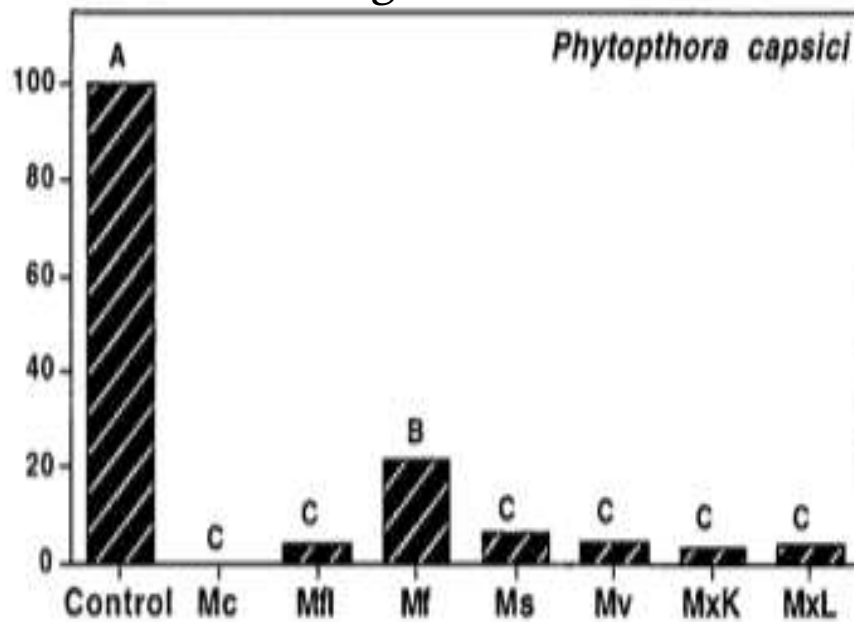
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Myxobacteria Kill and Inhibit Other Organisms

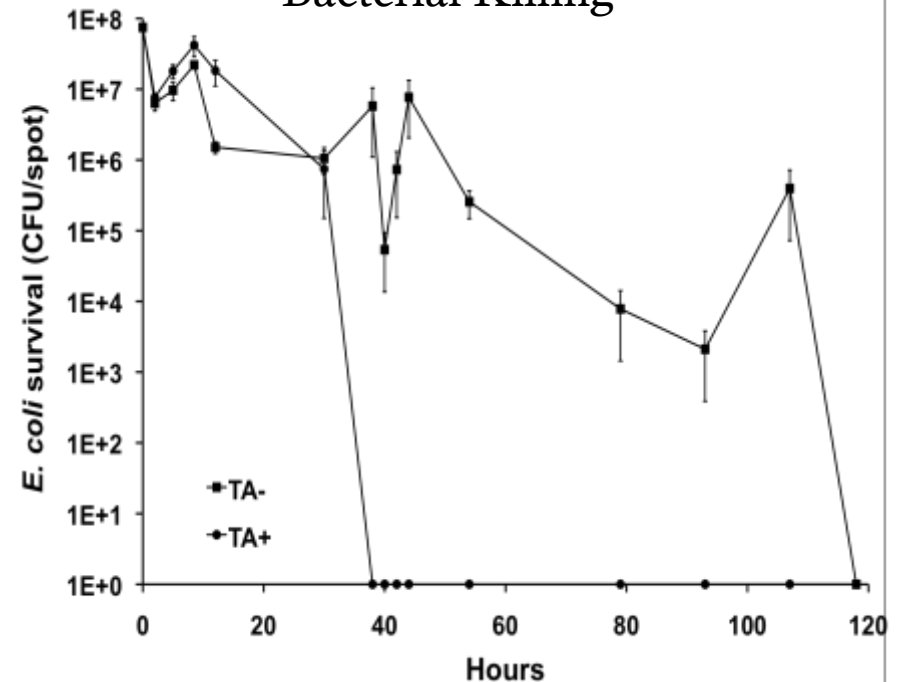
- A wide range of myxobacteria species affect fungi and bacteria.

