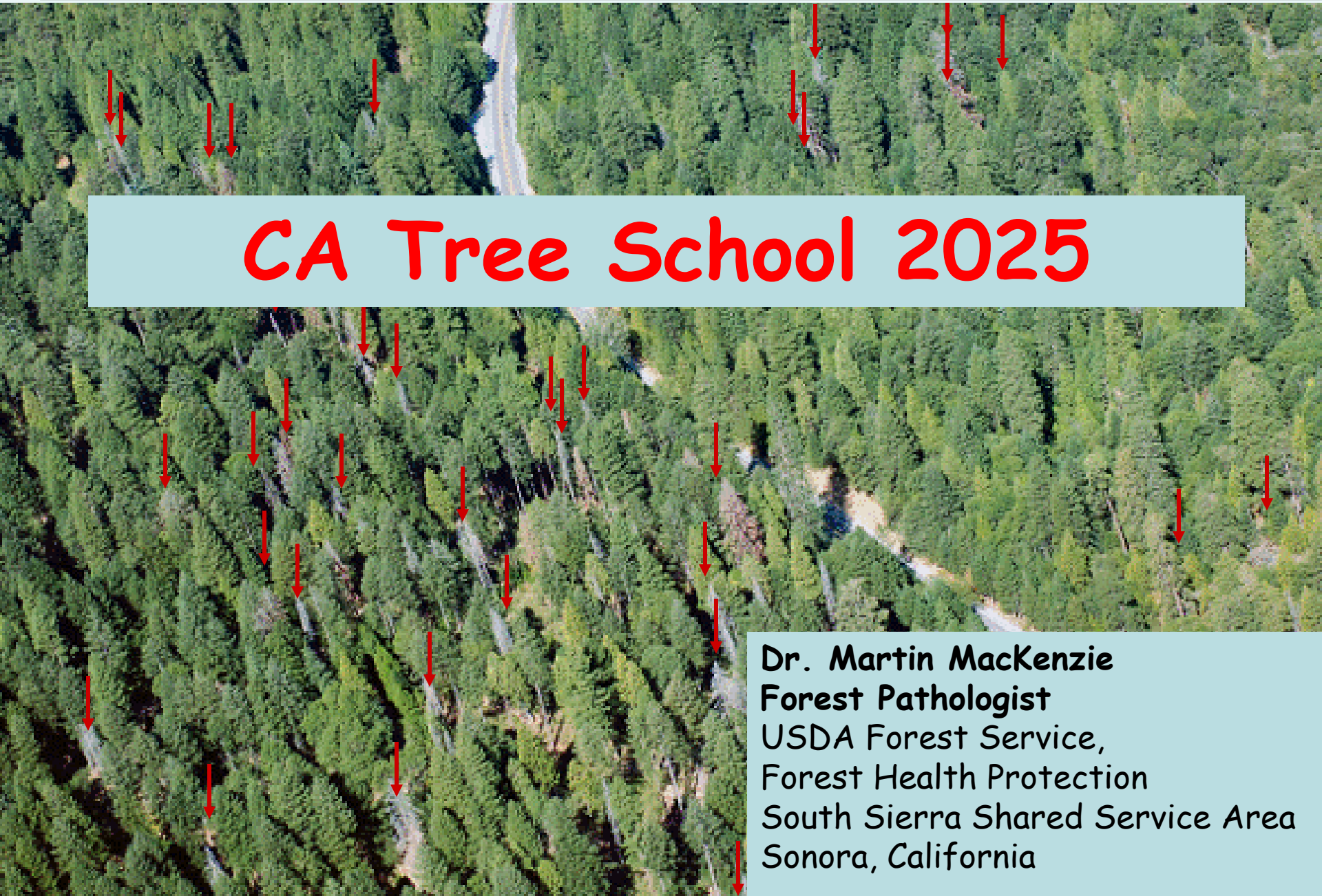
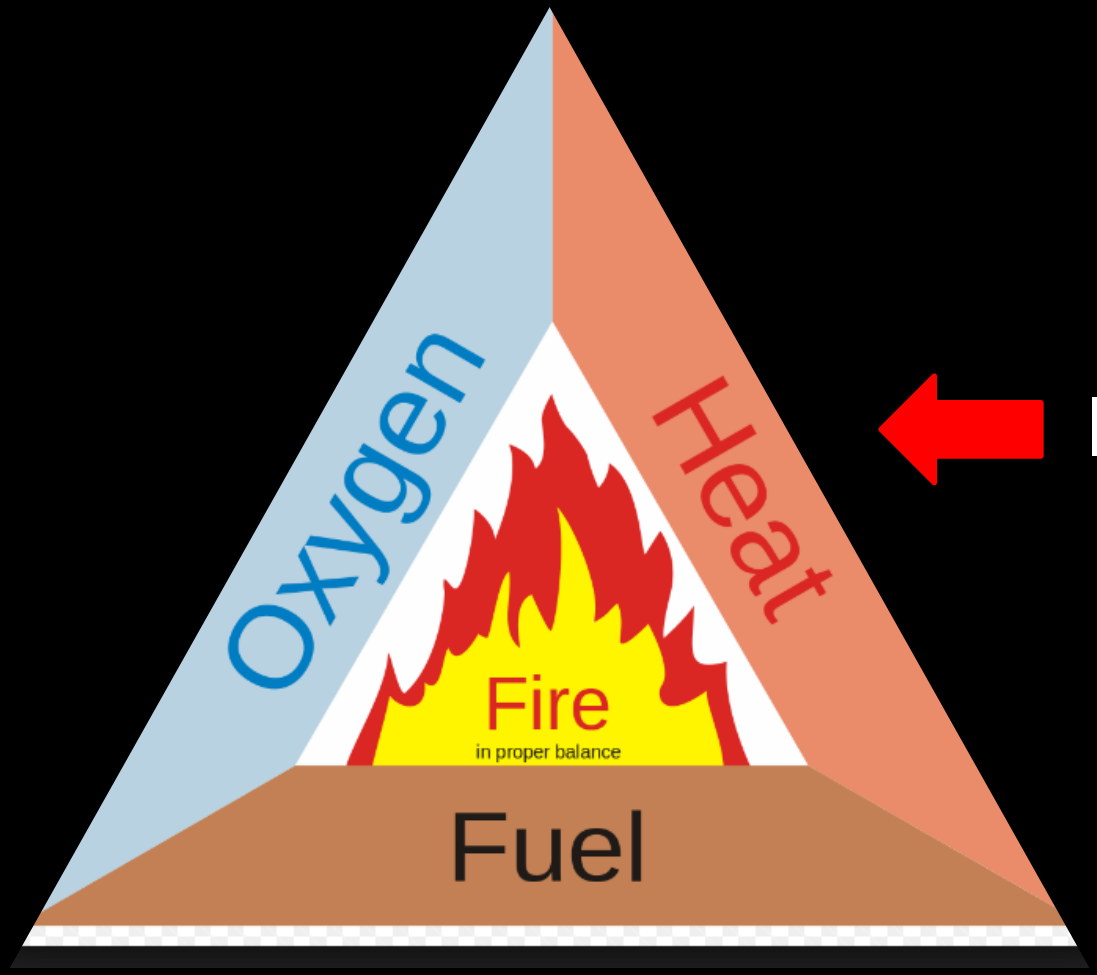


CA Tree School 2025

Dr. Martin MacKenzie
Forest Pathologist
USDA Forest Service,
Forest Health Protection
South Sierra Shared Service Area
Sonora, California

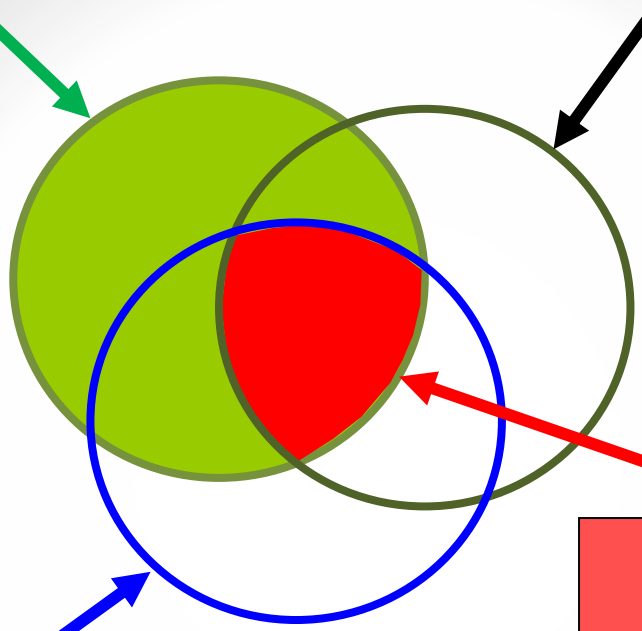


Ignition

The Fire Triangle

Host

Pathogen.

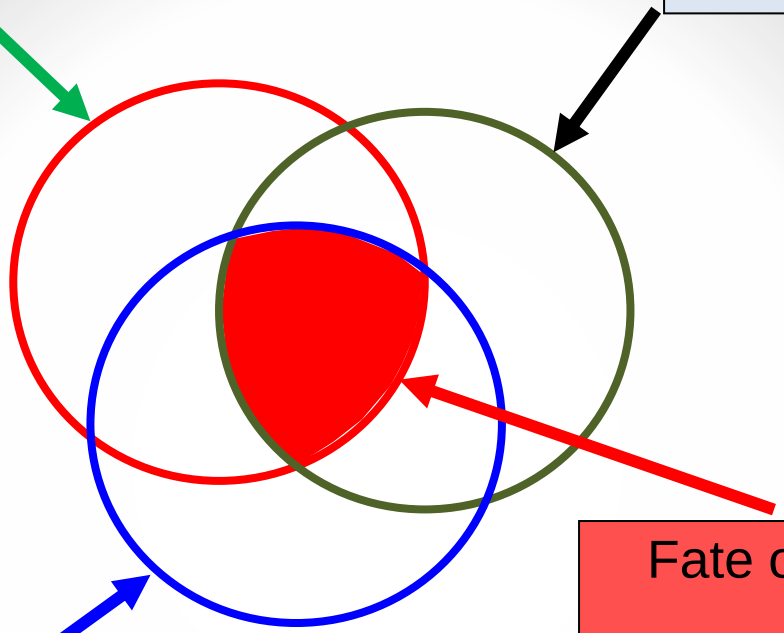


Disease

Environment

Presence of Root Diseases

Disposition of Bark Beetles.



Fate of the individual tree.

i.e Health, decline or death !

Drought or Climate Change

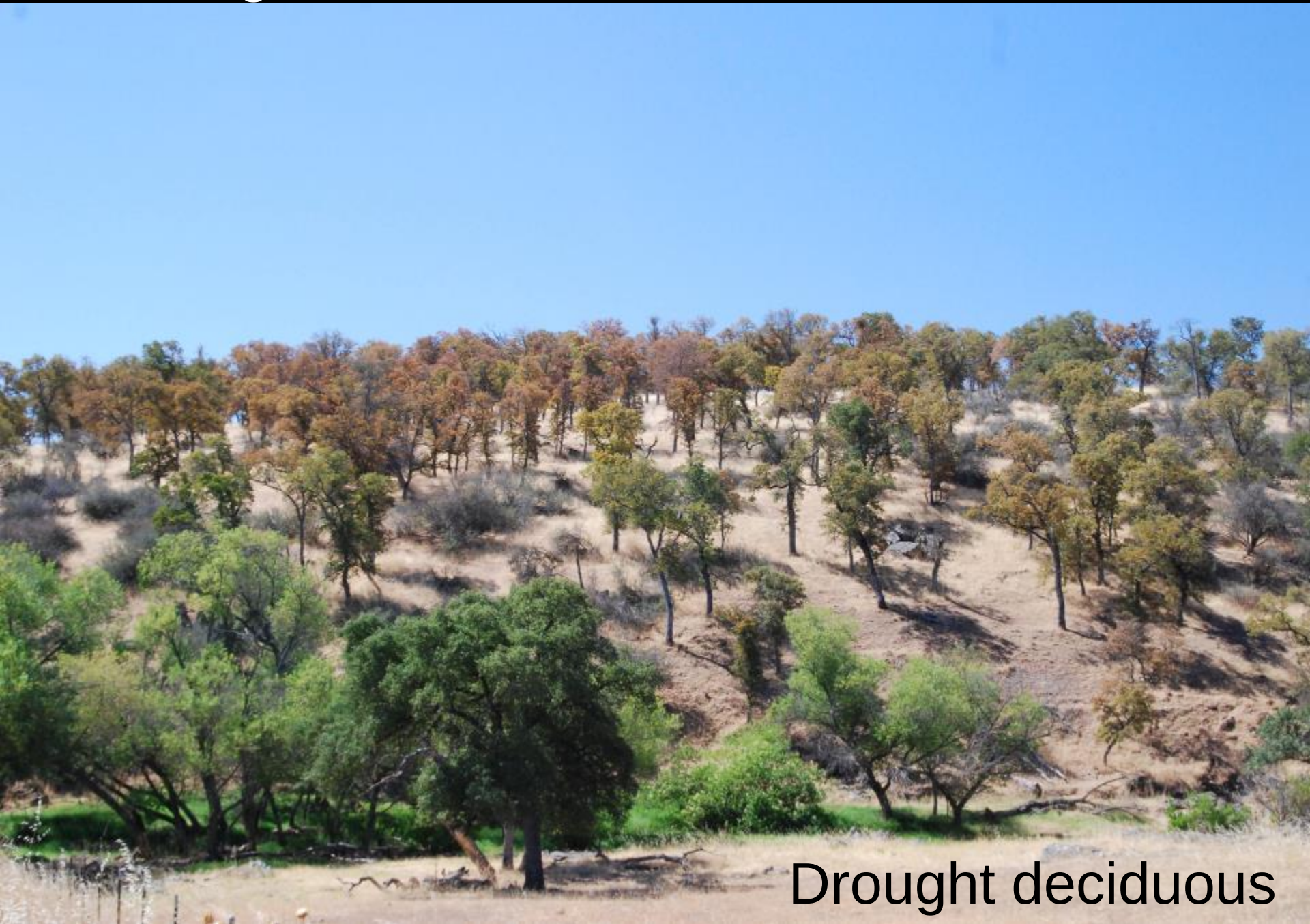
It's a complex because,

One can not separate the insects from the fungi they facilitate and vice versa!

