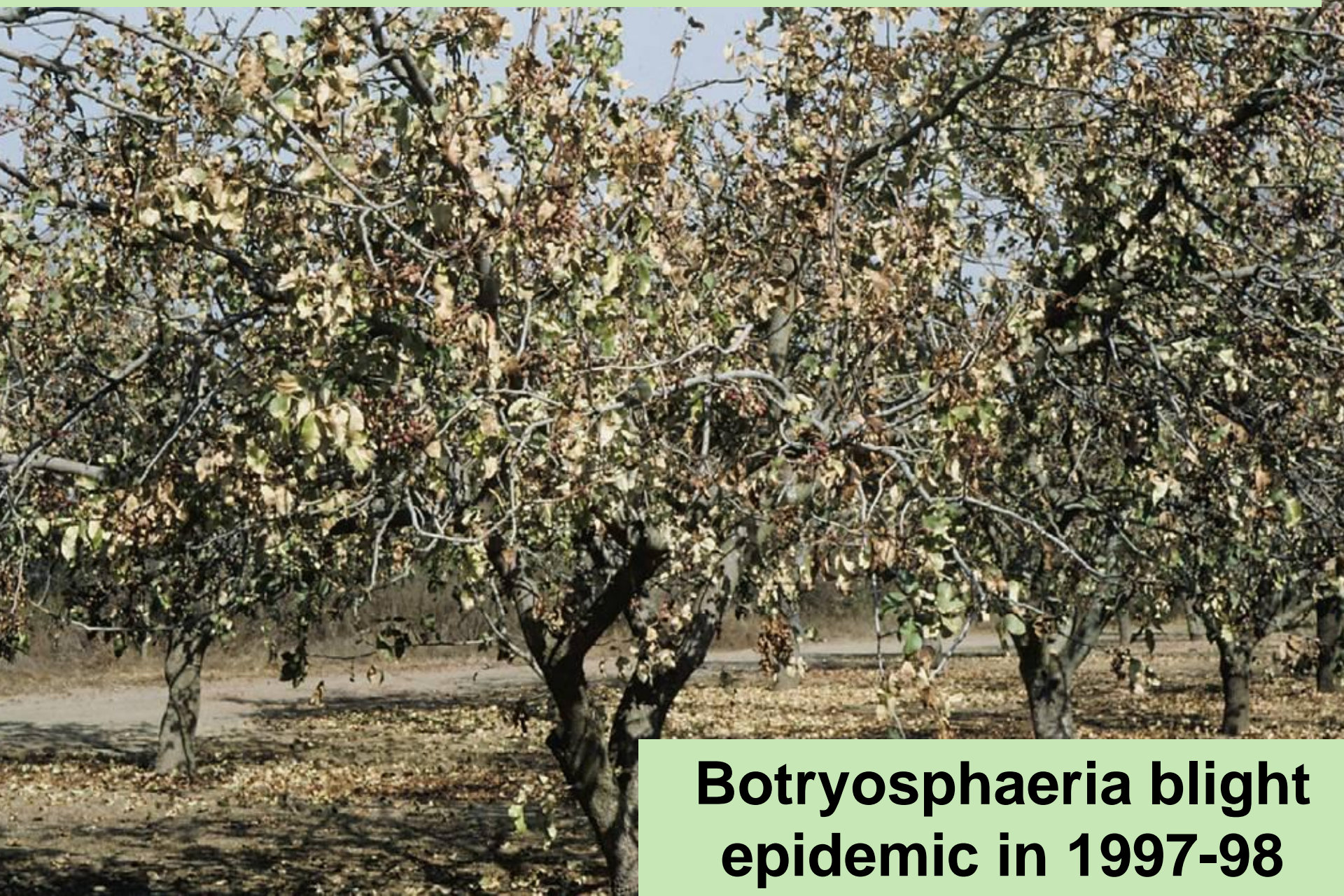


Phomopsis and Botryosphaeria in Walnut

Themis J. Michailides

**Department of Plant Pathology
University of California-Davis
Kearney Agricultural Center**

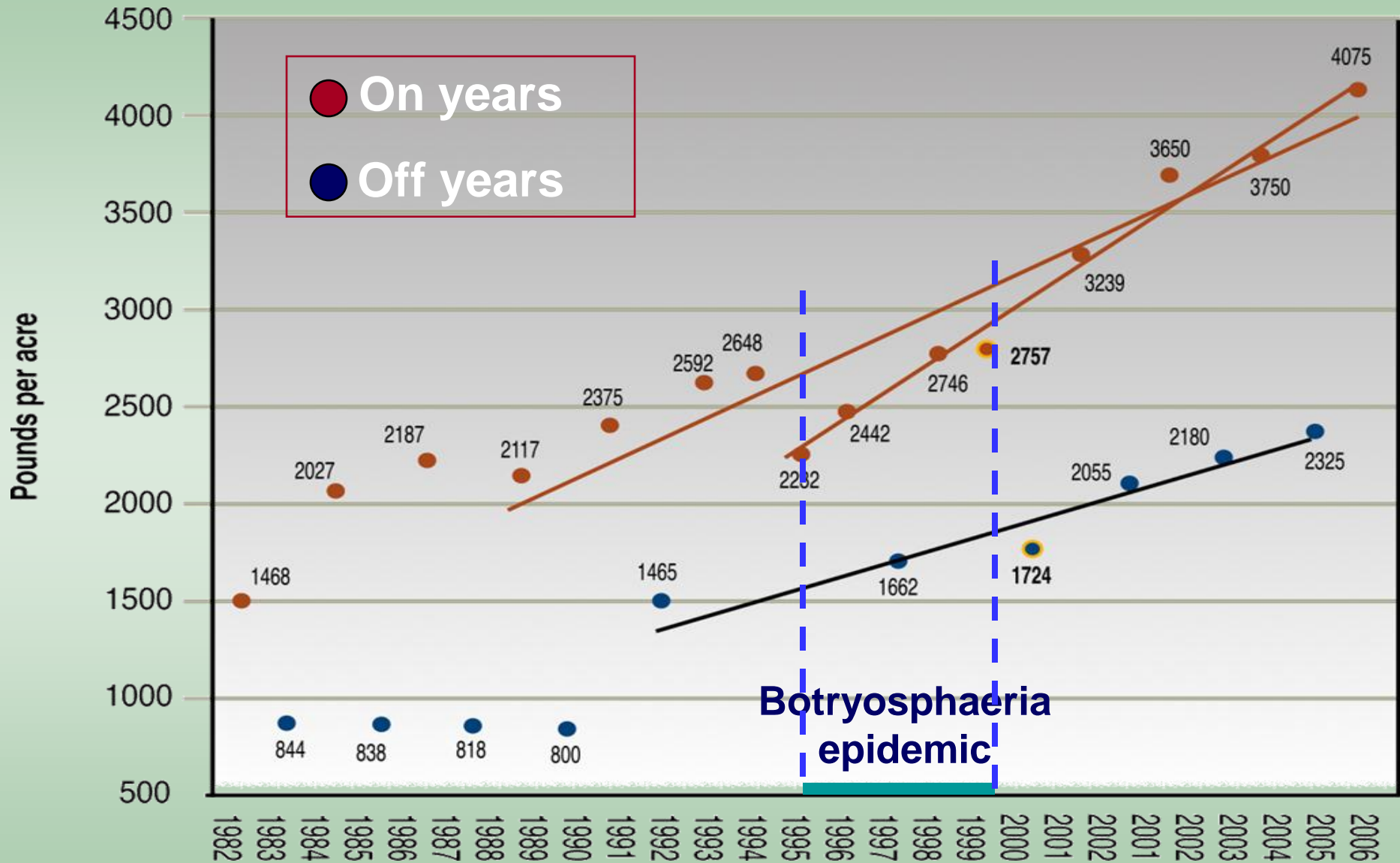
Botryosphaeria panicle and shoot blight



**Botryosphaeria blight
epidemic in 1997-98**



Pistachio yields and Botryosphaeria blight



Botryosphaeriaceae from pistachio



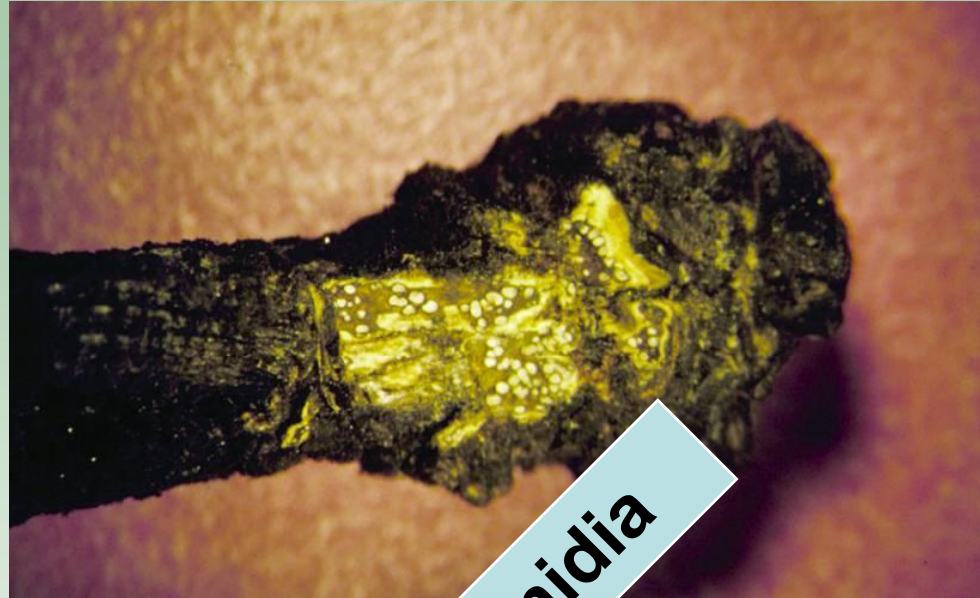
Botryosphaeriaceae on pistachio:

- *Botryosphaeria dothidea*
 - *Neofusicoccum mediterraneum*
 - *Lasiodiplodia theobromae*
 - *Diplodia seriata*
- California**
-
- *Botryosphaeria obtusa*
- South Africa**
-
- *Botryosphaeria dothidea*
 - *Neofusicoccum parvum*
- Greece**