Fungal Inhibition



Bull, et al. 2002. Plant Disease 86, 889.

Bacterial Killing



In Press. Xiao et al. 2011. Journal of Bacteriology

Bacterial Plant Pathogens

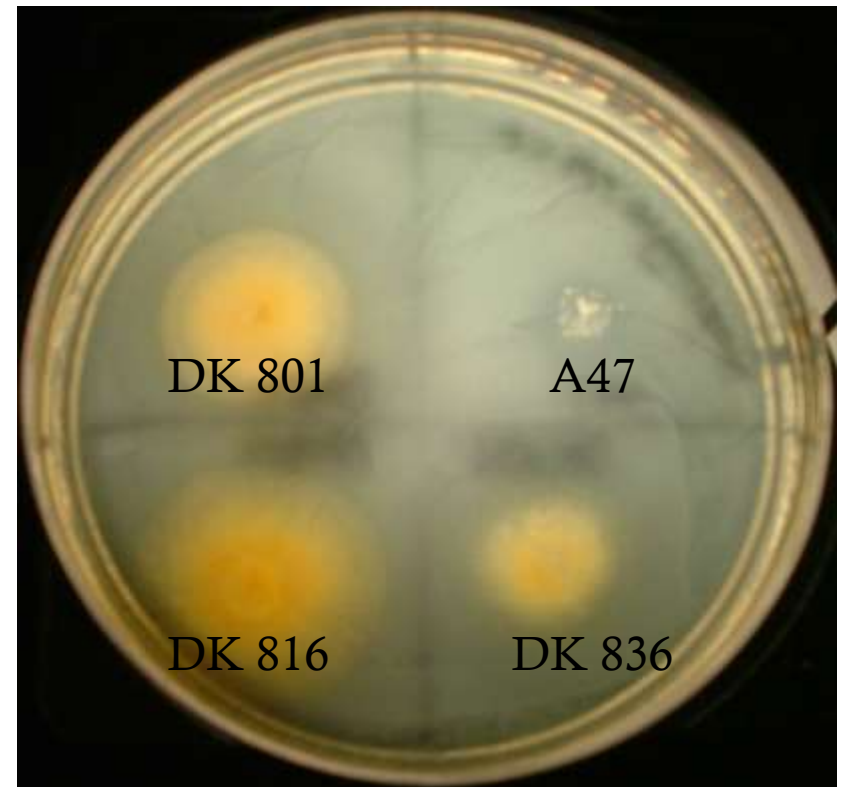


Bacterial spot of pepper and tomato
Ritchie, D.F. 2000. *The Plant Health Instructor*.