Drought deciduous

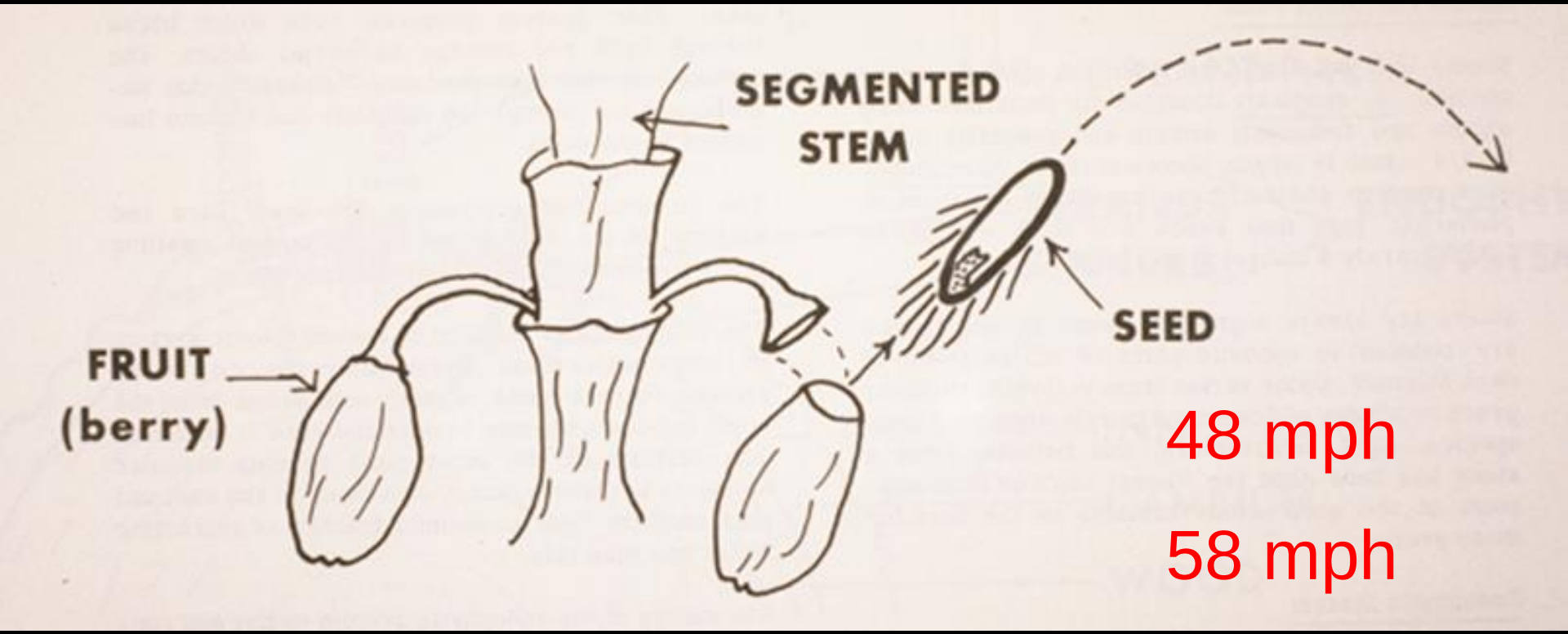

Drought deciduous

Drought deciduous



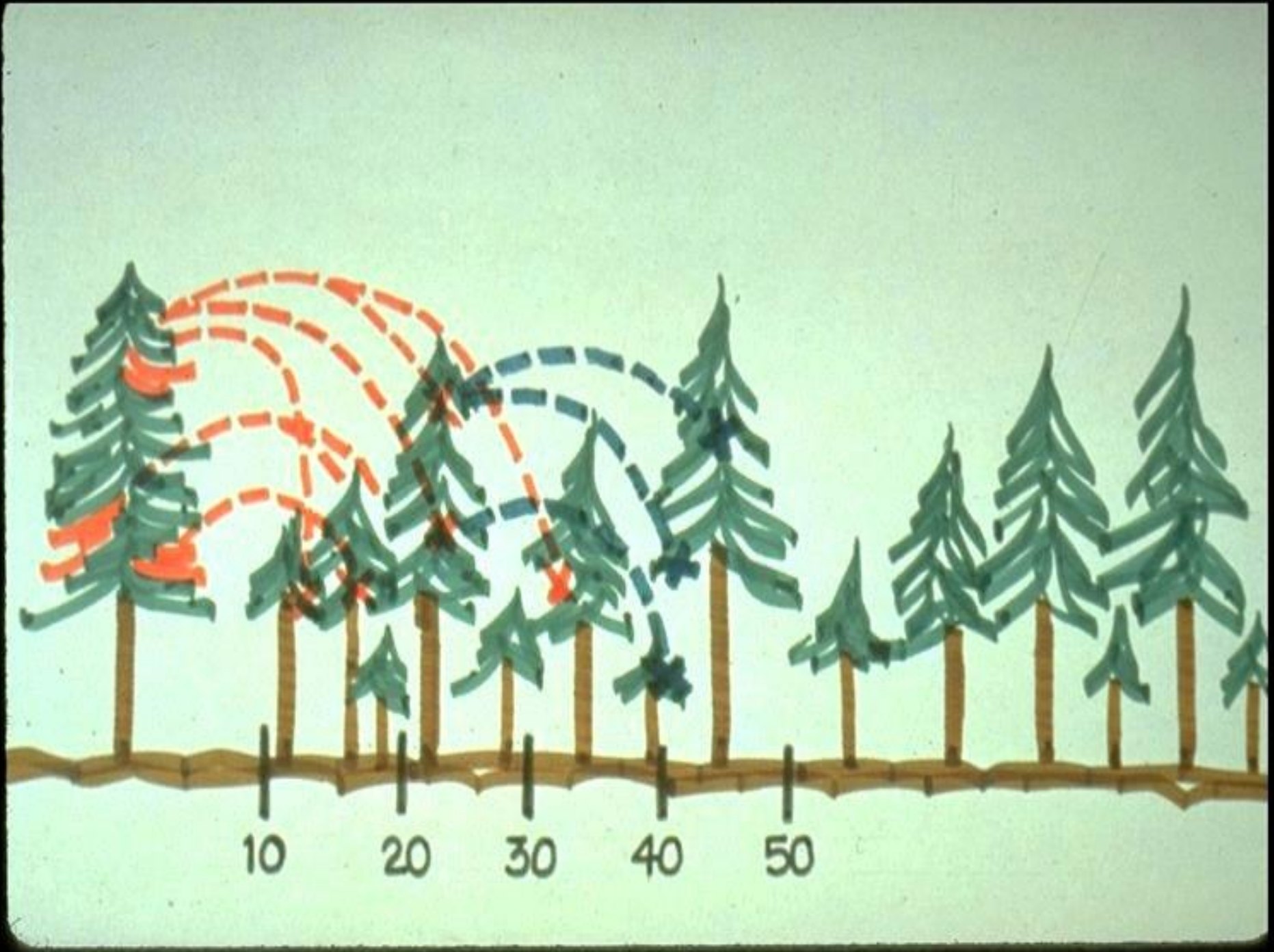
The World's Fastest land plant !

Dwarf Mistletoes explosively disperse their seeds to new trees or new branches within the same crown