Infection → damage

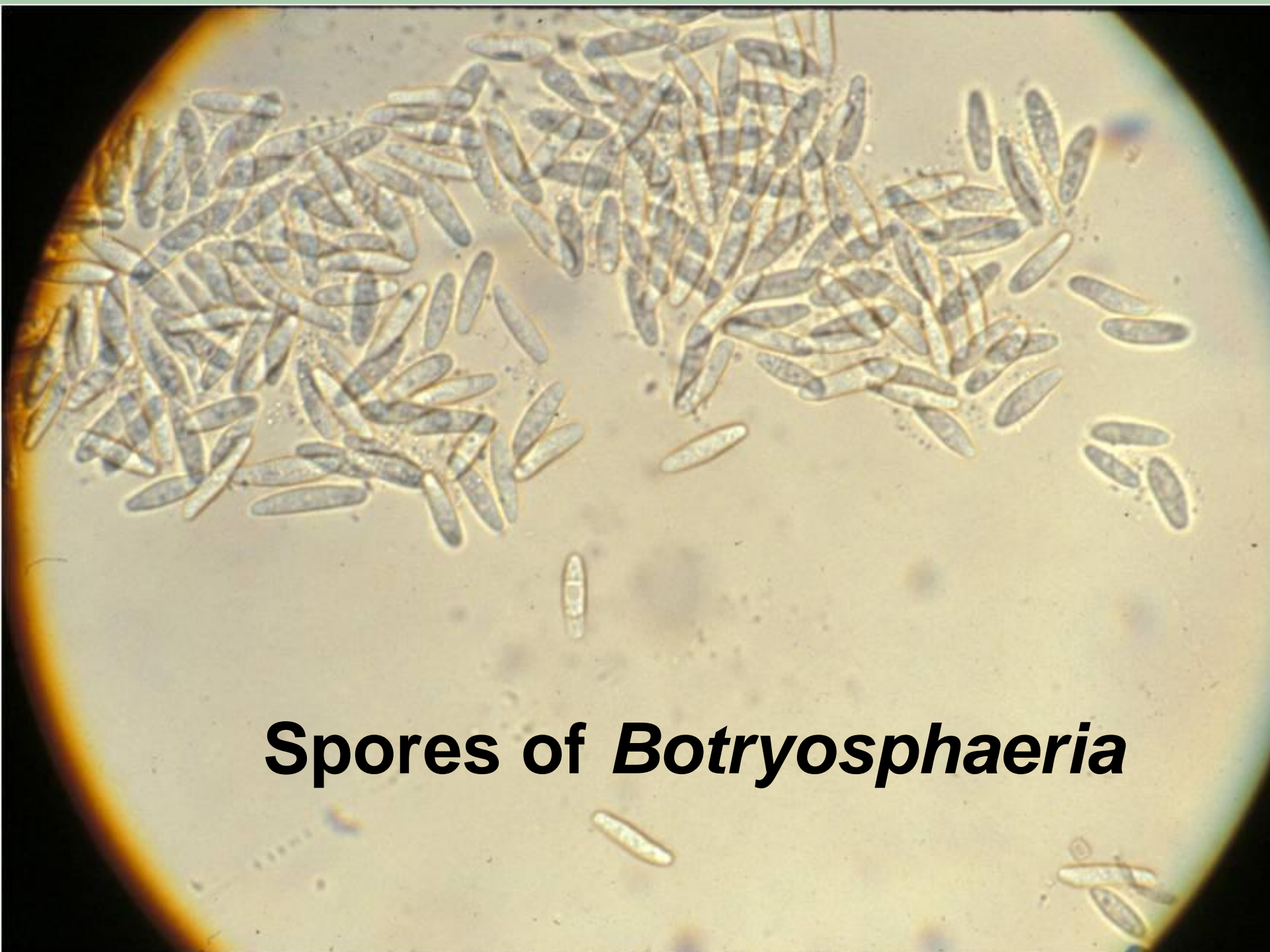


BOT cankers



BOT pycnidia

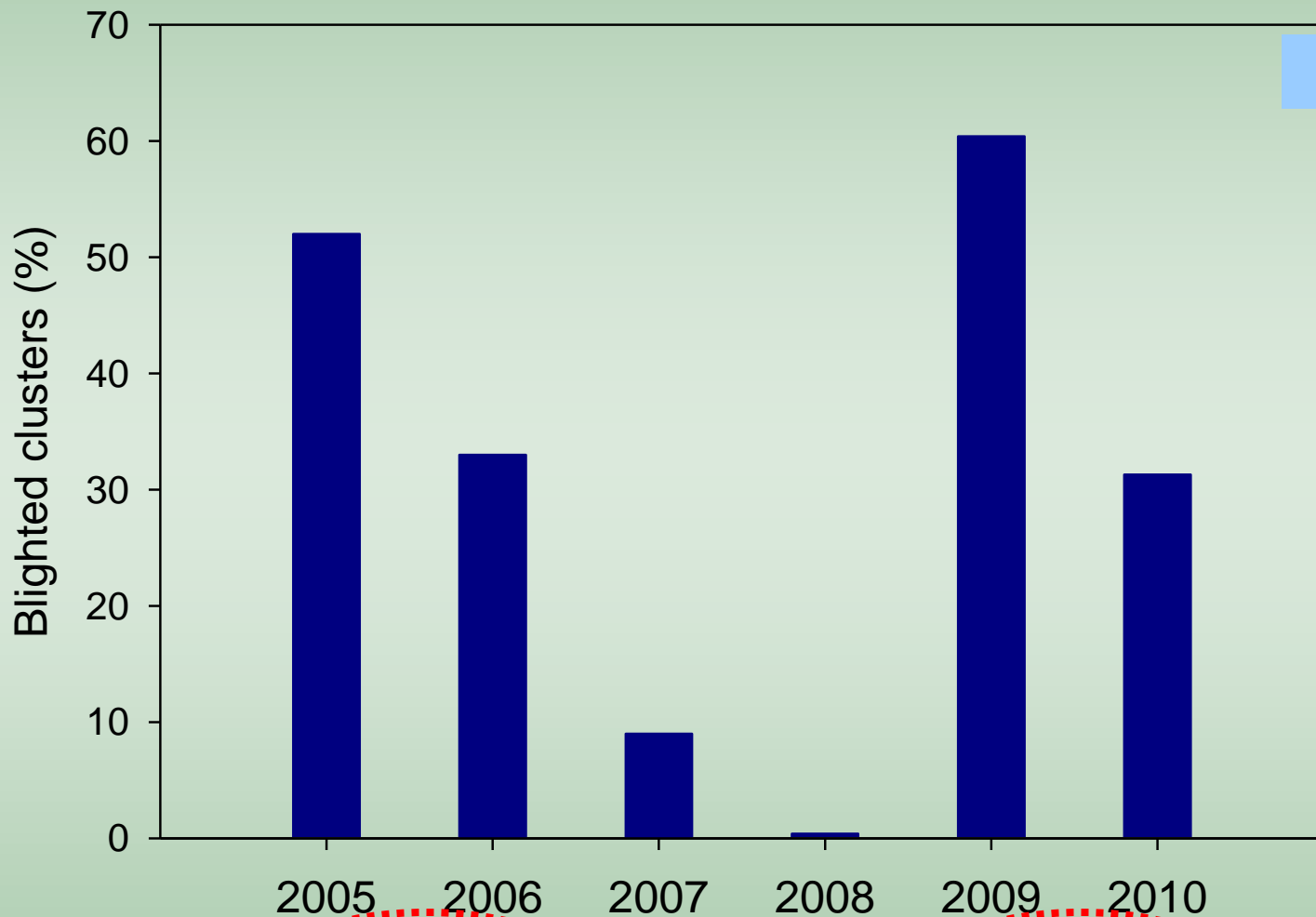




Spores of *Botryosphaeria*



Botryosphaeria blight in an unsprayed orchard (Glenn Co.)



Total rain →

19"

19"

10"

14"

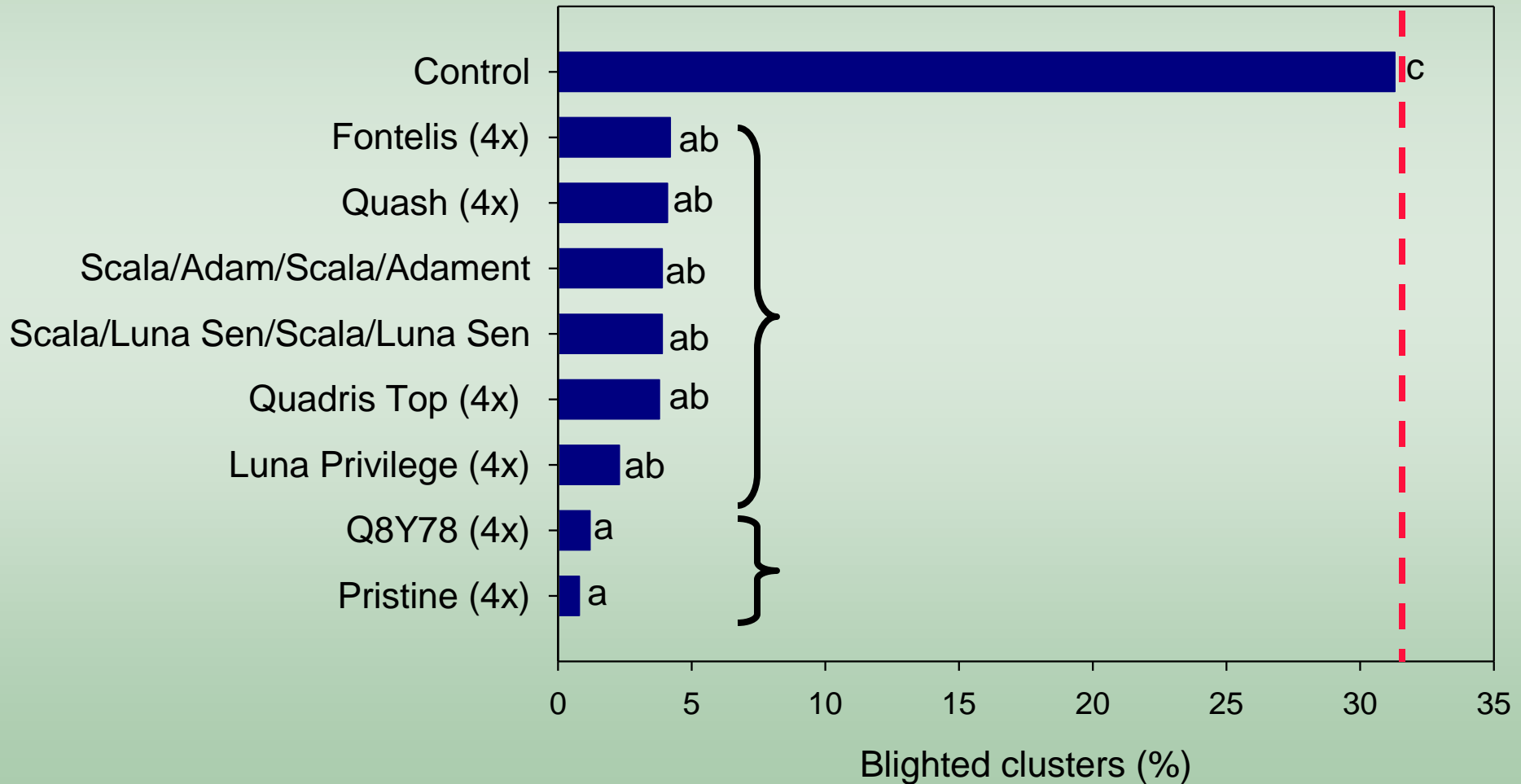
16"

24"

Fungicides registered for Botryosphaeria blight

Fungicide	Active ingredient	Efficacy
Adament.....	Trifloxystrobin+tebuconazole	++
Abound	azoxystrobin	+++
Bravo.....	chlorothalonil	++
Bumper/Tilt.....	propiconazole	++
Cabrio.....	pyraclostrobin	+++
Gem	trifloxystrobin	+++
Quash.....	metconazole	+++
Pristine	boscalid+pyraclostrobin	++++
Quilt-Xcel.....	azoxystrobin+propiconazole	+++
Scala.....	pyrimethanil	+++
Switch.....	cyprodinil+fludioxonil	++
Tebuzol.....	tebuconazole	+++
Topsin-M.....	thiophanate-methyl	++
Copper.....	Copper	+/-

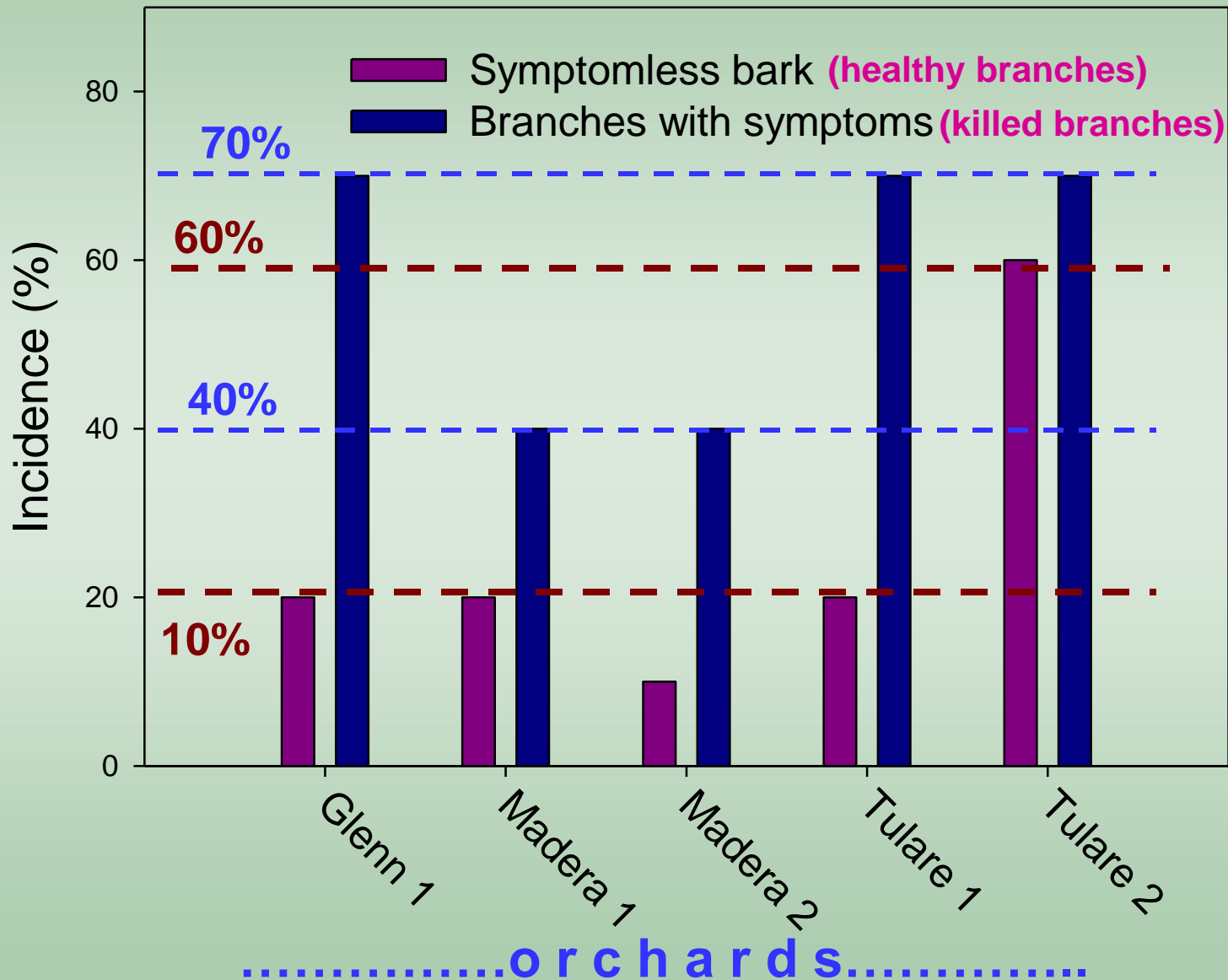
Botryosphaeria blight control – Glenn Co., 2010