- *Erwinia carotovora*
- *Pseudomonas syringae*
- *Xanthomonas campestris*

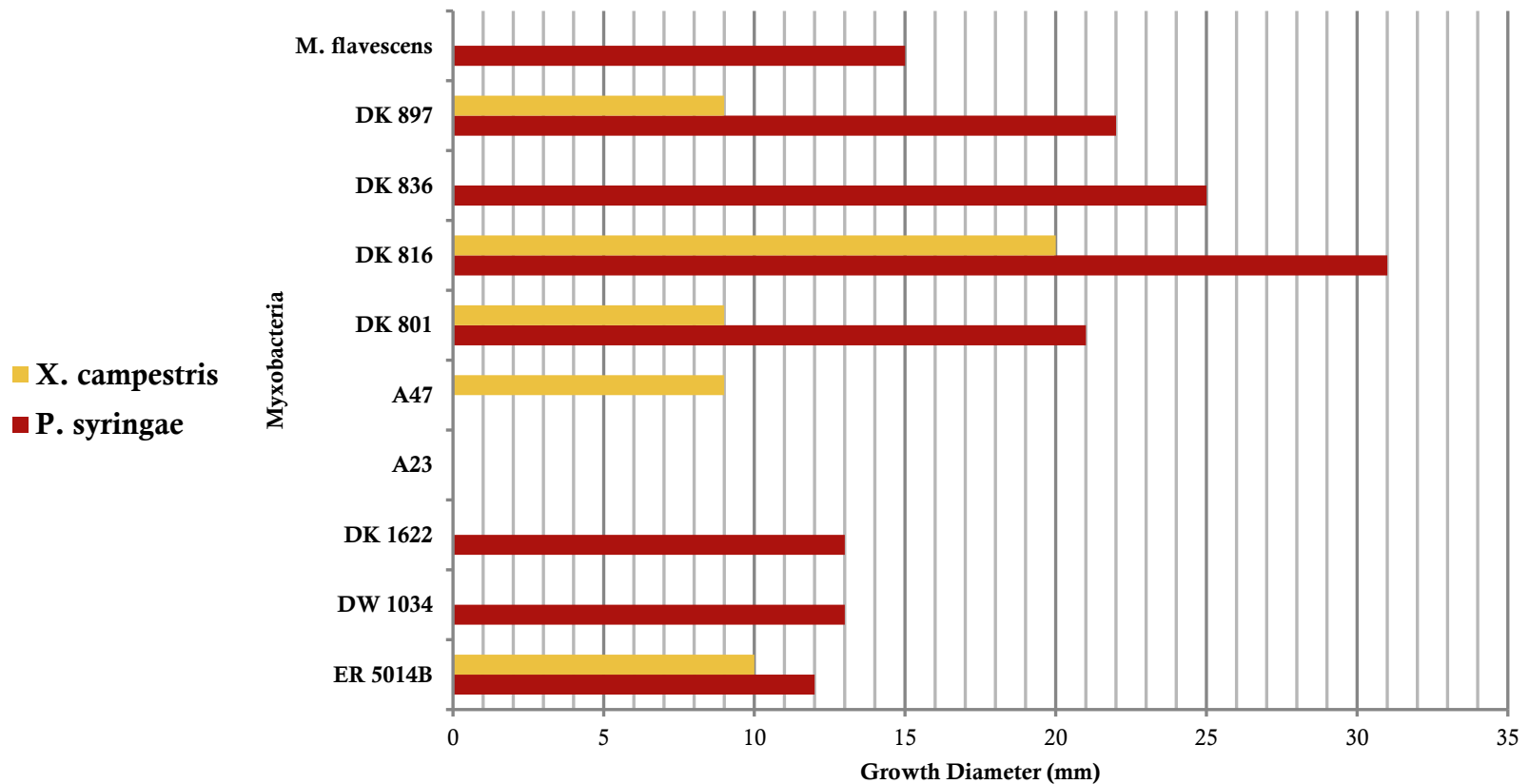
Swarm Expansion on Prey Lawn

- Panel of myxobacteria spotted on pathogenic bacteria lawns
- Myxobacteria capable of predation swarm over plate