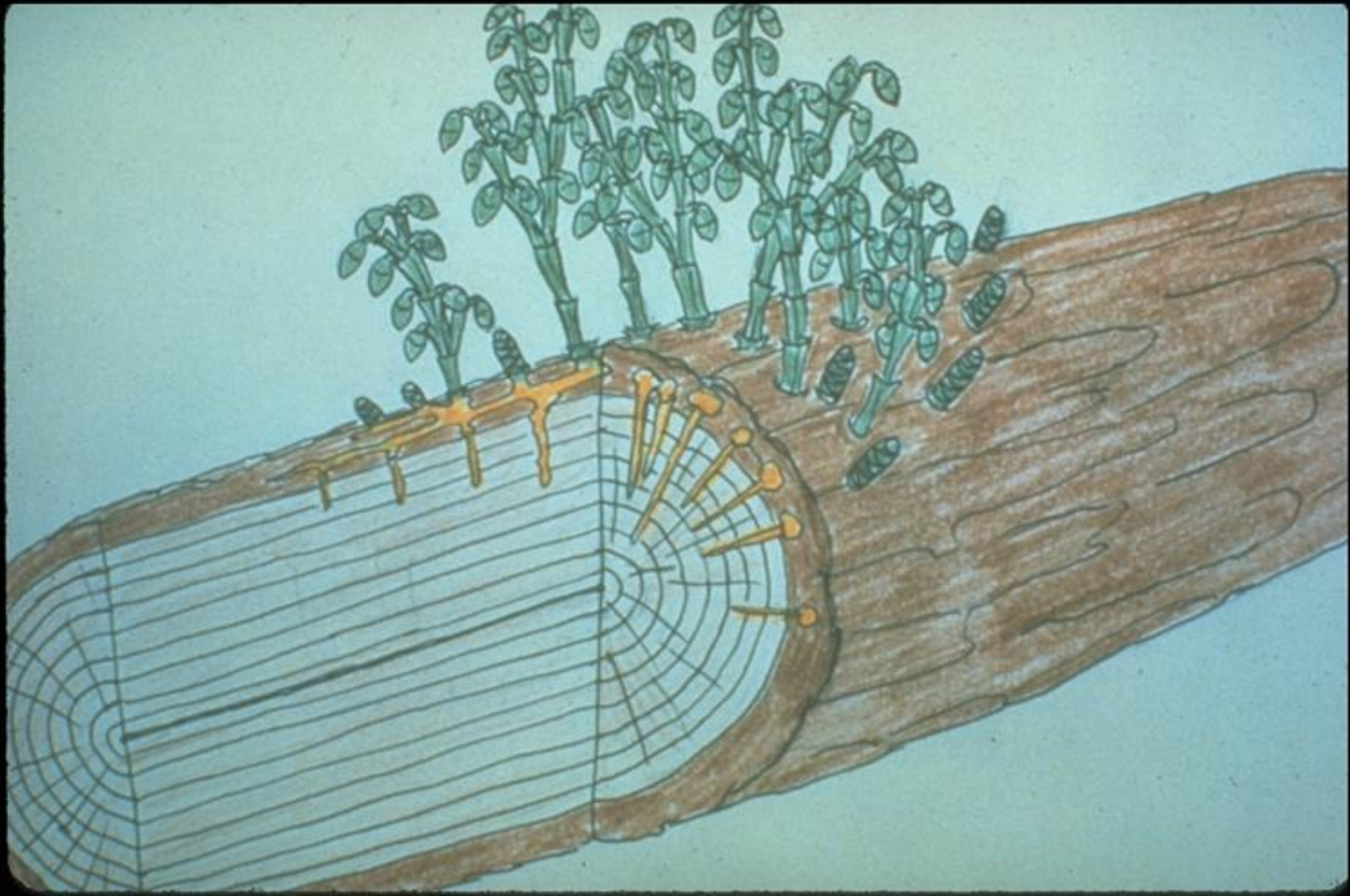


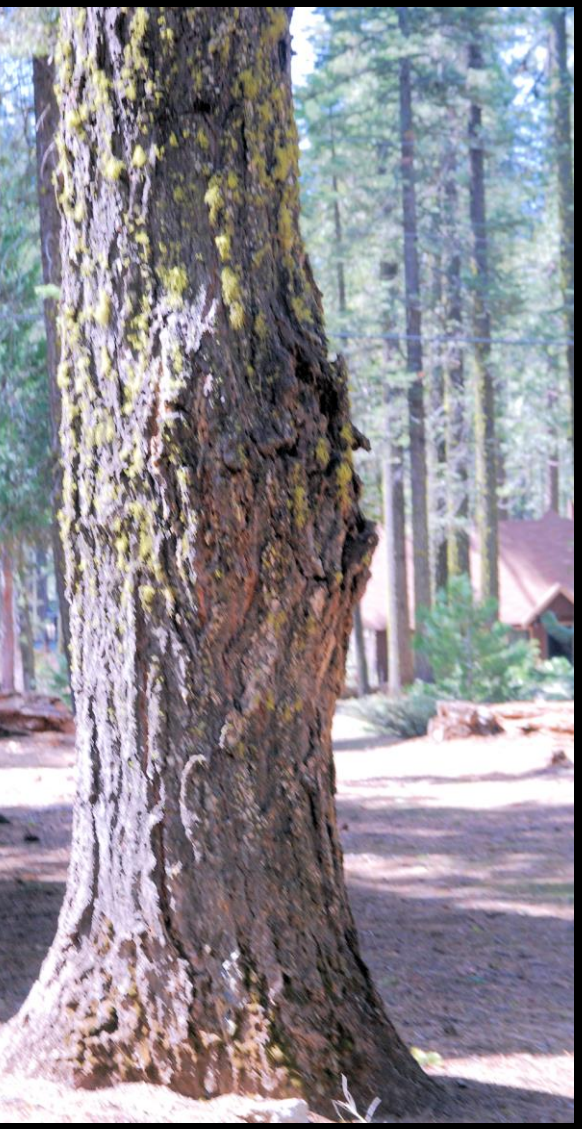
The plant shoots out and up sticky seeds and then gravity takes over.

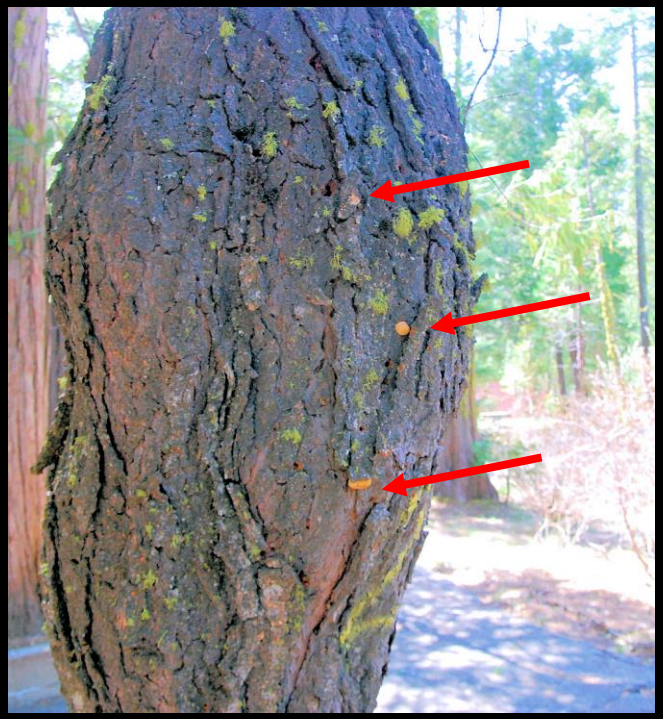
Hinds & Hawksworth (1965)

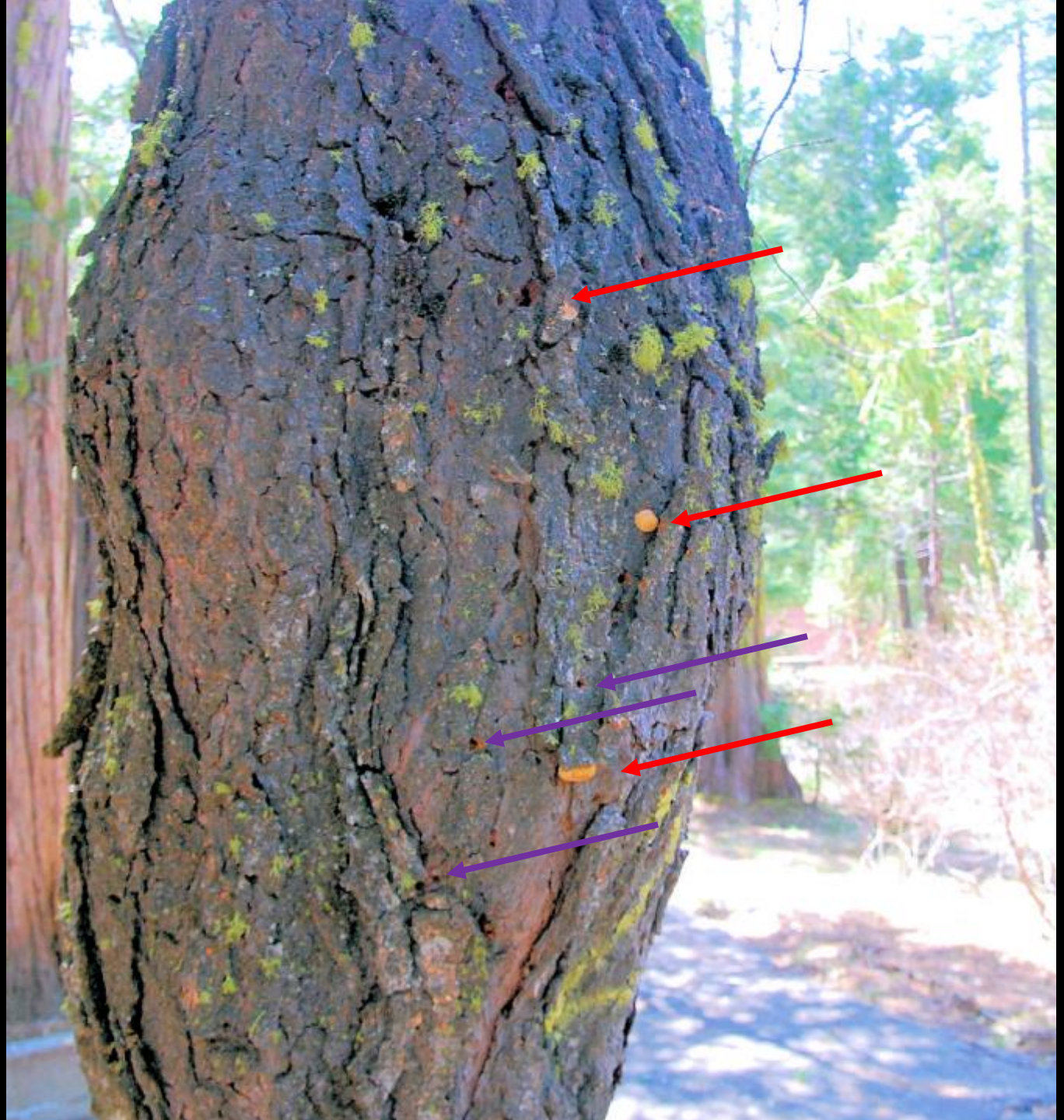

10
20
30
40
50


Red Fir Dwarf Mistletoe
APR 18 2007

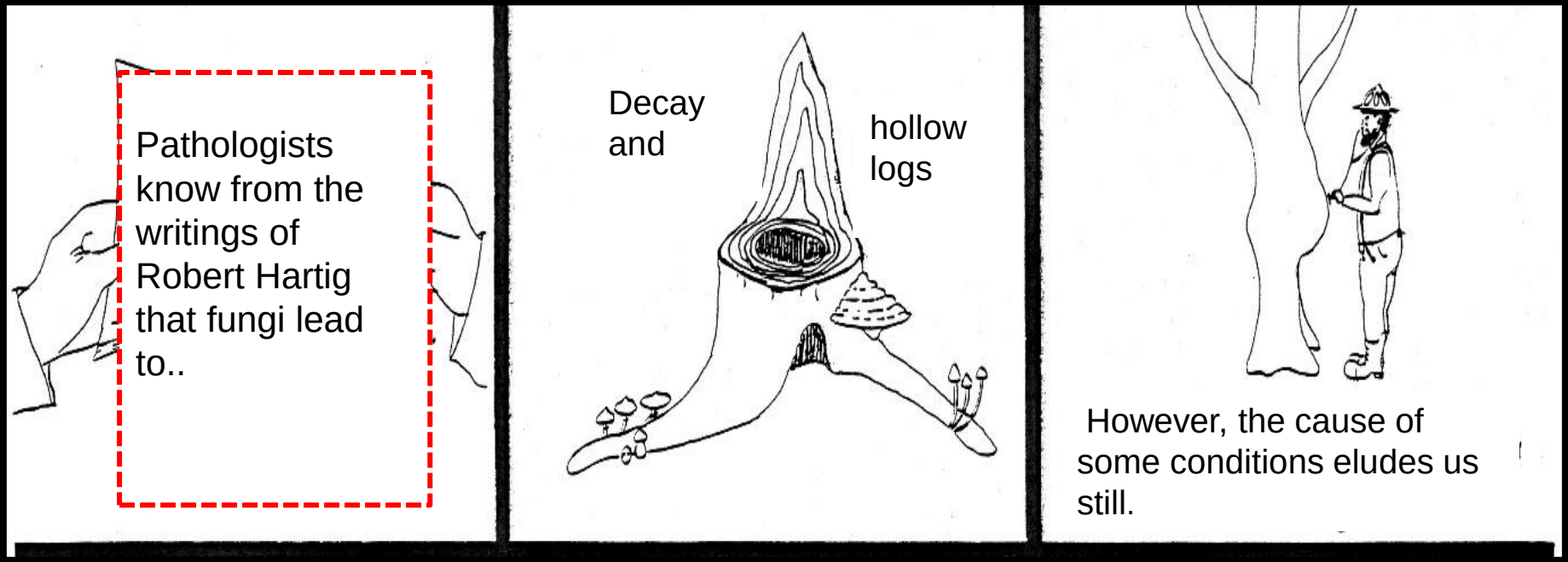


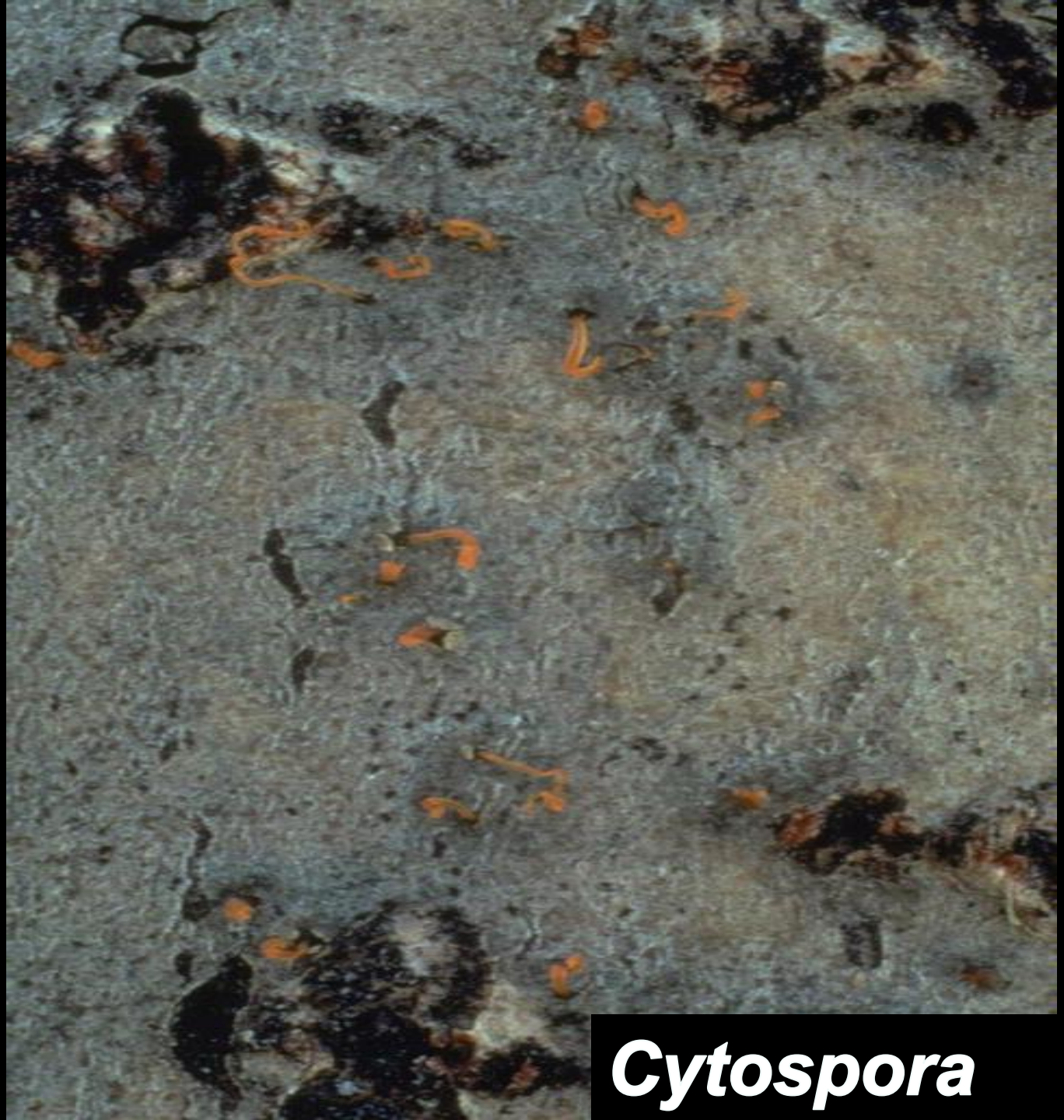






Al Bark *by M. MacKenzie*





Cytospora

Spore threads issuing from pycnidia embedded in the dead bark

Abies magnifica

"There can be a healthy amount of death or disease in a healthy forest!"