Lower limb dieback



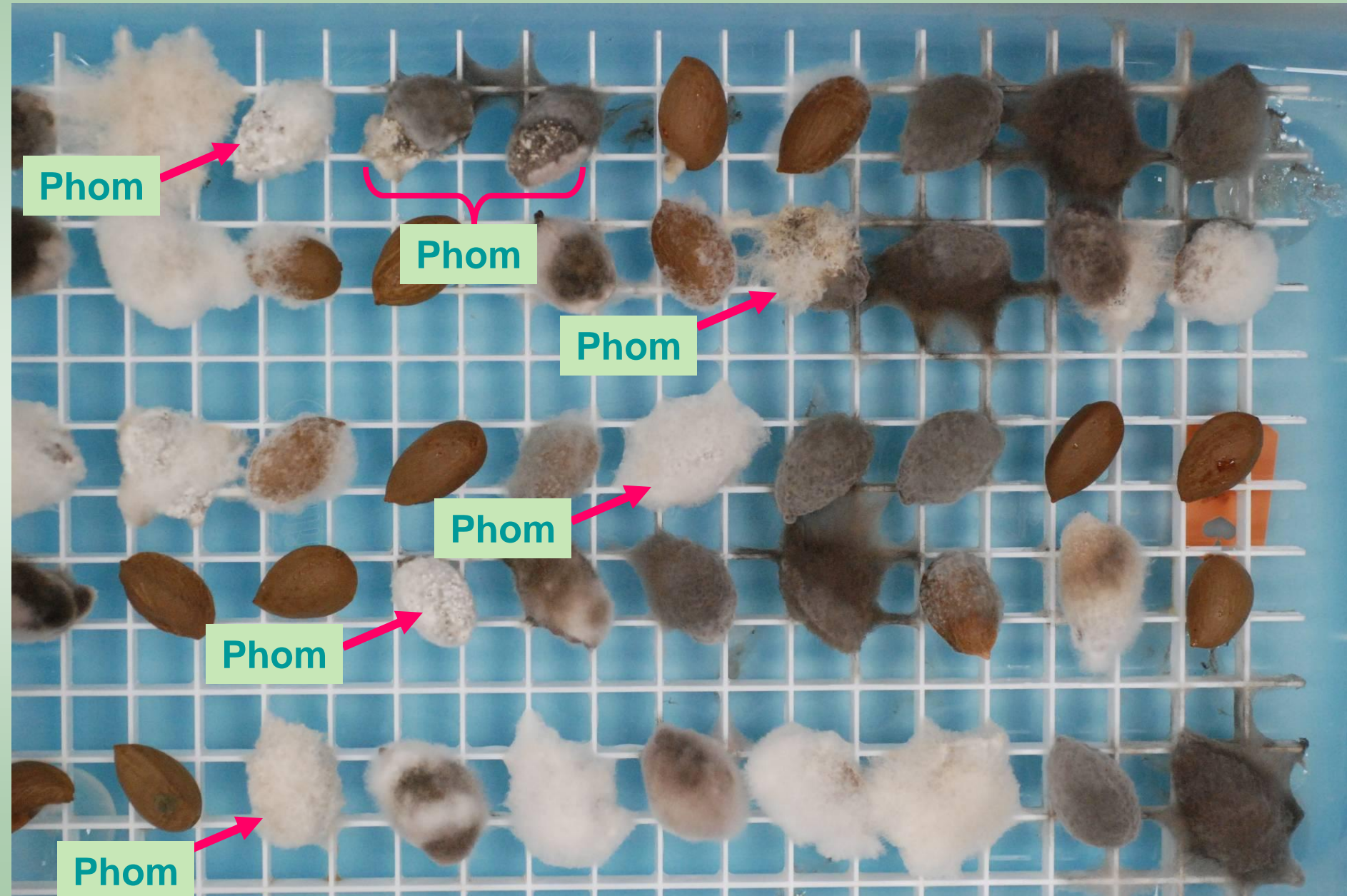
Incidence of *Botryosphaeria* from isolations of bark of pistachio branches of bark of pistachio branches



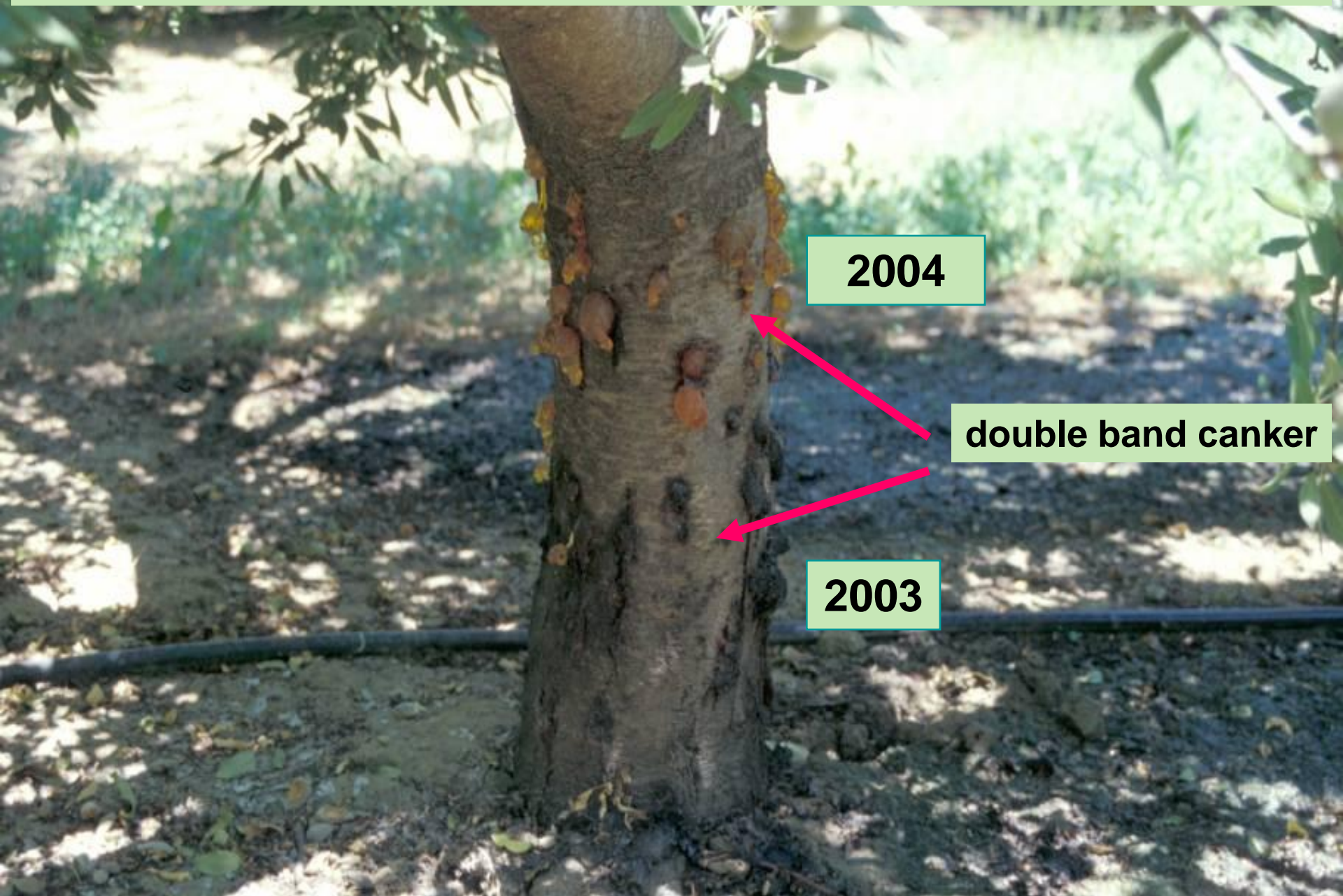


The Sleeping Dragon Syndrome...

Phomopsis on pistachio



Botryosphaeria of almond: band canker



2004

double band canker

2003







Infection of pruning wounds



2008 & 2009

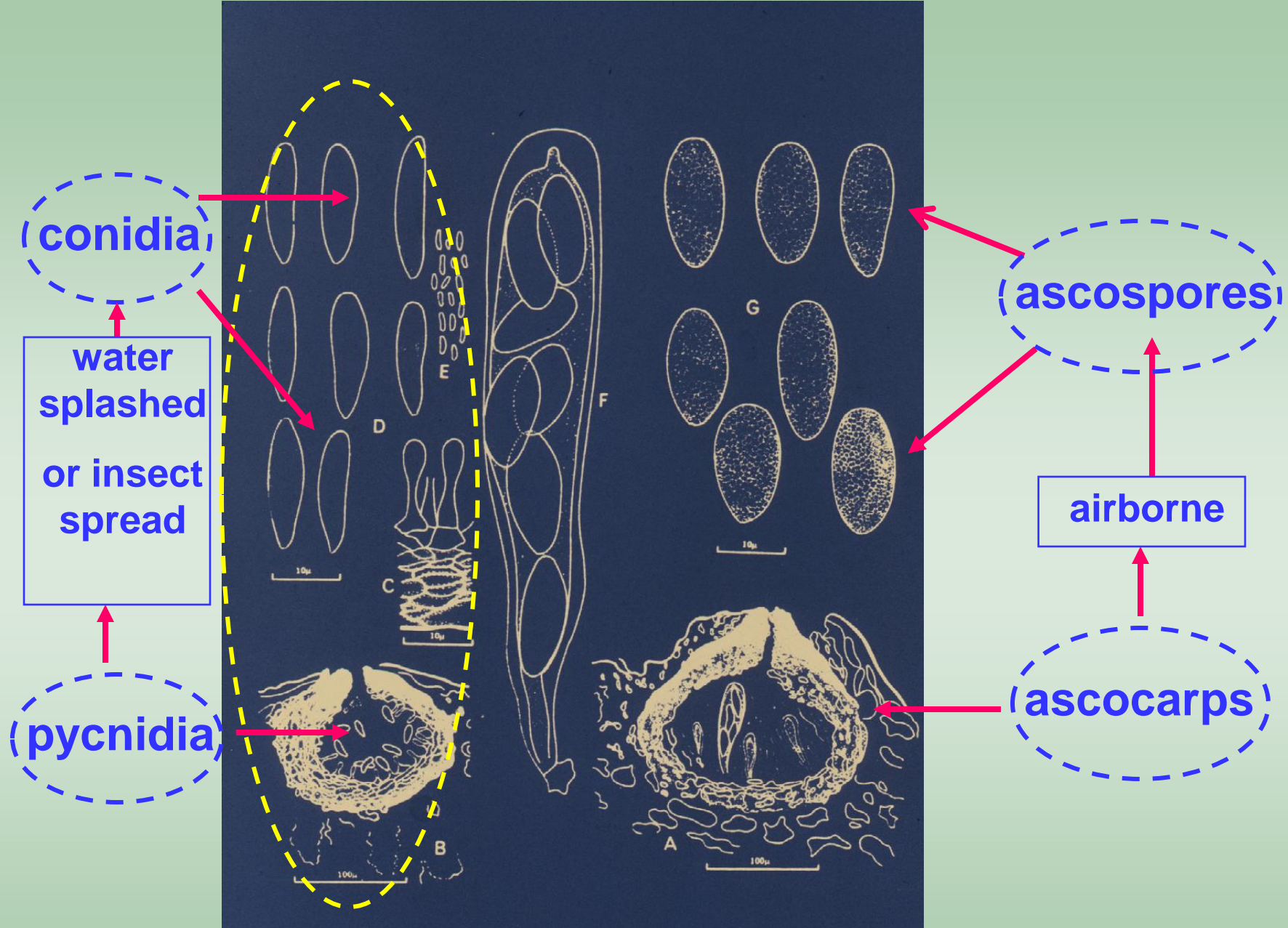


What was known about band canker (1966):

- ✓ Pathogen: *Botryosphaeria dothidea*
- ✓ Disease: Symptoms, pathogenicity, almond varieties

New findings: Pathogen:

- ✓ 8 different *Botryosphaeria* species were identified.
- ✓ Some of these species are similar to *Botryosphaeria* of pistachio, walnut, and other hosts.
- ✓ The same species were found colonizing healthy bark of almonds.
- ✓ Almond can have both airborne and water-splashed spores of *Botryosphaeria*.