Quantitative Analysis

Myxobacterial Growth on Bacterial Lawns- 10 days



Fungal Plant Pathogens

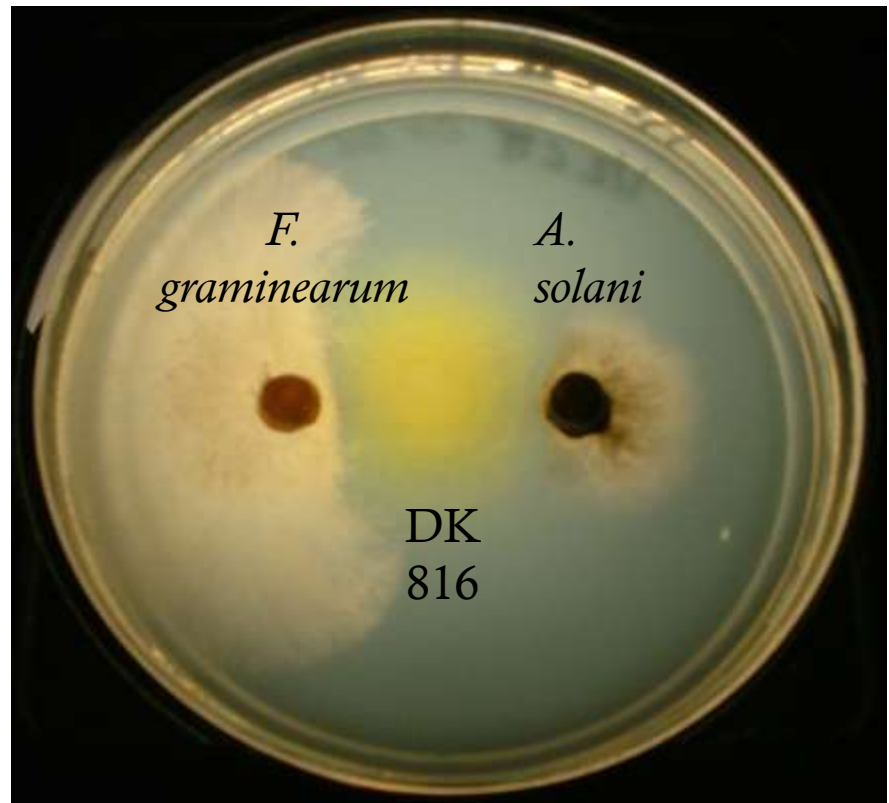
- *Alternaria solani* (AS12B)
- *Cercospora beticola* (08-128 & 09/1-34)
- *Fusarium culmorum* (F03-47)
- *Fusarium equiseti* (F04-24)
- *Fusarium graminearum* (F04-22)
- *Fusarium oxysporum* (F04-30)
- *Rhizoctonia solani* (L8)

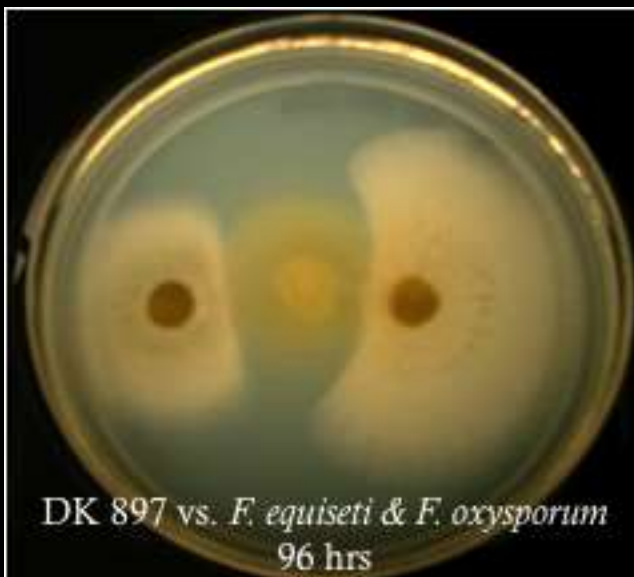


Early blight of potato and tomato
Kemmitt 2002. APS net.

Fungal Inhibition

- Myxobacteria that cannot inhibit fungal growth become completely overrun
- When myxobacteria show inhibition, it is one of two types:
 - Diffusible Factors
 - Contact Dependent