Abies magnifica

With Dwarf Mistletoes

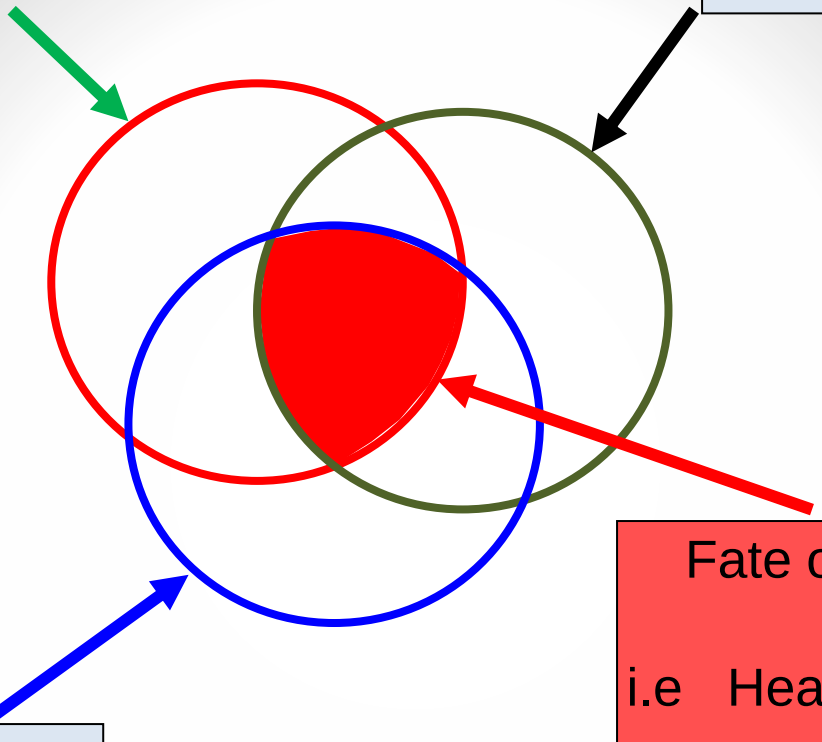

With Dwarf Mistletoe
2014
2013
2012
2011
2010
2009

Without Dwarf Mistletoes

2010 2011 2012 2013 2014

Presence of Root Diseases

Disposition of Bark Beetles.



2010

Fate of the individual tree.

i.e Health, decline or death !

Drought or Climate Change

It's a complex because,

One can not separate the insects from the fungi they facilitate and vice versa!

Without Dwarf Mistletoes

2010 ← 2011 2012 2013 2014

Without Dwarf Mistletoes

2010 2011 2012 2013 → 2014

Presence of Root Diseases

Disposition of Bark Beetles.

2014

Fate of the individual tree.

i.e, Death !

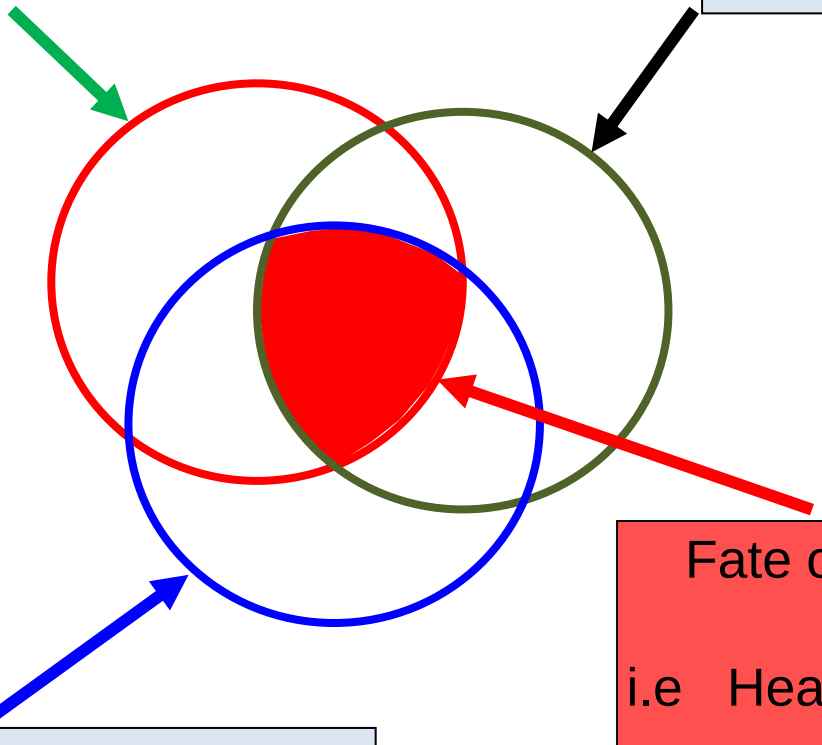
Drought or Climate Change

It's a complex because,

One can not separate the insects from the fungi they facilitate and vice versa!

Presence of Root Diseases

Disposition of Bark Beetles.



2010

Fate of the individual tree.

i.e Health or Decline

Drought or Climate Change

It's a complex because,

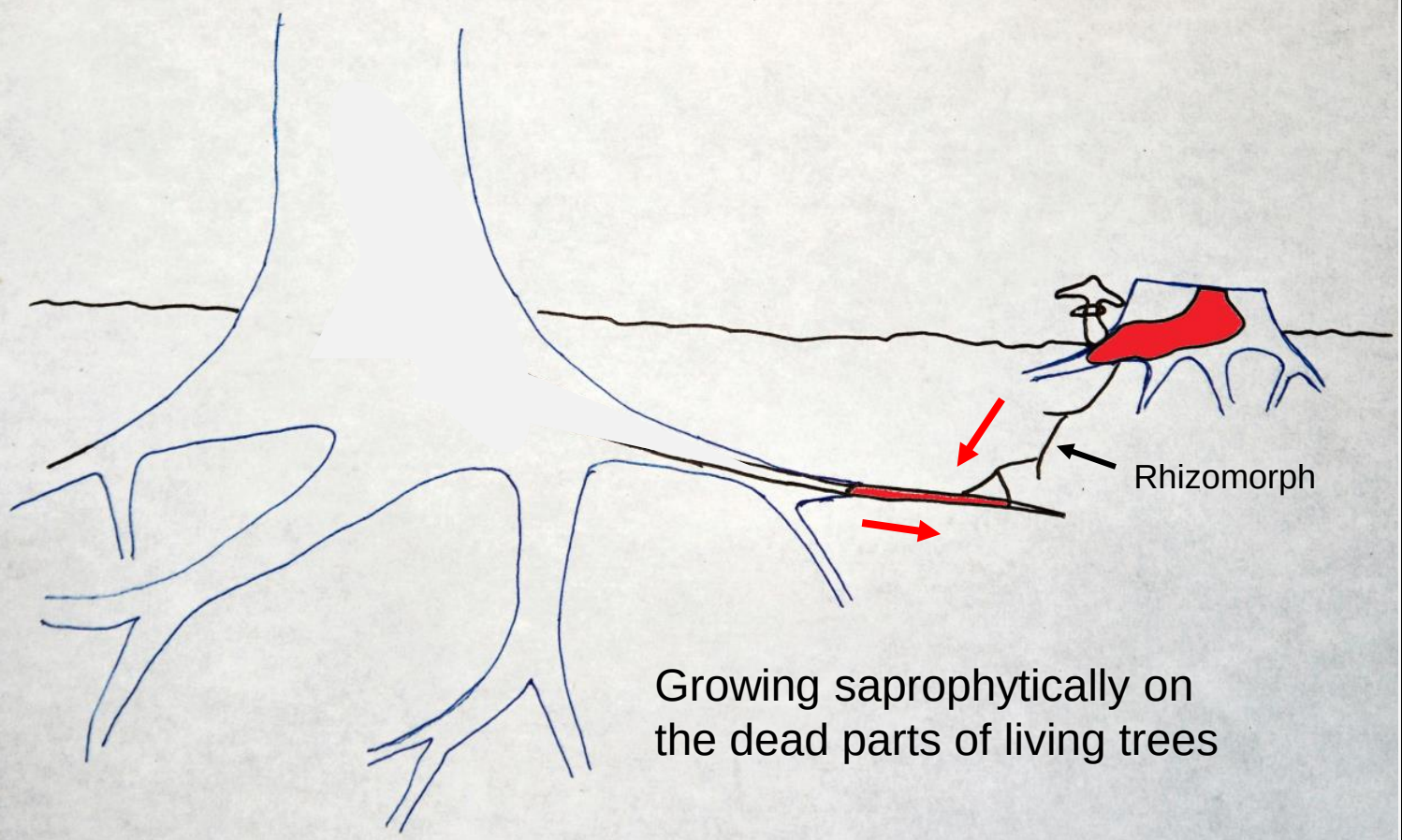
One can not separate the insects from the fungi they facilitate and vice versa!


With Dwarf Mistletoes
2014

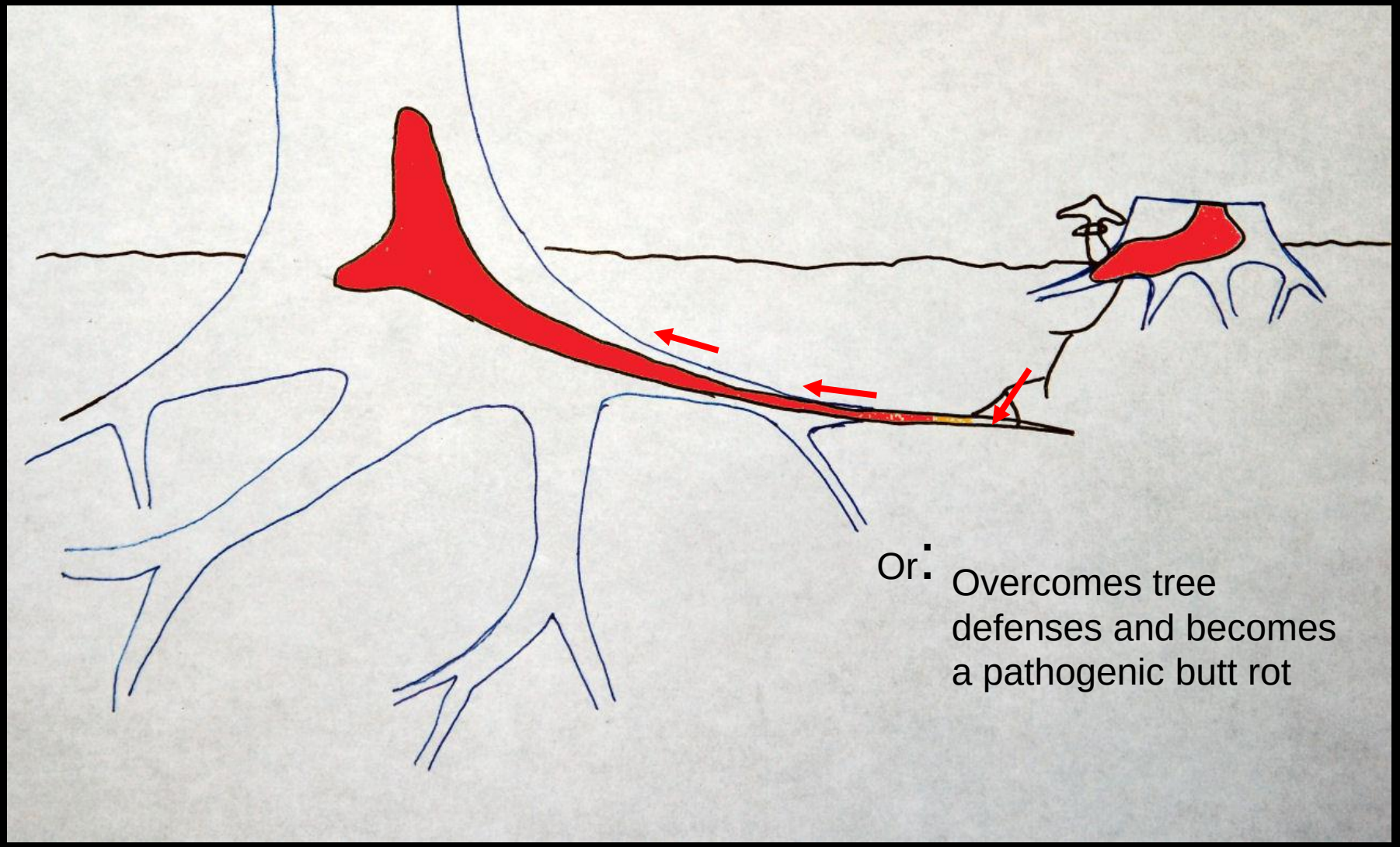
Armillaria Root Rot:

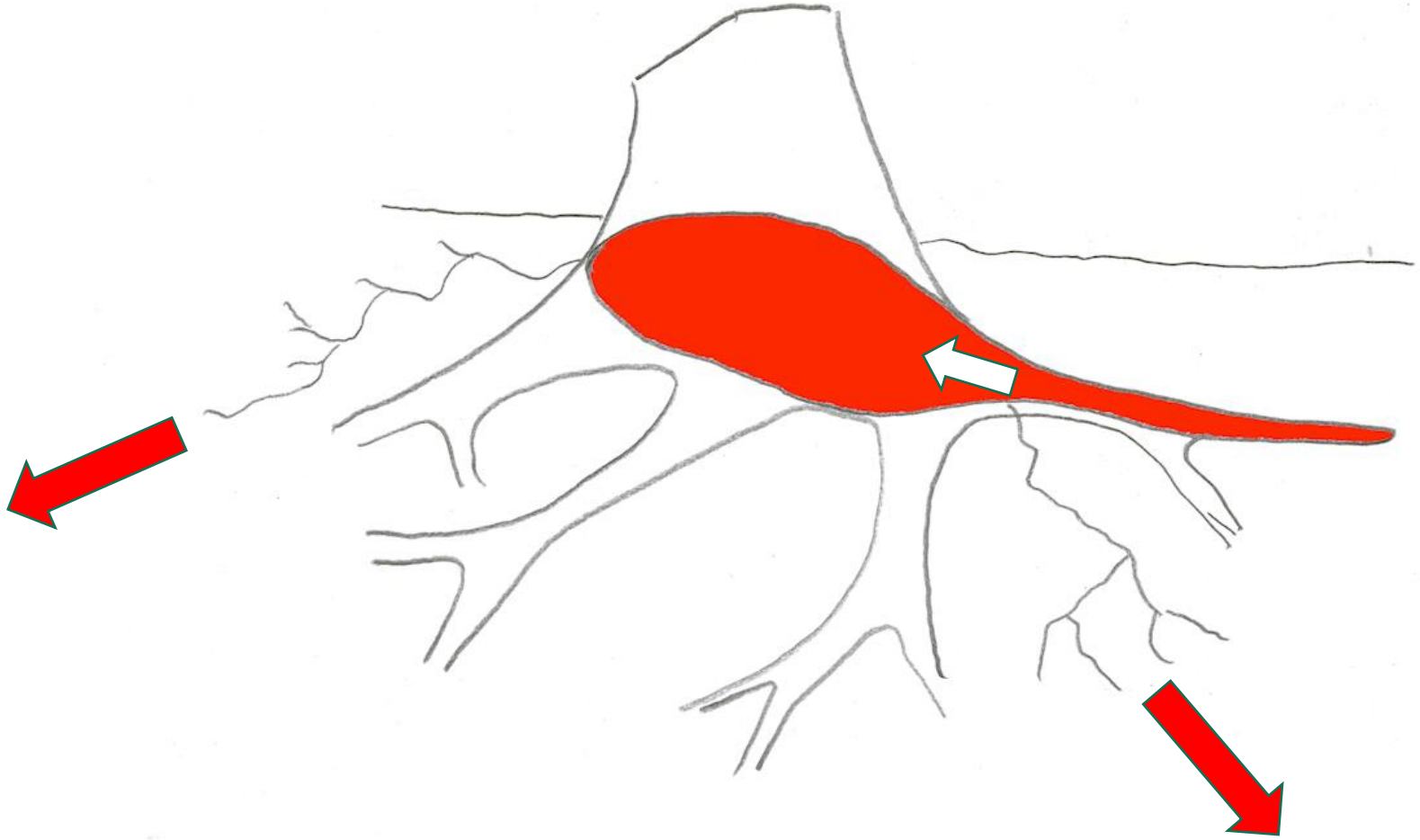
Resinosus

Armillaria root disease



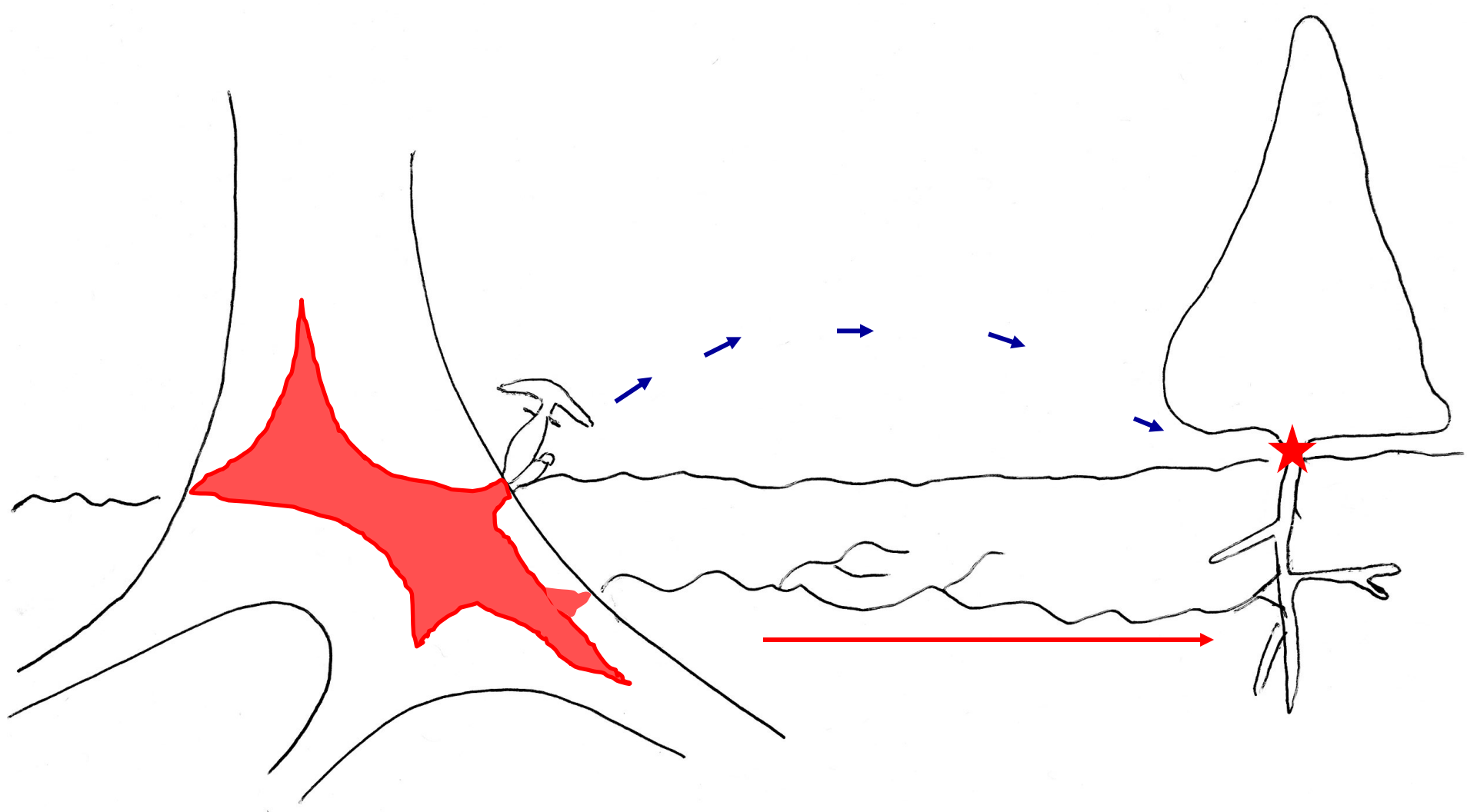
Growing saprophytically on
the dead parts of living trees


Or:
Overcomes tree defenses and becomes a pathogenic butt rot



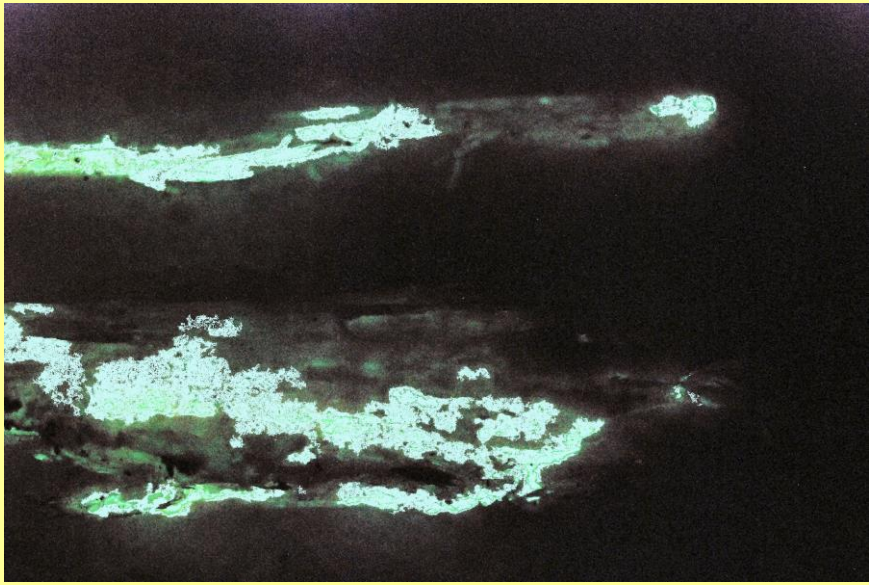
Means of spread by this fungus

1. Above ground by spores, to new pockets (long distance)
2. Below ground by Rhizomorphs, within pocket (short distance)



Armillaria rot glows in the dark.