***Botryosphaeria dothidea* reproductive structures**

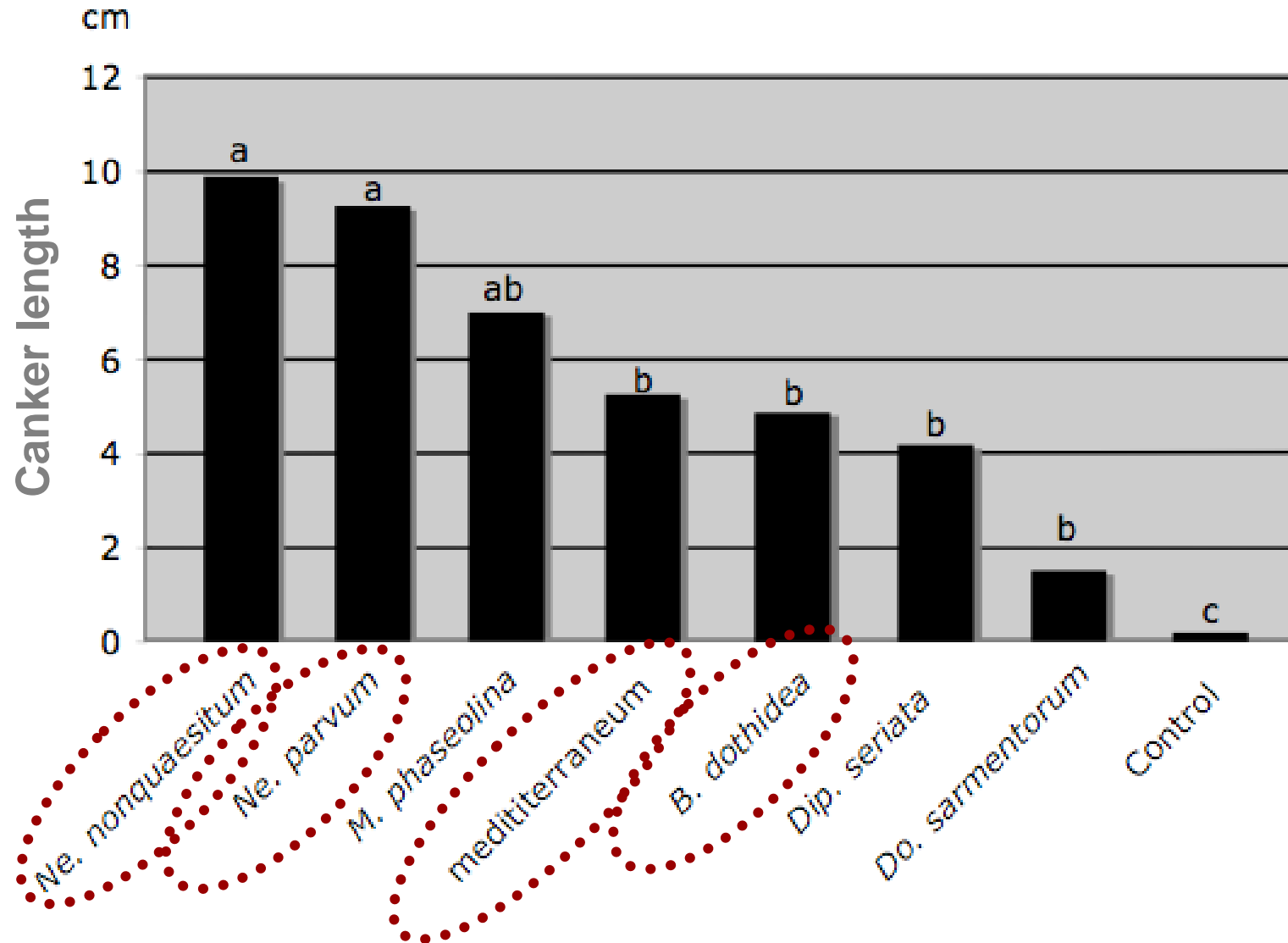
***Botryosphaeriaceae* on almond in California:**

1. *Botryosphaeria dothidea* *
2. *Neofusicoccum parvum* *
3. *Neofusicoccum mediterraneum* *
4. *Neofusicoccum nonquaesitum*
5. *Diplodia seriata* *
6. *Macrophomina phaseolina* *
7. *Dothiorella sarmentorum*
8. *Lasiodiplodia theobromae* *

Almond

*** also on pistachio**

Pathogenicity of various *Botryosphaeriaceae* on almond cv. Padre



New findings:

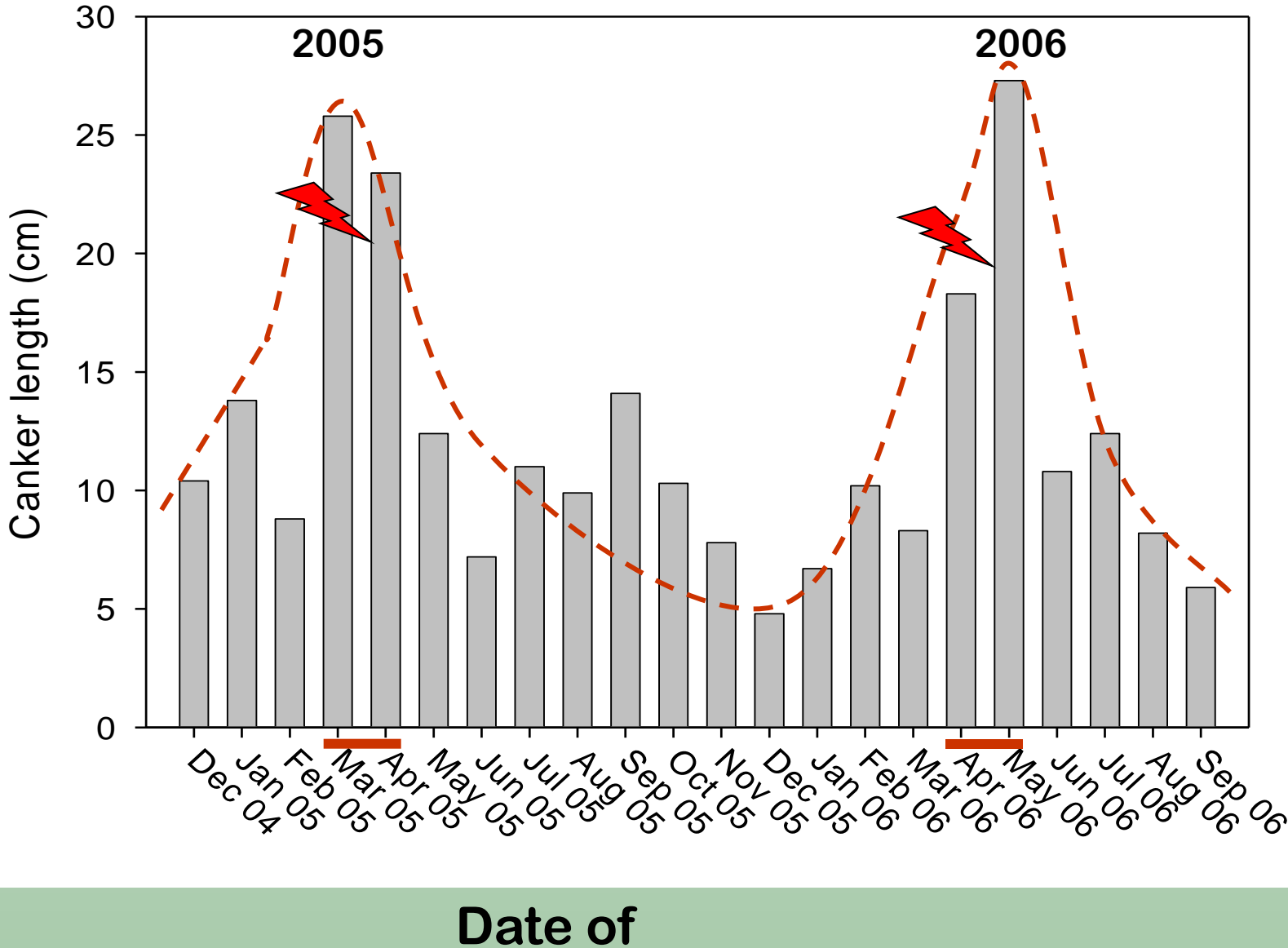
Relevant to Disease:

- ✓ Sources of inoculum were identified inside and outside the almond orchards.
- ✓ Ways of infection = growth cracks in canopy, lenticels, fruit stems, pruning wounds.
- ✓ Cankers develop the most in March to May: suggestion for treatment.



Potted almond trees

Canker length after inoculation with *Botryosphaeria*



Disease management:

- ✓ Treating cankers by injecting fungicides has no effect.
- ✓ Applying fungicides on the canker (paint/contact or spraying) has no effect.
- ✓ Applying fungicide simultaneously with inoculum controlled the disease (protection!).
- ✓ Managing irrigation (keeping trunks dry) has a major effect.
- ✓ Removal of tree stumps is essential.

Inoculated and treated simultaneously

Treatment	<u>Canker</u> (inches) after 6 months	
Propiconazole	1.0 cd	
Azoxystrobin	0.2 e***	
Iprodione	0.4 de	
<i>Trichoderma viride</i>	1.5 bc	
<i>Trichoderma harzianum</i>	1.7 ab	
Control (inoculated but not treated)	2.3 a	

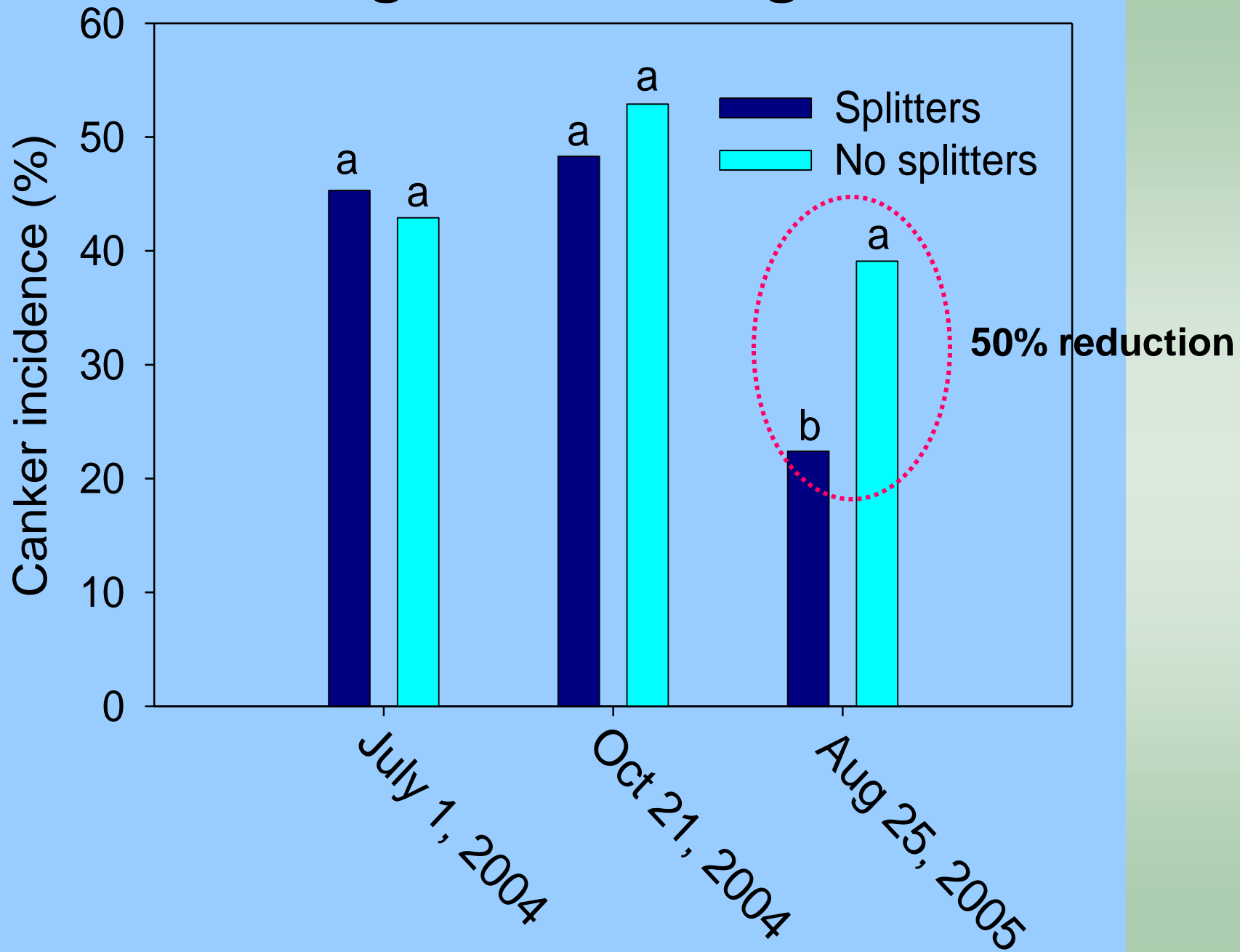
Sprinkler irrigation wets the tree trunk