DK 897 vs. *F. equiseti* & *F. oxysporum*
96 hrs



DK 1622 4530 KO vs. *C. beticola* & *C. beticola*
3 weeks



DK 897 vs. *C. beticola* & *C. beticola*
3 weeks



DK 1622 4530 KO vs. *F. culmorum* & *R. solani*
96 hrs



M. flavescens vs. *F. culmorum* & *R. solani*
96 hrs



C. corralloides vs. *F. equiseti* & *F. oxysporum*
96 hrs

■ = Inhibition ■ = No Inhibition ■ = Inconclusive

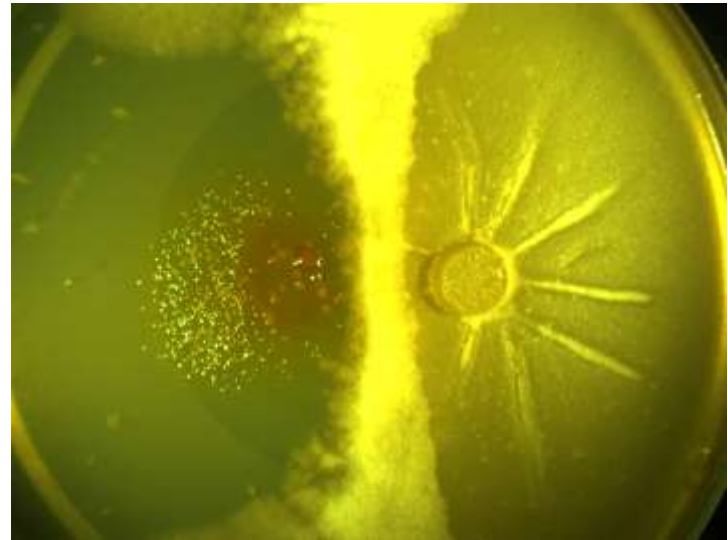
Fungi

	<i>A. solani</i>	<i>C. beticola</i> 08-128	<i>C. beticola</i> 09/1-34	<i>F. culmorum</i>	<i>F. equiseti</i>	<i>F. graminearum</i>	<i>F. oxysporum</i>	<i>R. solani</i>
<i>P. aeruginosa</i>	+	+++	+++	+	++	-	++	-
DK 1622 4530 KO	+	+++	+++	-	-	-	-	-
DK 1622	+	+++	+++	-	+	-	-	-
DK 801	+	+++	+++	?	++	+	++	-
DK 816	++	+++	+++	+	+++	++	+++	+
DK 836	++	+++	+++	+	++	++	++	+
DK 897	++	+++	+++	+	++	+	++	+
<i>C. corralloides</i>	+	++	++	-	-	-	-	-
<i>M. flavescens</i>	+	++	++	+	+	++	++	-

Bacteria

Secondary Metabolite Knockouts

- 18 mutants defective in secondary metabolite function screened
- None showed defect in inhibiting fungal growth

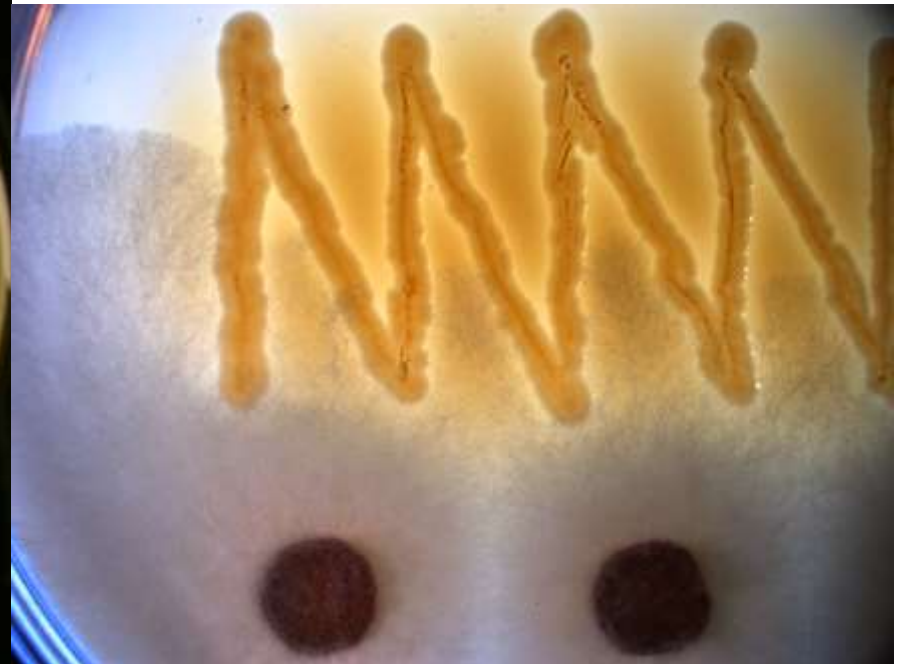


Contact Dependency

Fungi does not grow into highest concentration gradient, nor does it grow over myxobacteria.