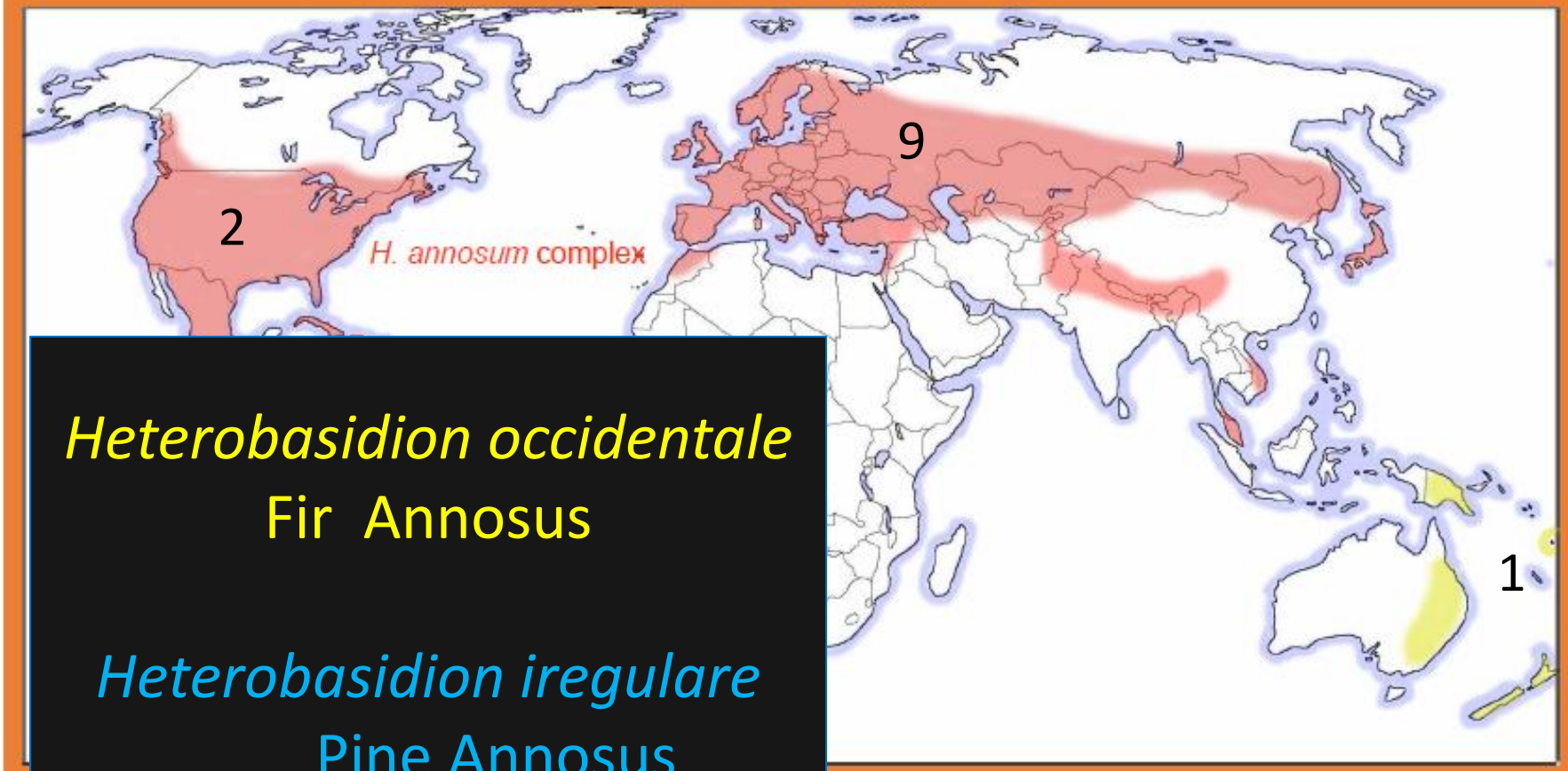
Shot at ISO 1600, f 3.3 & 30 sec with 60mm macro on a Nikon D80




Whitaker's
Forest

Heterobasidion spp. distribution (Korhonen, 2004)