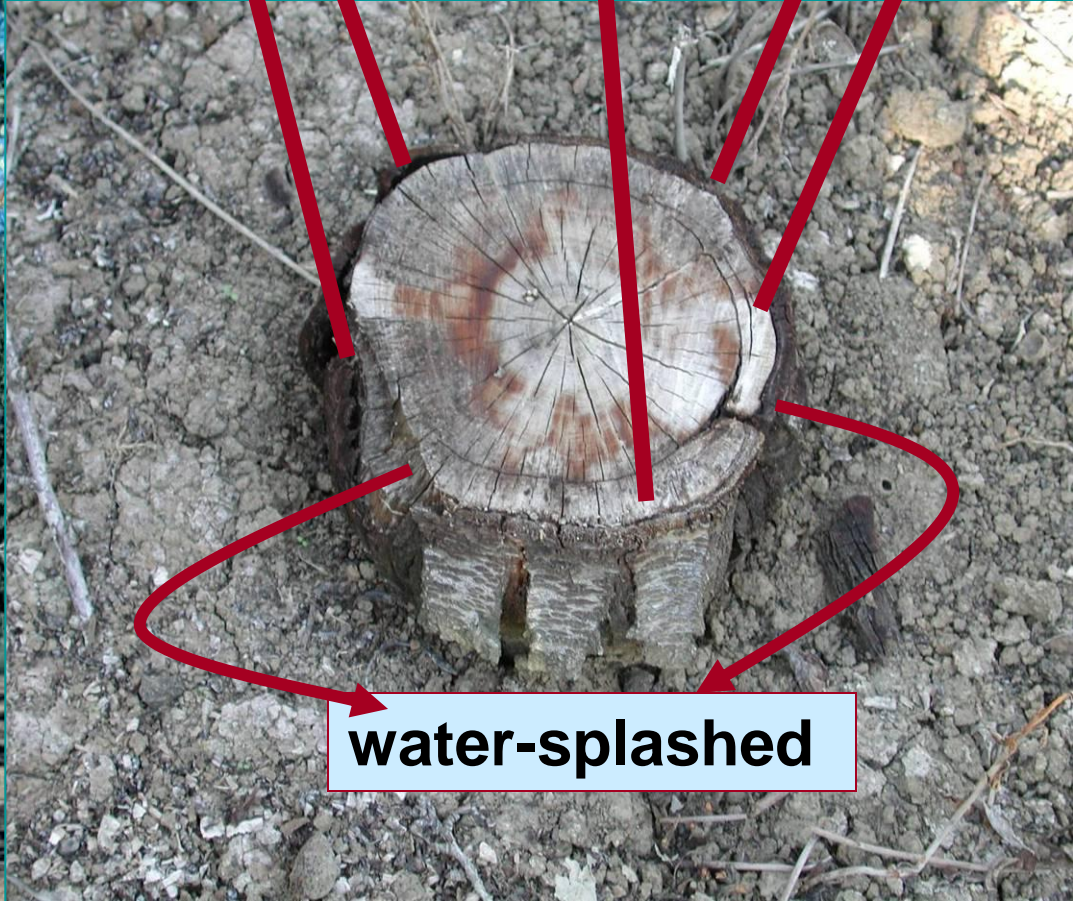


Management of irrigation





**airborne
ascospores in the
orchard**



water-splashed

Walnuts





14600



It is not always branch wilt but also Botryosphaeria blight

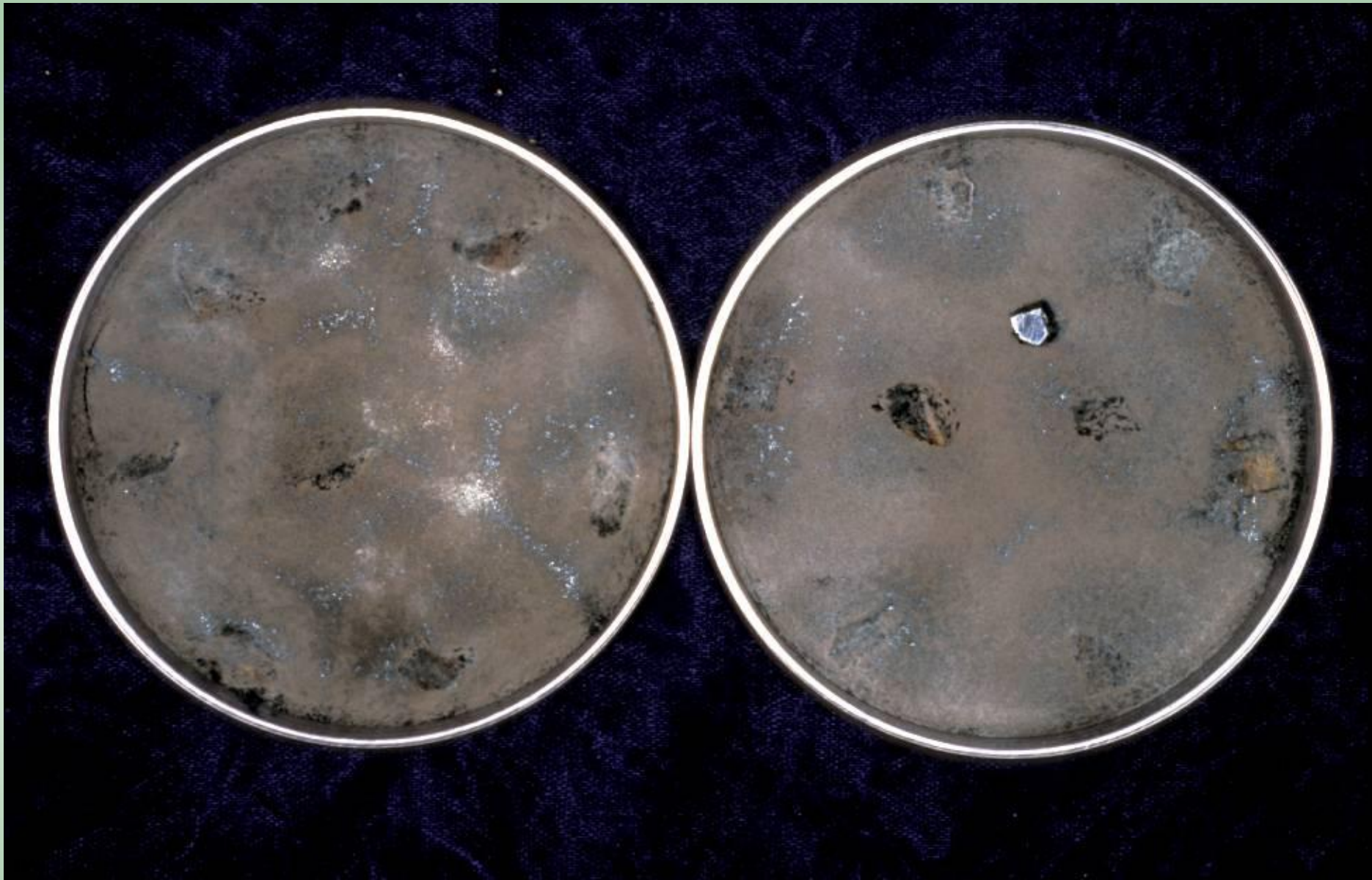


**Branch wilt: *Hendersonula toruloidea*
now *Nattrassia mangiferae***



spores





(Hendersonula toruloidea) = Natrassia mangiferae



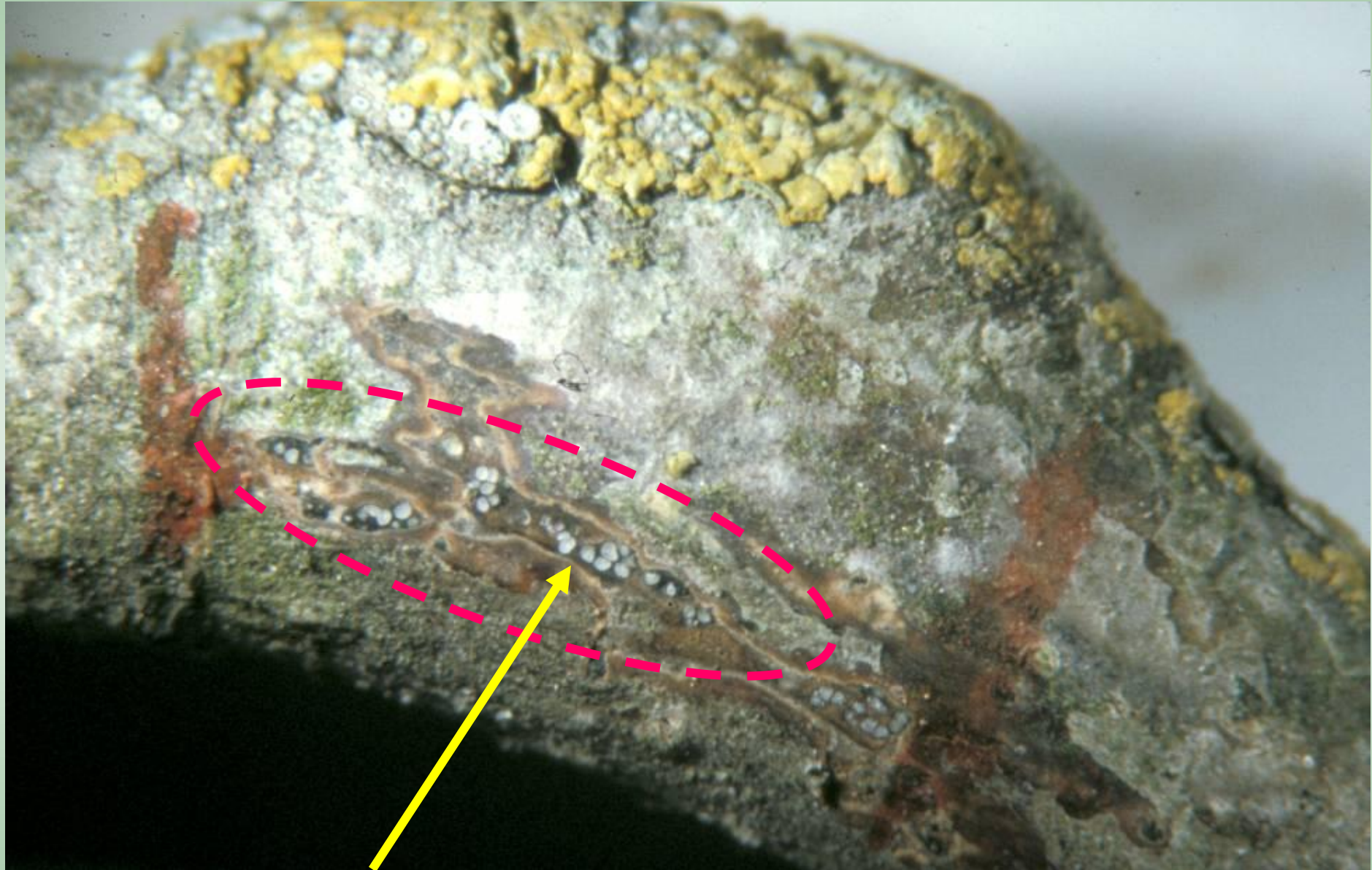




Botryosphaeria



Phomopsis



Pycnidia of *Botryosphaeria*

Isolations from walnut limb samples in 2009

County	Incidence (%)				
	<i>Botryosphaeria</i>	<i>Geosmithia</i>	<i>Nattrassia</i>	<i>Phomopsis</i>	Other
Fresno (2)	100	0	0	0	0
Kings (1)	100	0	0	0	0
Stanislaus (2)	50	0	0	50	0
Tehama (1)	100	0	0	0	0
Tulare (1)	100	100	0	0	0
Yolo (1)	100	100	0	0	0

Geosmithia = 1000 cankers disease



Isolations from walnut limb samples in 2010

County	Incidence (%)				
	<i>Botryosphaeria</i>	<i>Geosmithia</i>	<i>Nattrassia</i>	<i>Phomopsis</i>	Other
Lake (2)	0	0	50	50	<i>Fusarium</i> (50)
Stanislaus (6)	100	17	0	67	<i>Diaporthe</i> (17)
Sutter-Yuba (4)	100	0	0	100	<i>Diaporthe</i> (25)
Tehama (2)	0	0	0	50	<i>Armillaria</i> (25)
Tulare (6)	33	17	0	50	<i>Fusarium</i> (17) <i>Seimatosporium</i> (17)
Yolo (4)	50	0	25	75	<i>Seimatosporium</i> (50)

Diaporthe= another form of *Phomopsis*; *Geosmithia* = 1000 cankers disease



5 species of *Botryosphaeriaceae* occur on walnut

Species of *Botryosphaeriaceae* and *Phomopsis* that cause cankers and blights in tree nuts grown in California