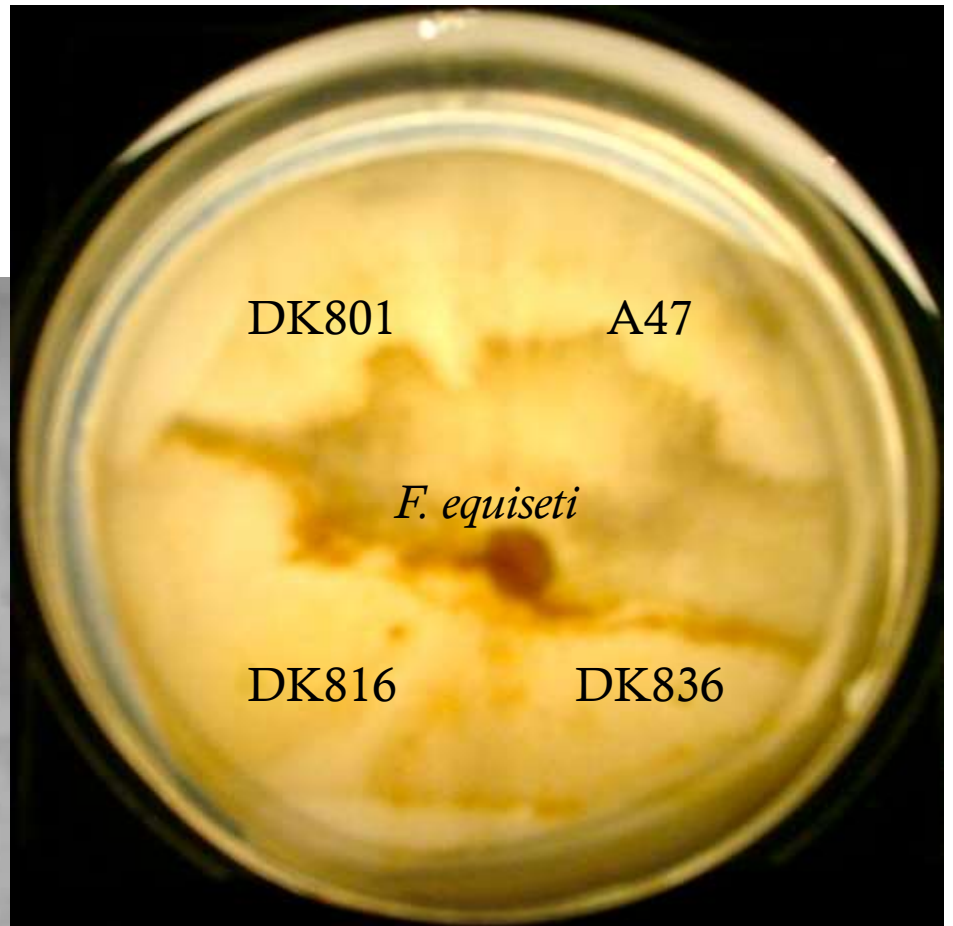
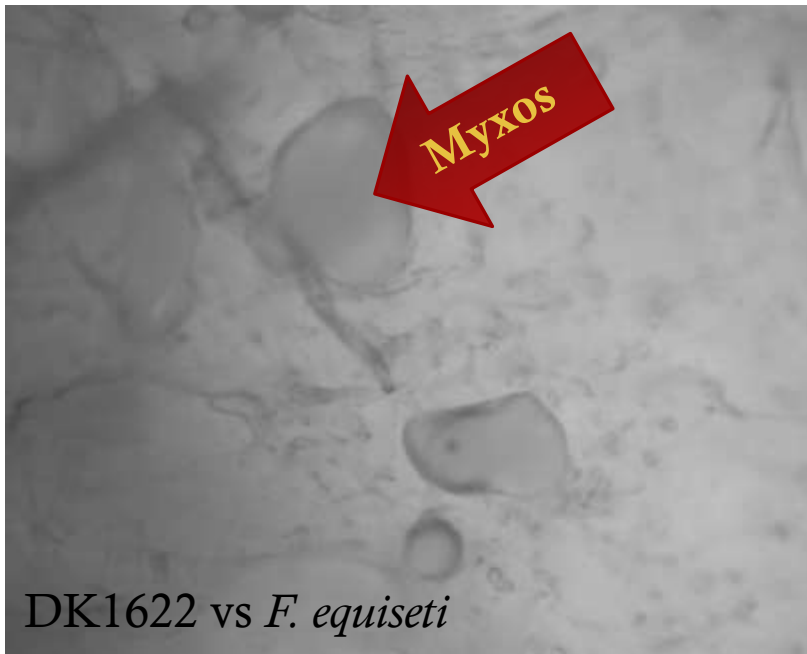