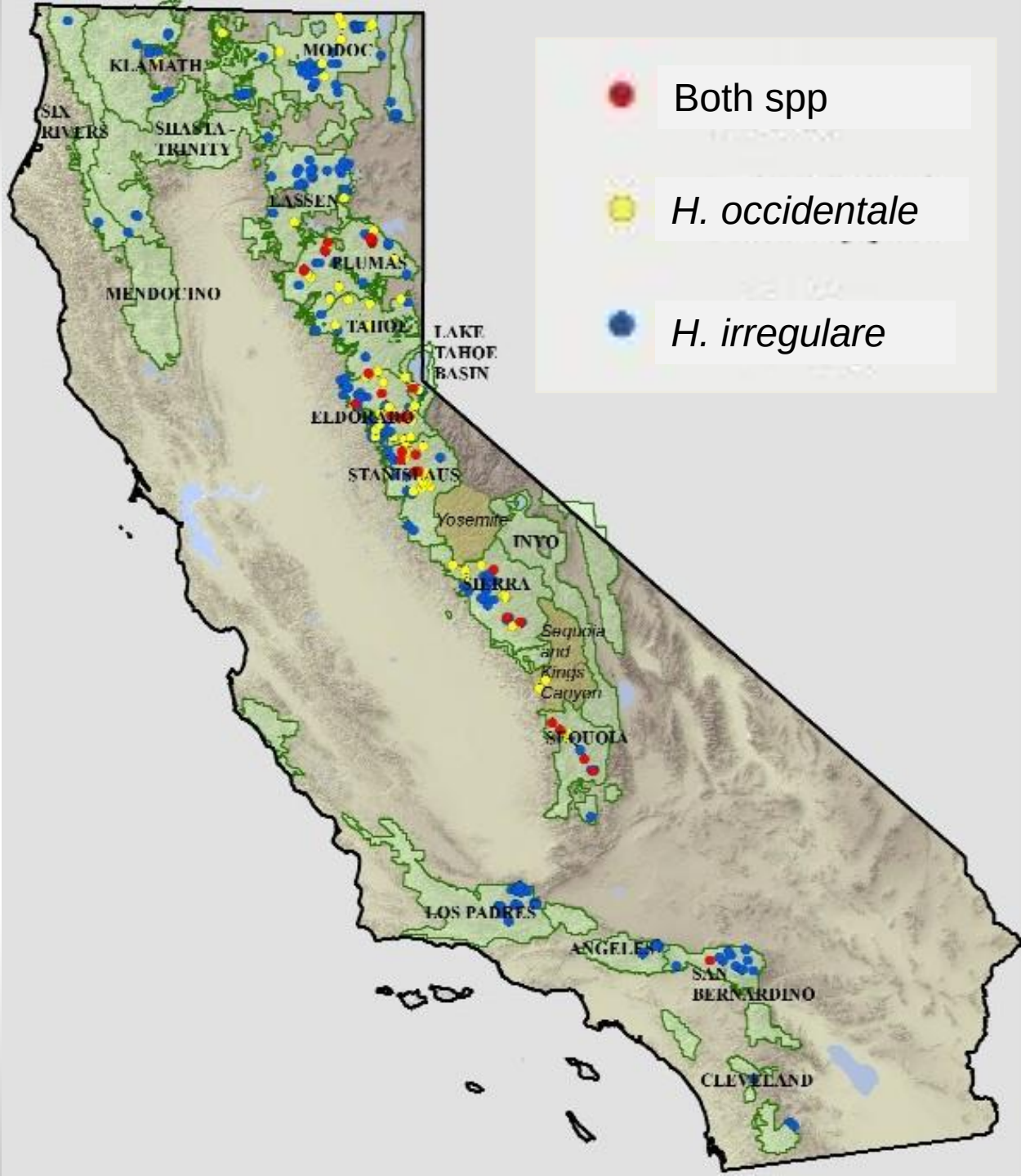
Species complex, 6 species

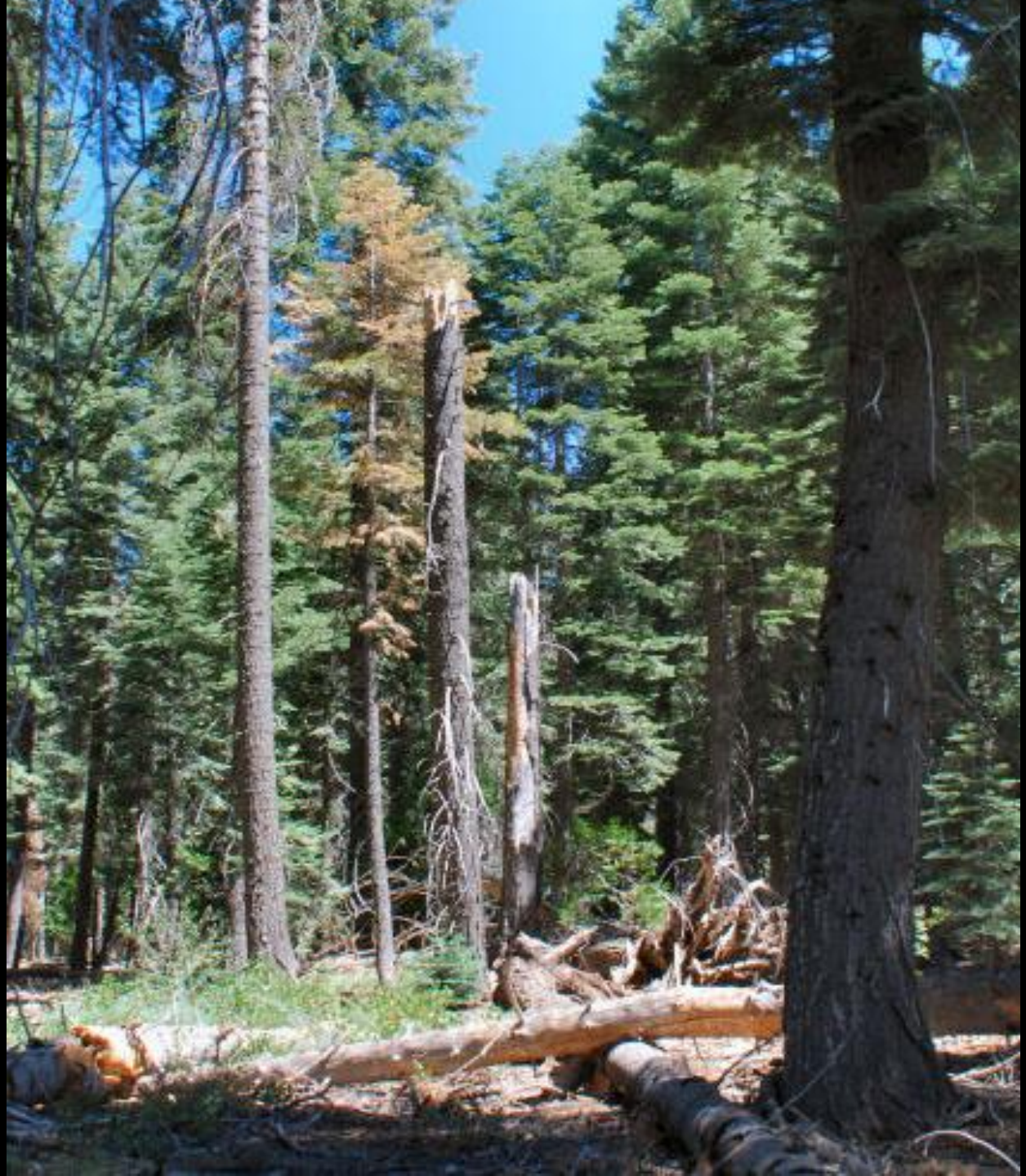


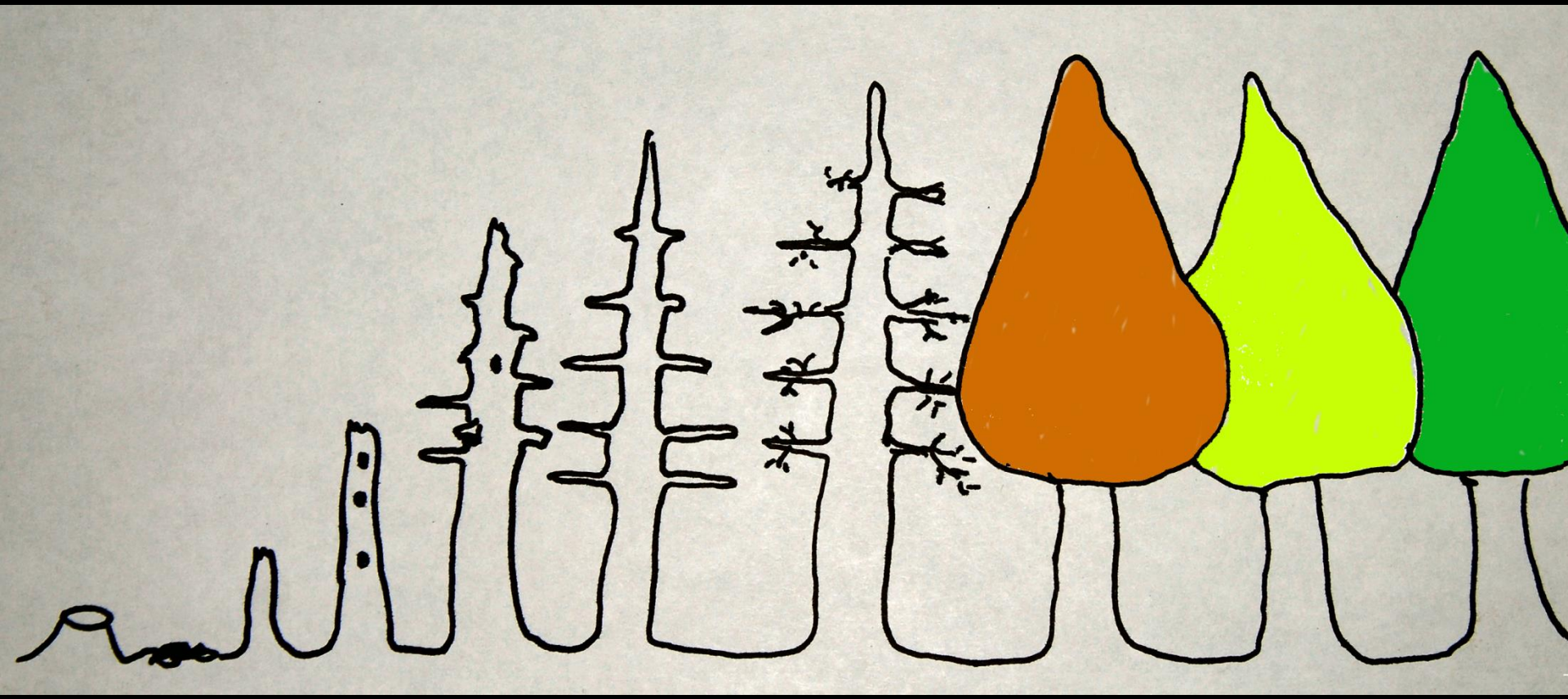
Heterobasidion occidentale
Fir Annosus

Heterobasidion iregulare
Pine Annosus

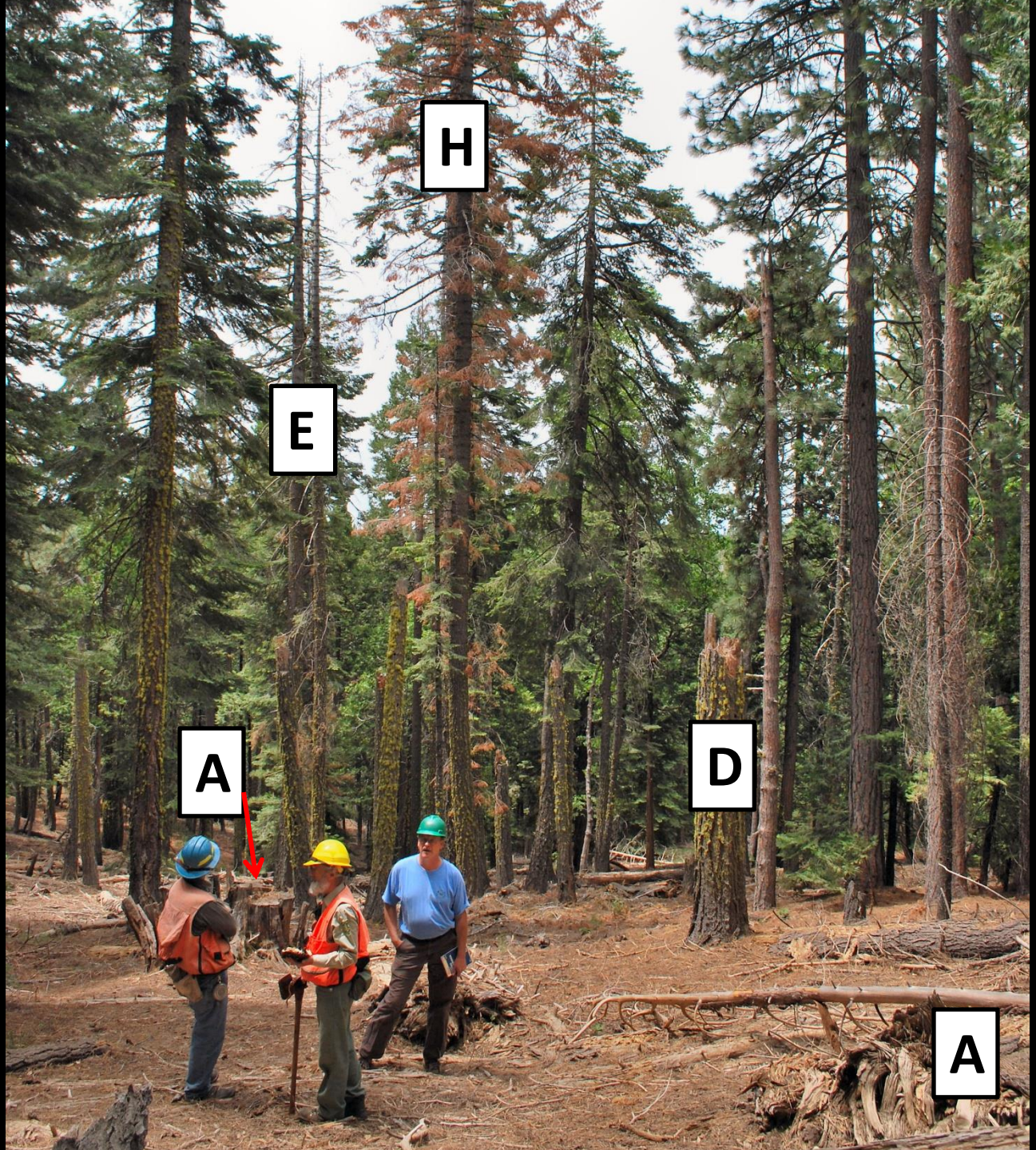
Annosus Root Disease Reports in California