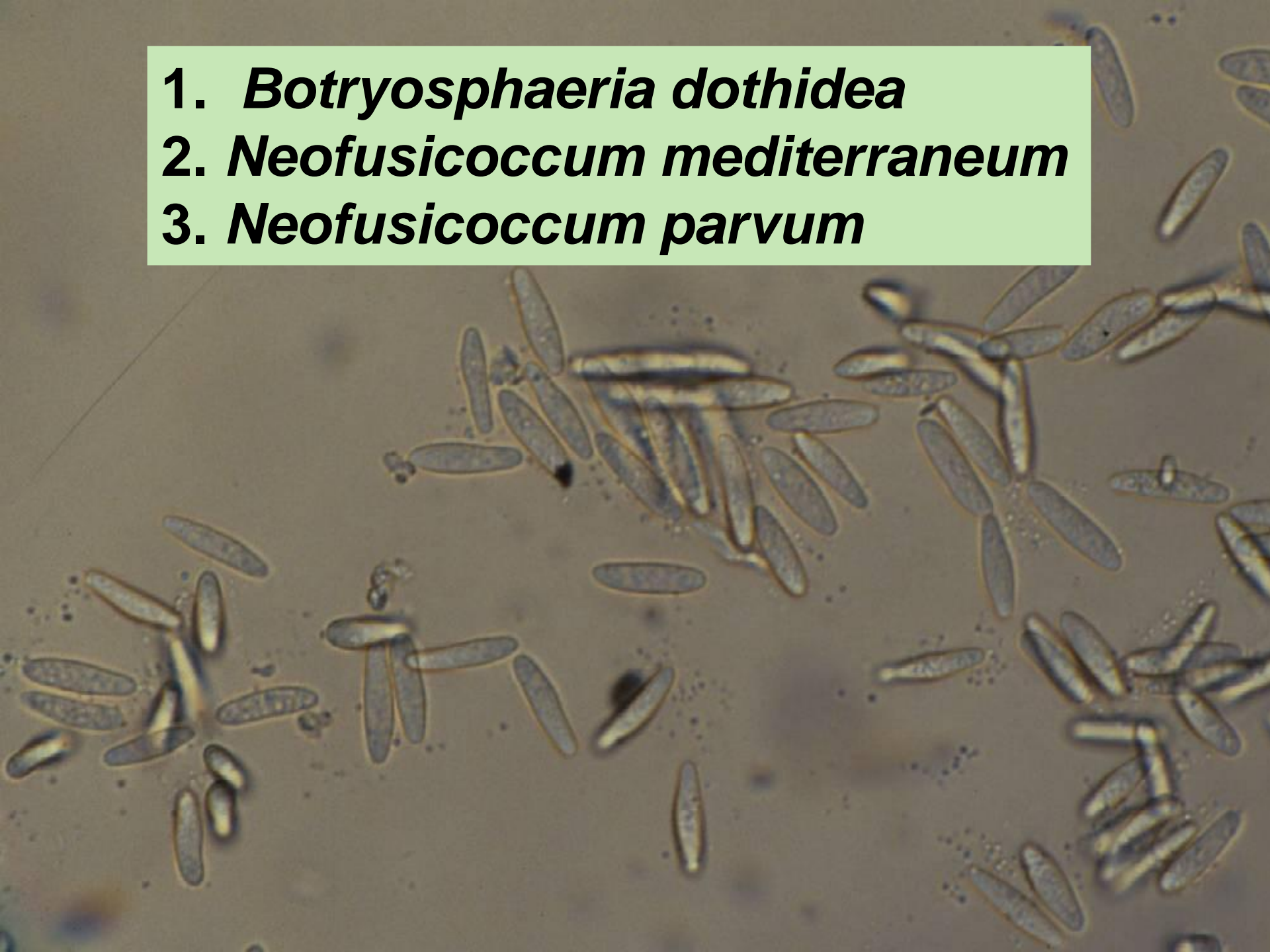
Fungal species	Almond	Pistachio	Walnut
<i>Neofusicoccum nonquaesitum</i>	+	---	---
<i>Neof. parvum</i>	+	+ ^a	+ ^b ←
<i>Macrophomina phaseolina</i>	+	+	---
<i>Neof. mediterraneum</i>	+	+	+ ←
<i>Botryosphaeria dothidea</i>	+	+ ^a	+ ←
<i>Diplodia seriata</i>	+	+ ^c	+ ←
<i>Dothiorella sarmentorum</i>	+	---	---
<i>Lasiodiplodia theobromae</i>	+	+	+ ←
<i>Phomopsis</i>	+	+	+ ←

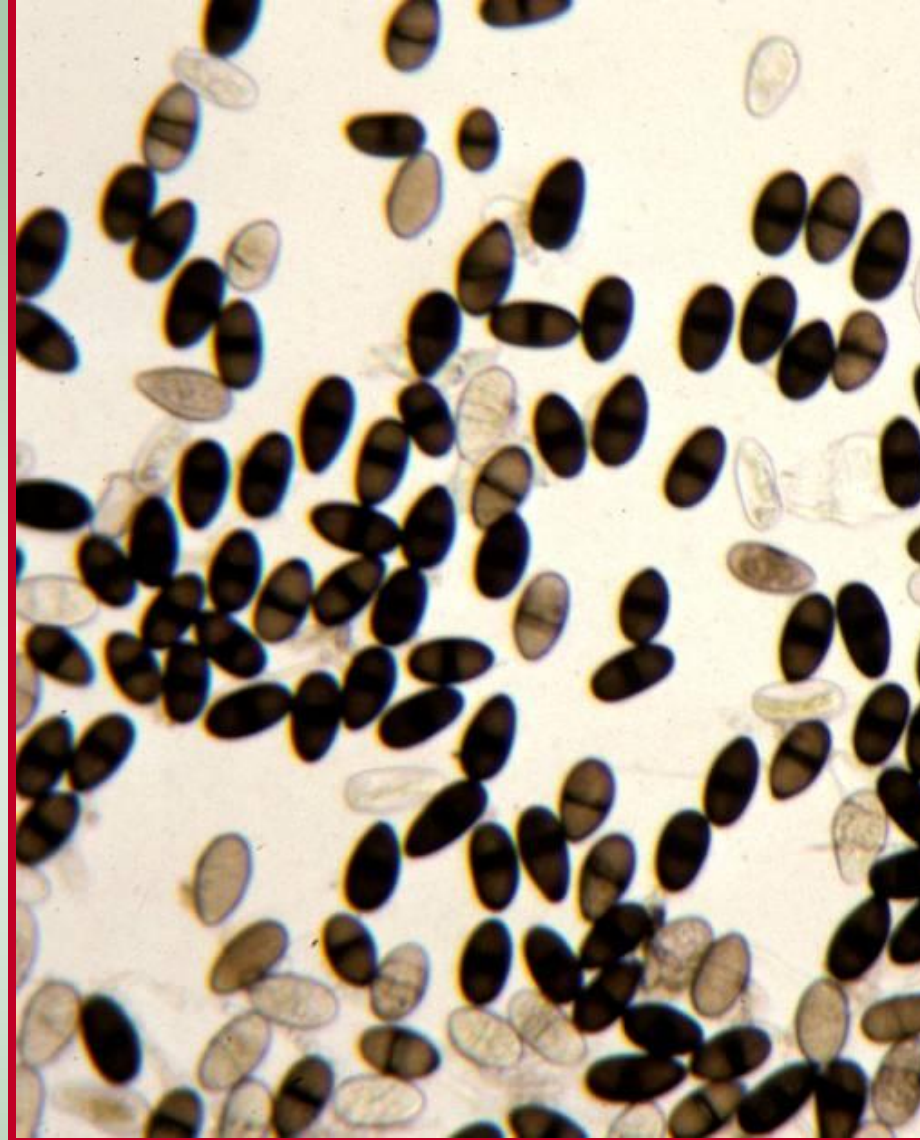
Botryosphaeriaceae on walnut in California

1. *Botryosphaeria dothidea*
2. *Neofusicoccum mediterraneum*
3. *Neofusicoccum parvum*
4. *Lasiodiplodia theobromae*
5. *Diplodia seriata*

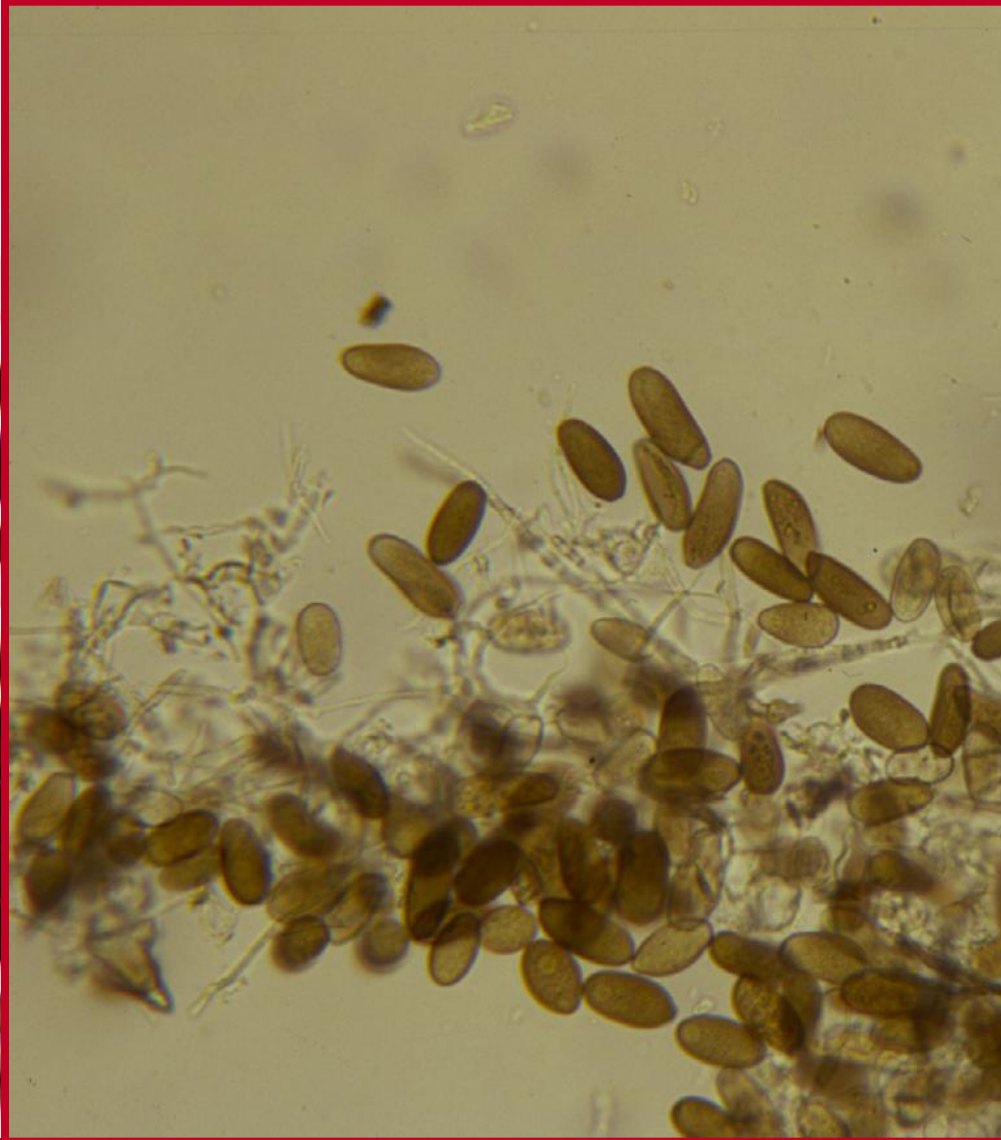
Walnut

1. *Botryosphaeria dothidea*
2. *Neofusicoccum mediterraneum*
3. *Neofusicoccum parvum*