DK 6204 vs *F. culmorum*



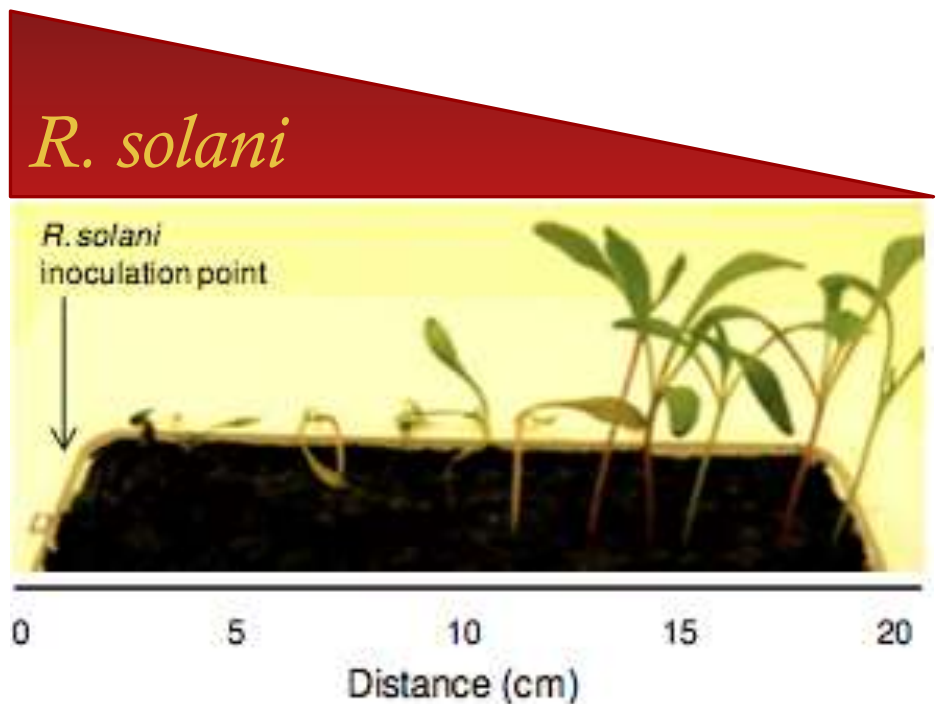
Predation of Fungi

Myxos can inhibit growth, persist, and presumably predate on fungal lawns



Plant Model: Sugar Beets

- Sugar beets (*Beta vulgaris* BTS 66RR60)
- Susceptible to most fungal strains
- Short germination time
- Important agricultural crop in Wyoming



Mendes, et. al. 2011. Science 332. 1097.

Effects on Plants

Sugar Beets



Sugar Beets with *R. solani*



Future Direction

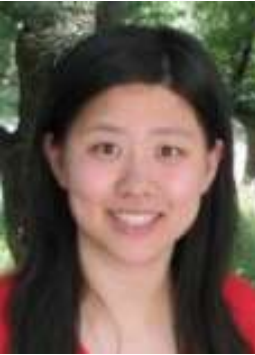
- Test whether myxobacteria can be used as biocontrol agents of plant pathogens
 - Determine whether myxobacteria can predate on fungi
 - Characterization of contact dependent inhibition
 - Plant bioassays testing myxobacteria against pathogens
 - Identification of functional groups involved in protection

Acknowledgements

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