4. *Lasiodiplodia theobromae*



5. *Diplodia seriata*



Botryosphaeria and Phomopsis cankers

Plenty of light; no shade





Walnut scale





**Ascocarps of
*Botryosphaeria***



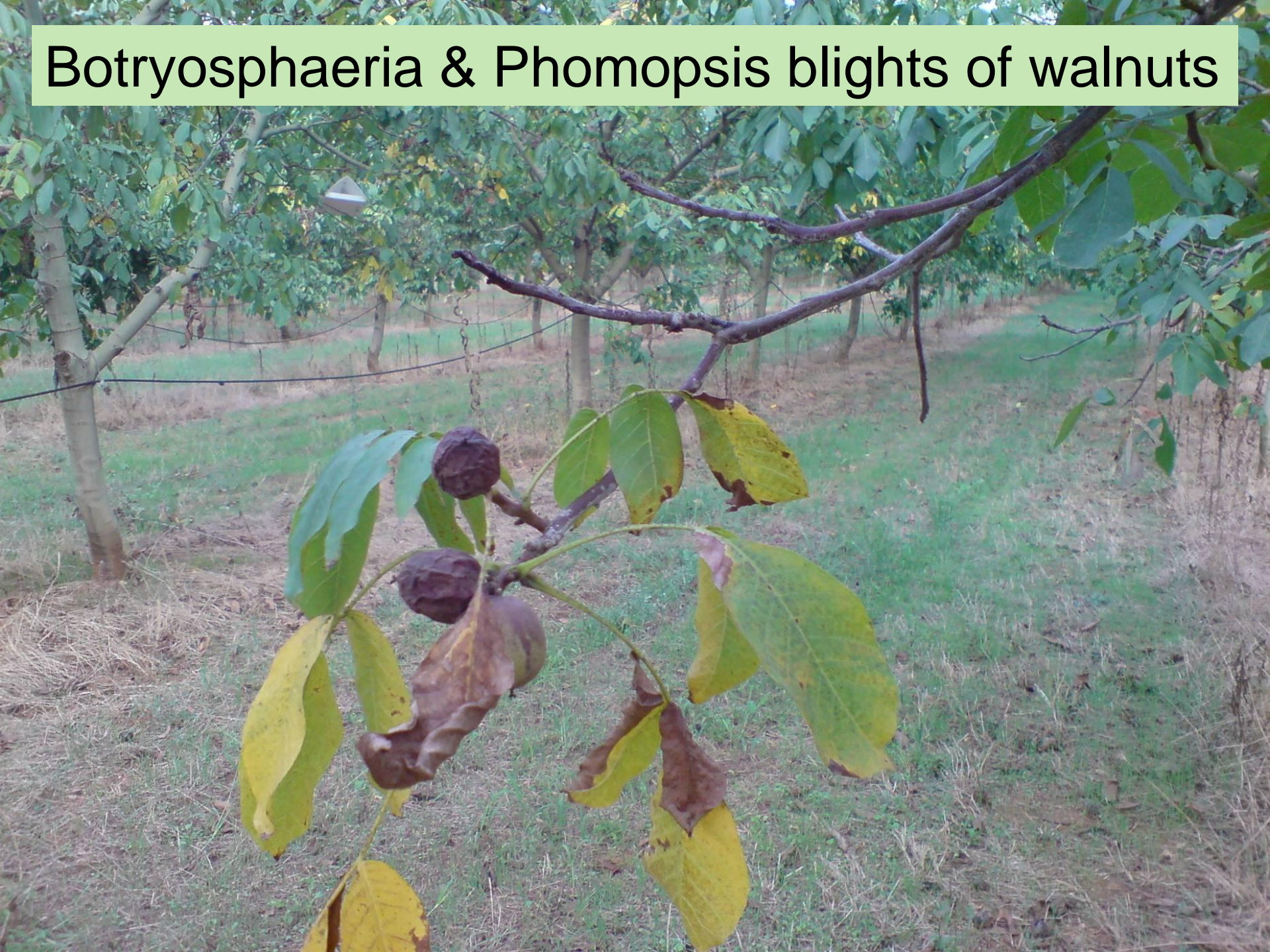
**Pycnidia of
*Botryosphaeria***

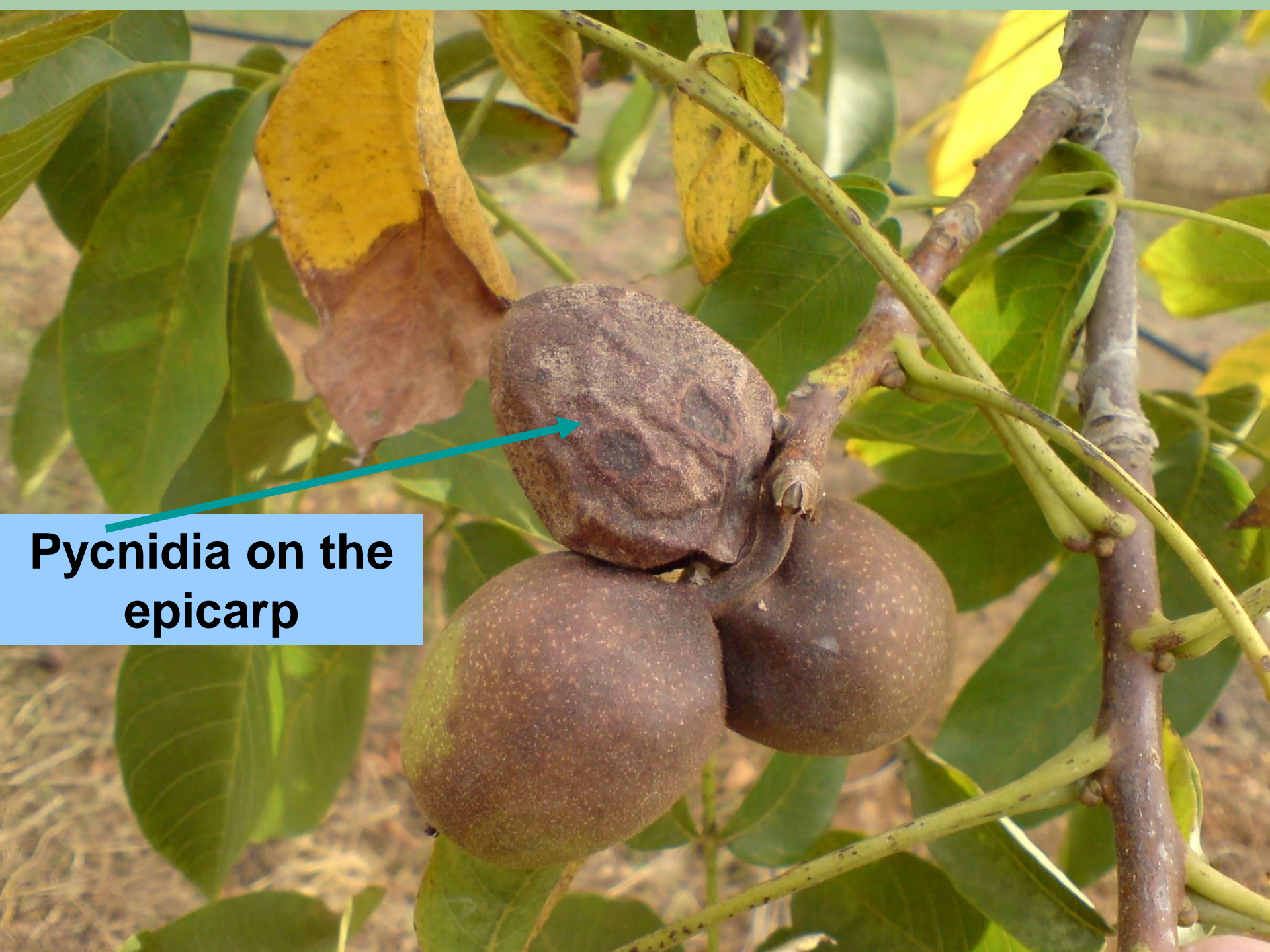
Botryosphaeria blight (Spain)



06.15.2006

Botryosphaeria & Phomopsis blights of walnuts





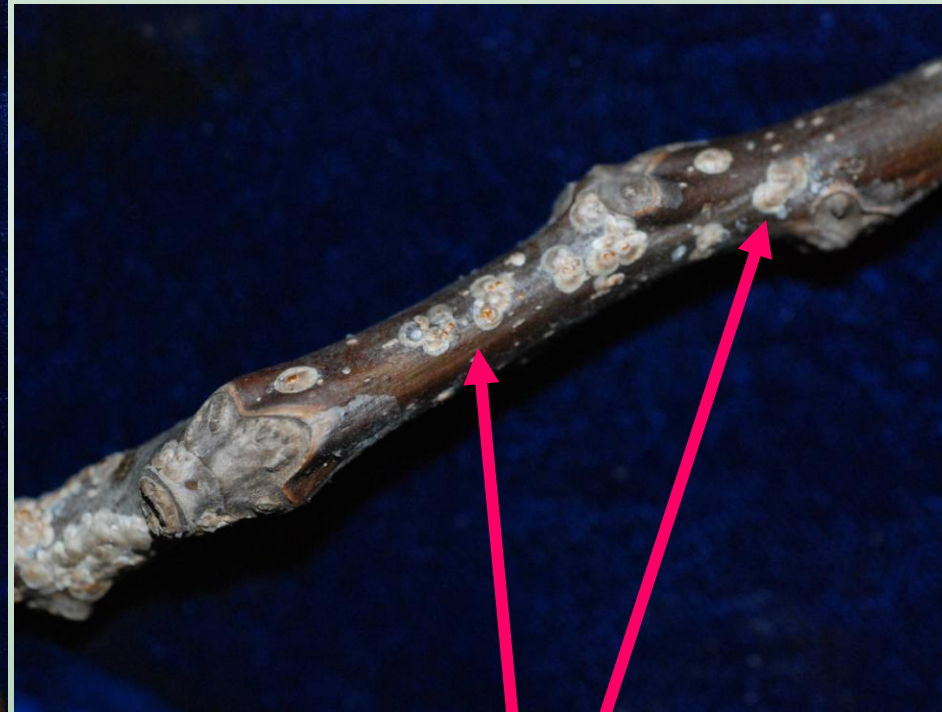
**Pycnidia on the
epicarp**



Severe case of Botryosphaeria & Phomopsis on walnut in Spain

. 12 . 2006

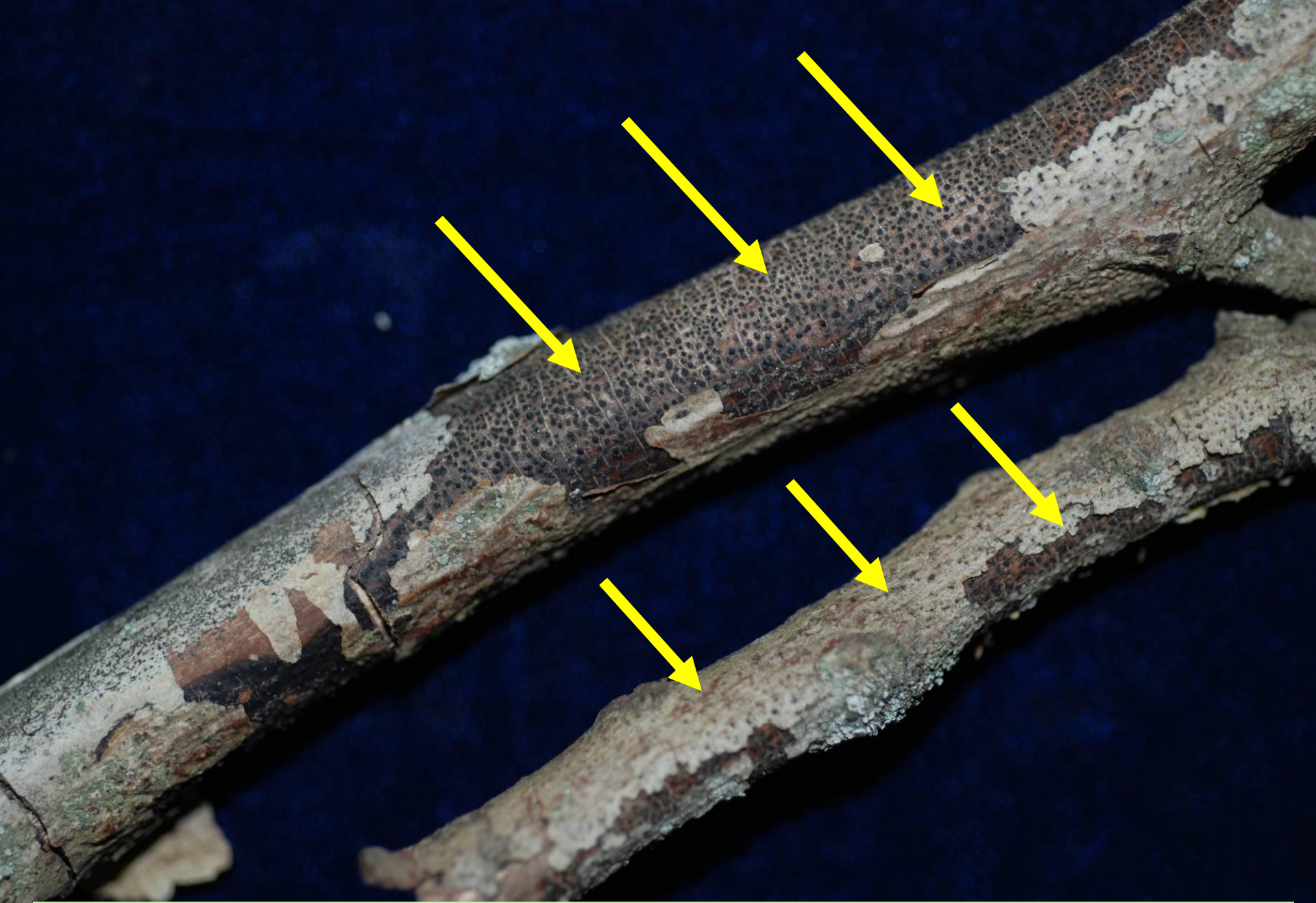
**Botryosphaeria
blight of current
growth (California)**



scale



***Phomopsis* pycnidia (sometimes also mixed with those of *Botryosphaeria*) in walnut shoots**



Pycnidia of *Phomopsis* on walnut (Stanislaus Co.)

“Disease” Management in walnuts

- 1. We do not know very much.**
- 2. Prune out killed branches to reduce inoculum.**
- 3. Destroy prunings.**
- 4. Prune when weather is dry.**
- 5. Control walnut scale???**







Inoculations in the field



Objectives (2011)

1. Survey systematically walnut orchards in northern, central, & southern regions, isolate putative pathogens from branch wilt, shoot blights, branch cankers, limb dieback, and record severity of walnut scale infestation.
2. Compare pathogenicity among the major canker producing fungi and identify the most damaging species.
3. Determine whether pruning wounds are infected by *Botryosphaeriaceae* fungi and *Phomopsis* species, and if so, how long the wounds remain susceptible.
4. Determine if walnut scale predisposes branches/shoots to infection by *Botryosphaeria* and *Phomopsis* species.



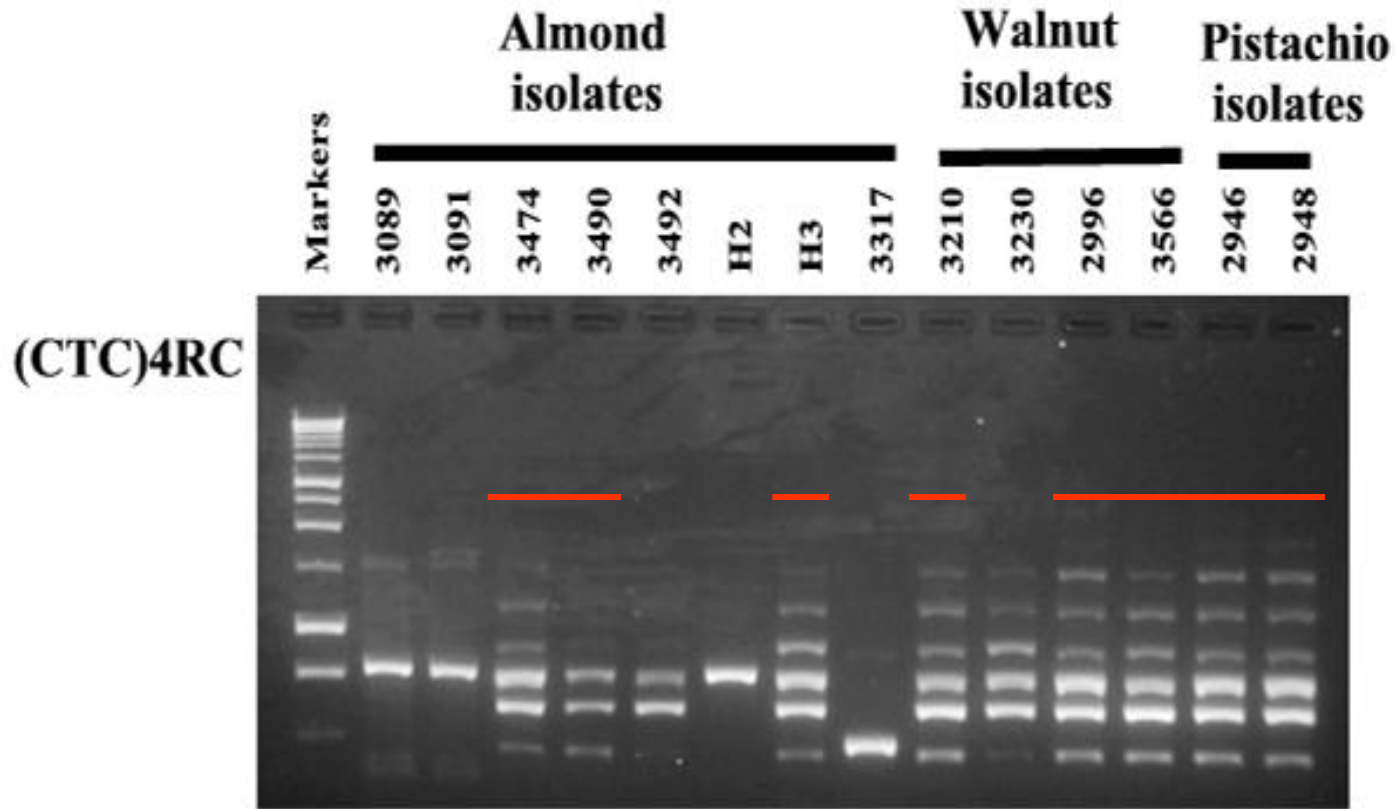
determine ways to control it.

Acknowledgments:

- David Morgan
- Patrik Inderbitzin
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- Heraclio Reyes
- Farm advisors*
 - Janine Hasey
 - Kathy Anderson
 - Bob Beede
 - Elizabeth Fitchner
 - Rick Buchner
 - Joe Connell
 - Bill Krueger



DNA fingerprints of *Botryosphaeria*

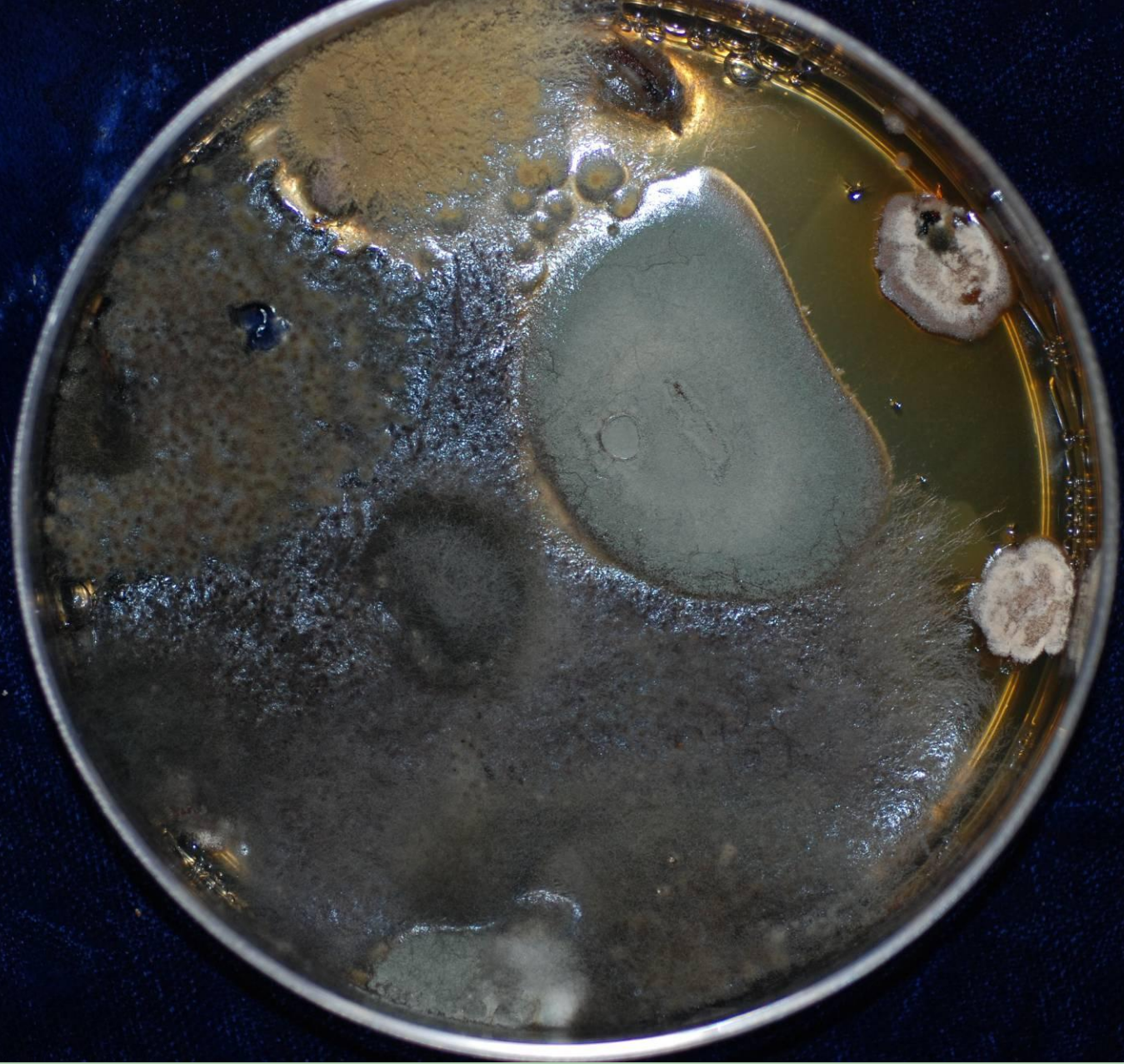


— = similar isolates

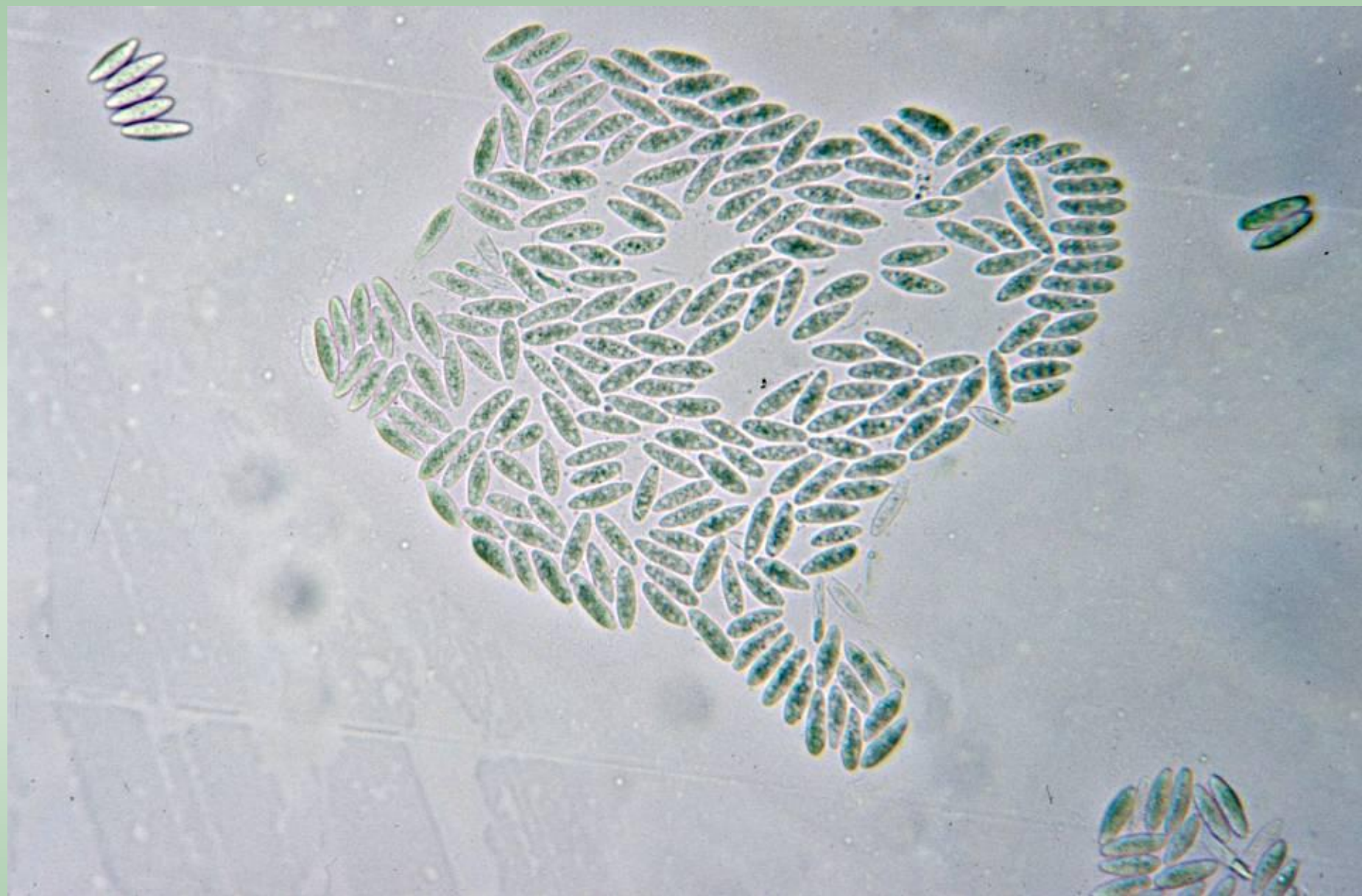
Riparian areas next to pistachios













Pycnidia of
Botryosphaeria