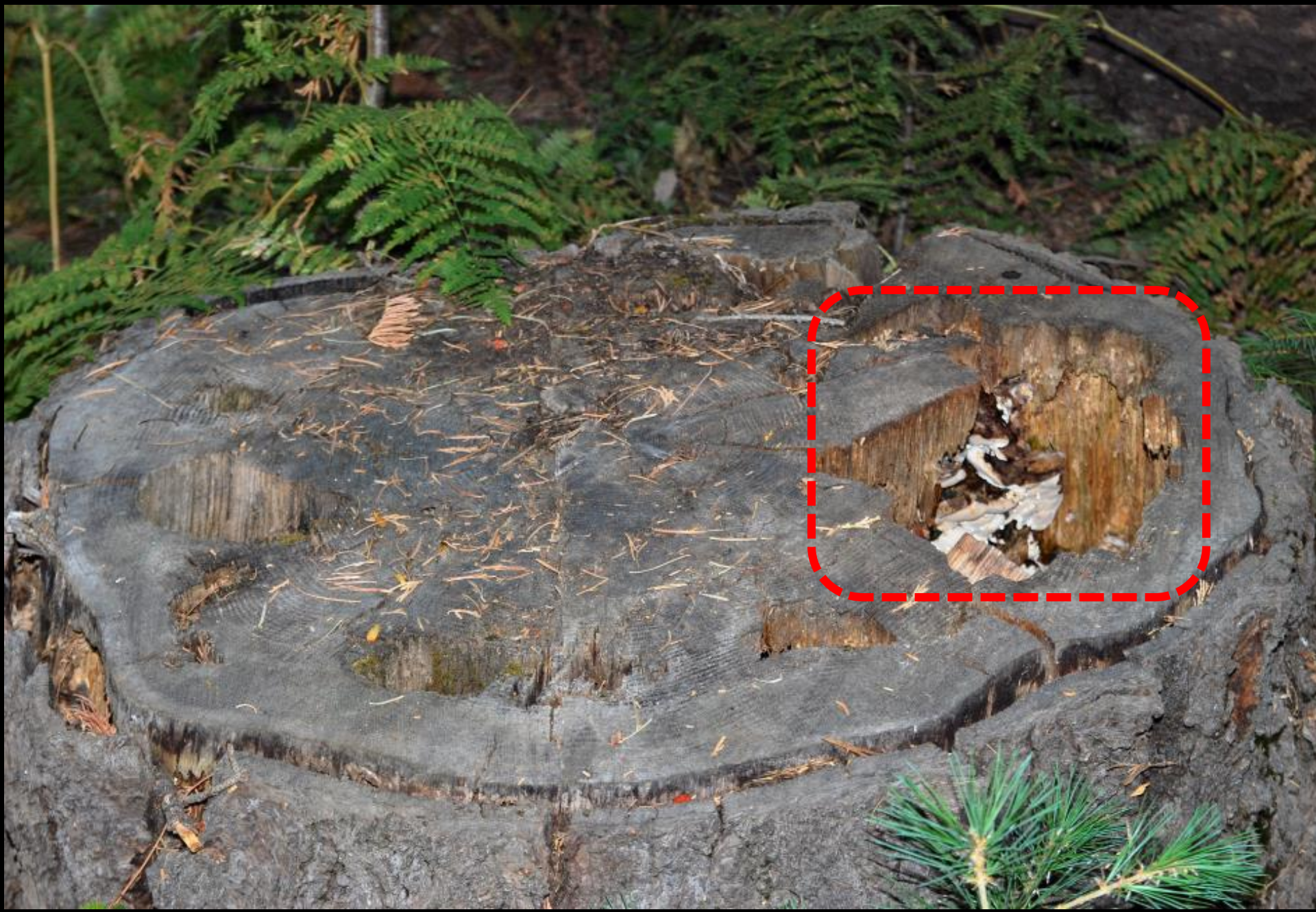
A B C D E F G H I J


H
E
A
D
A

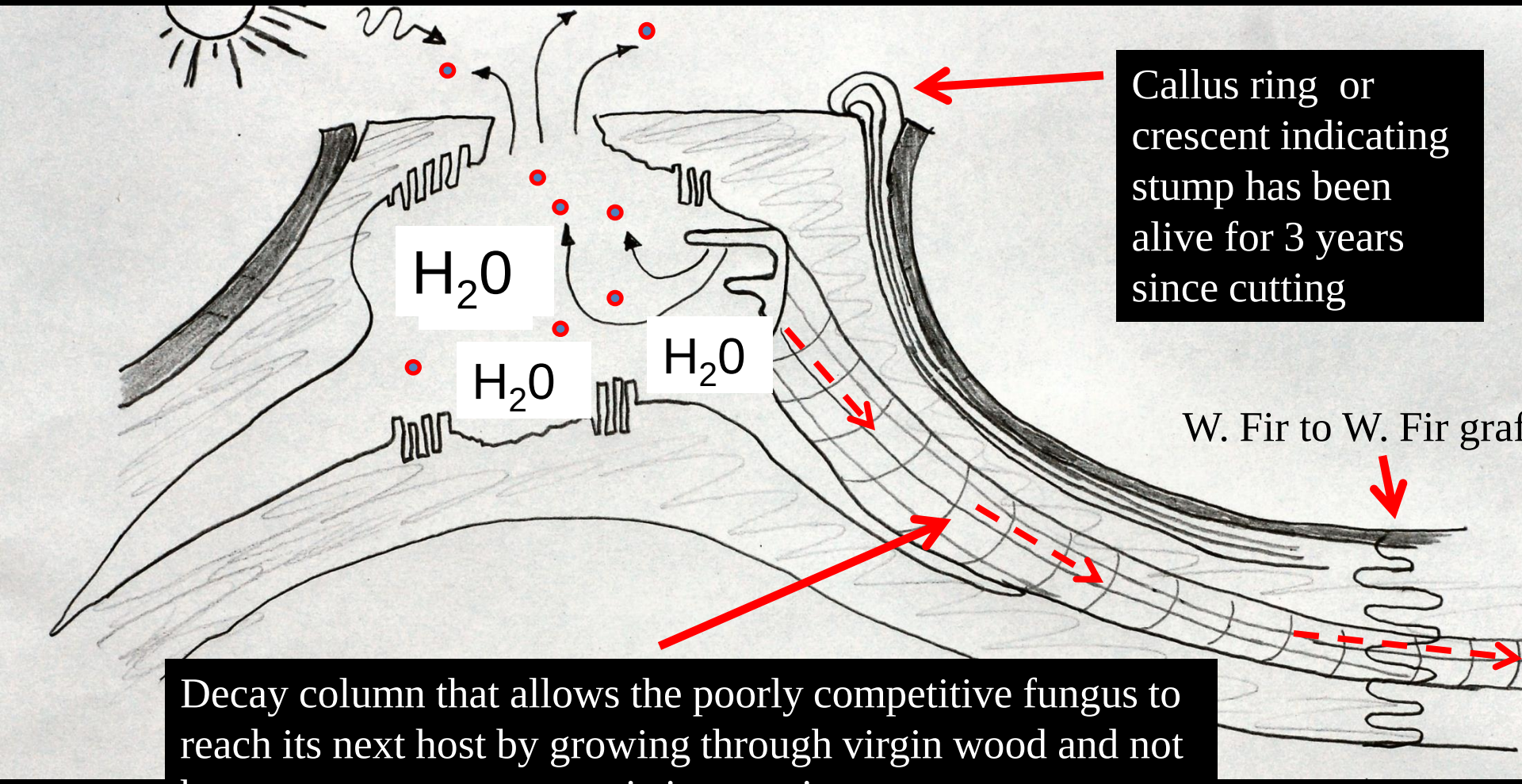

E
E
E
C
A


A
B


A

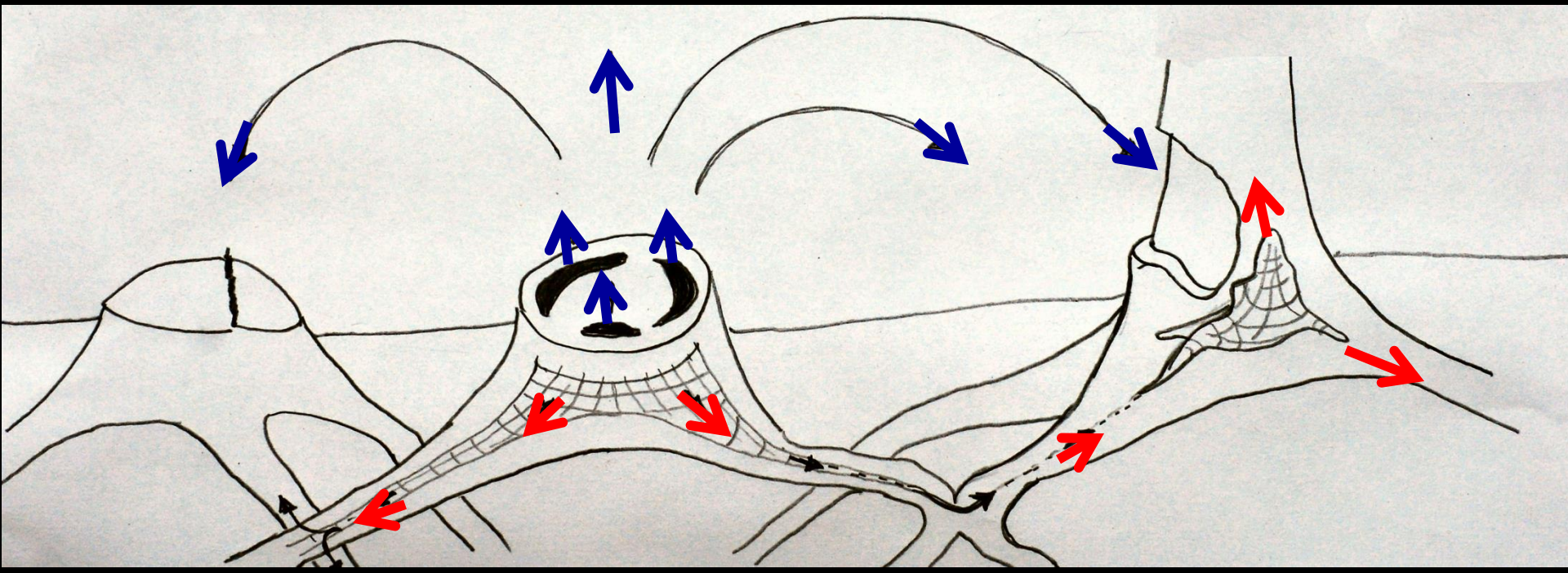


(1) Sun warms the moist air in the decay chamber and the rising warm air carries the spores out, to be transported in the breeze to the next freshly cut stump.

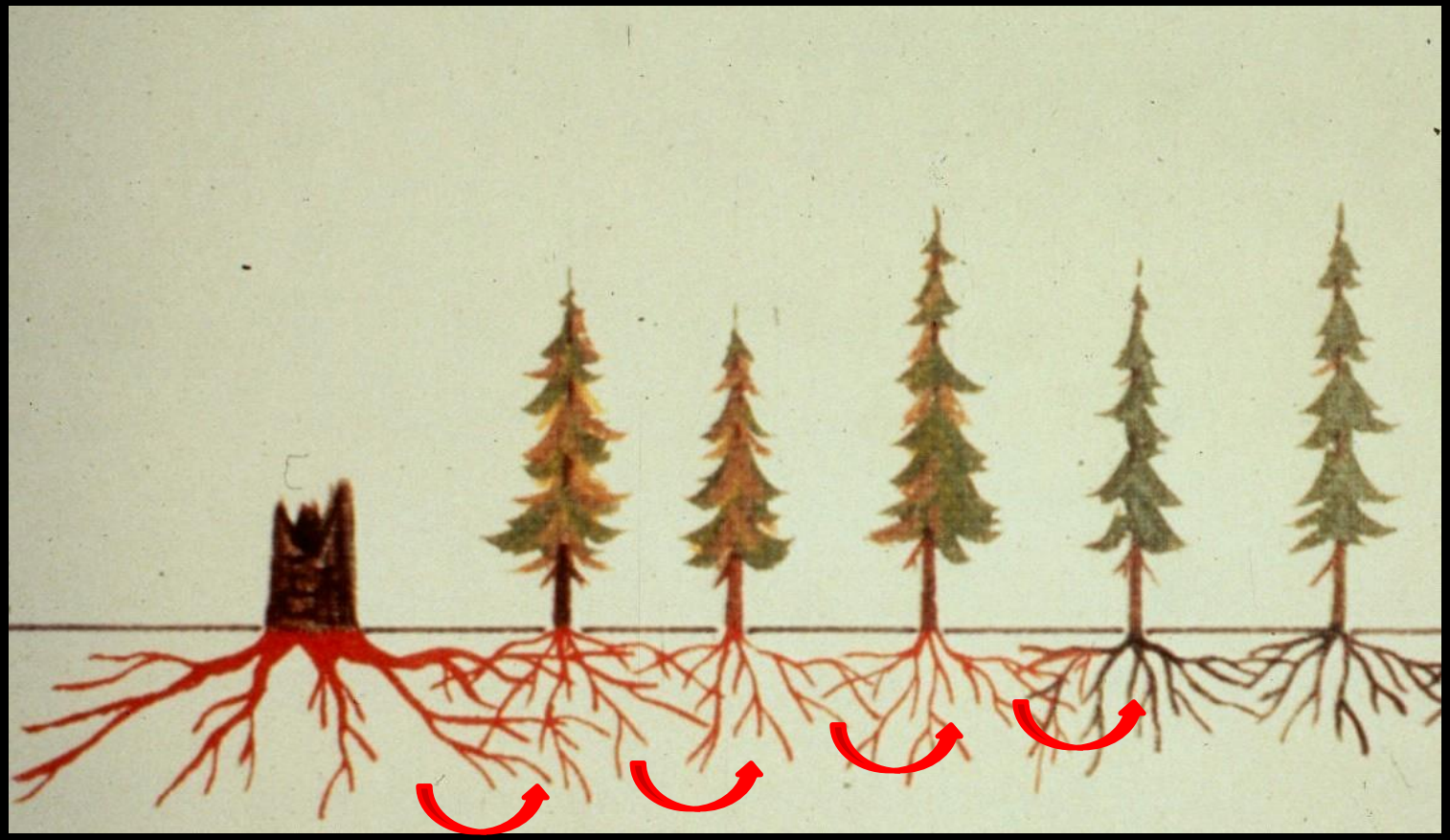


Means of spread of this fungus:

- Within pockets by root contacts or grafts
- To new pockets by windblown spores



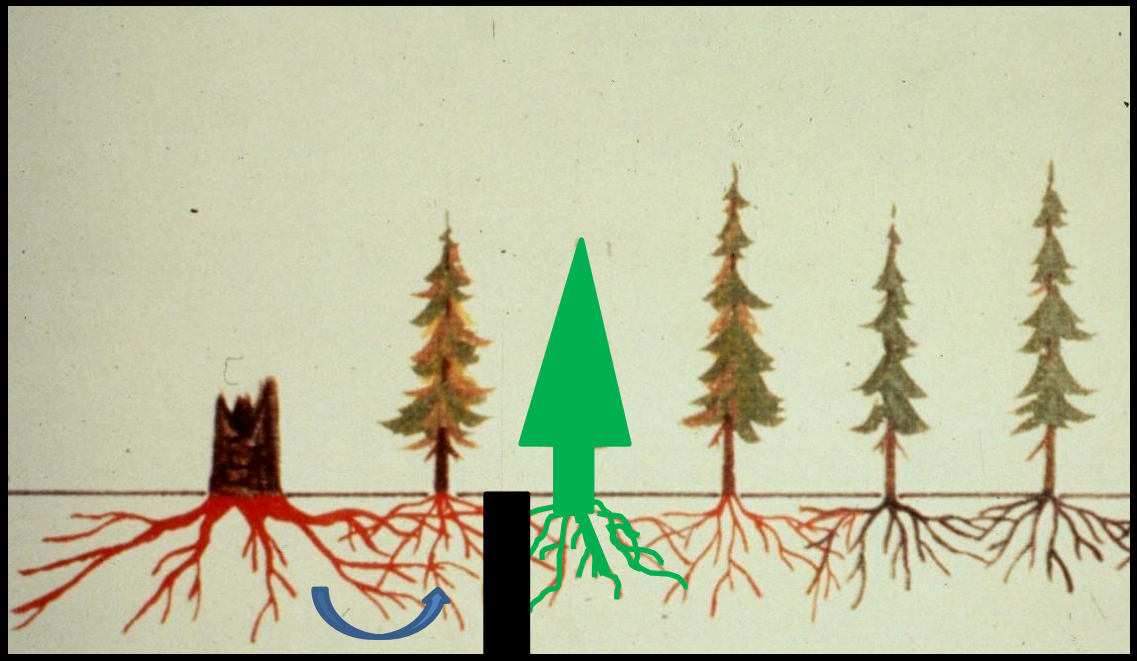
Root-to-Root Spread



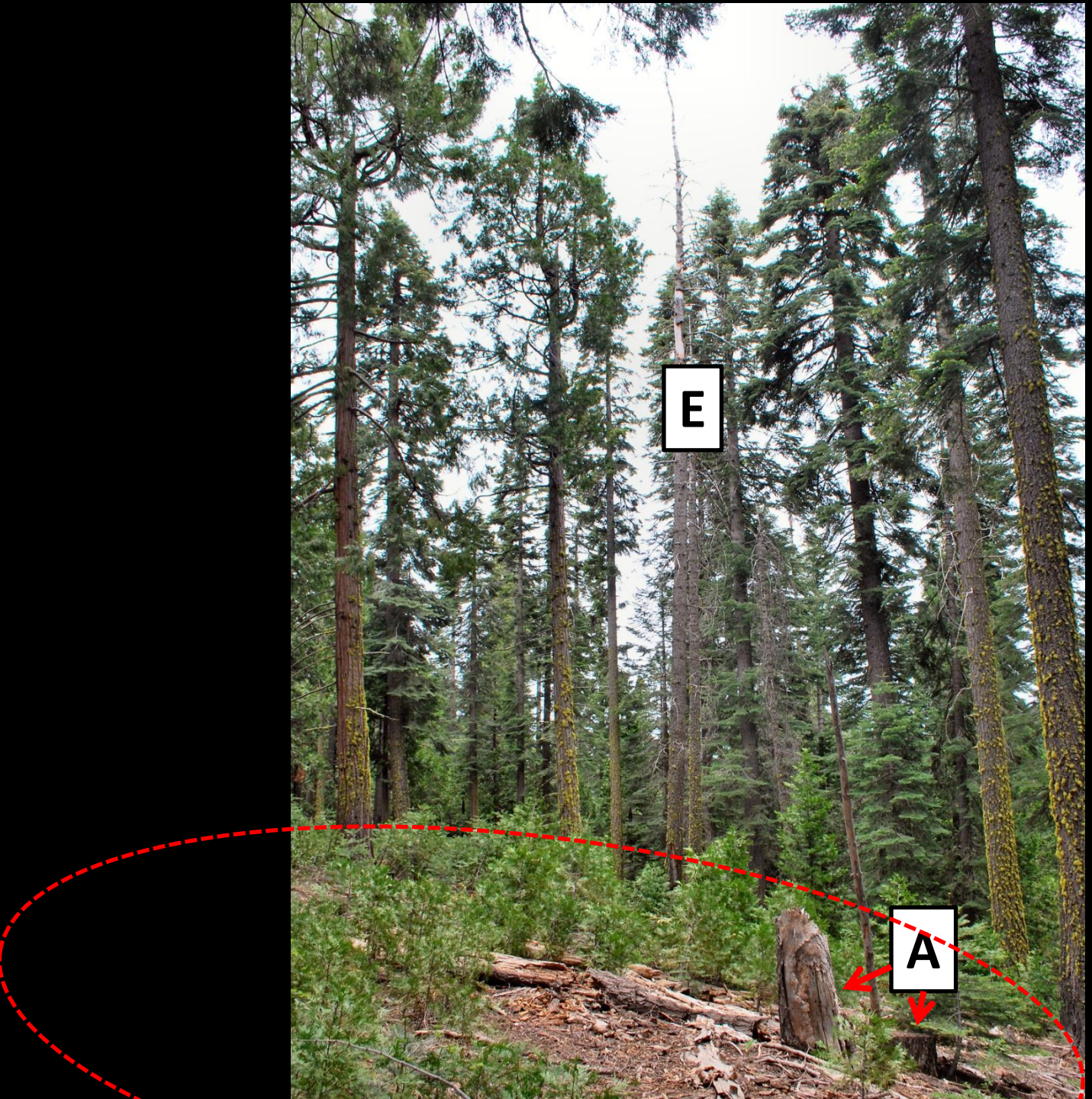
Disease is *beyond* trees with crown symptoms

Spread 1 – 6 ft / year

Root-to-Root Spread



Disease is *beyond* trees with crown symptoms

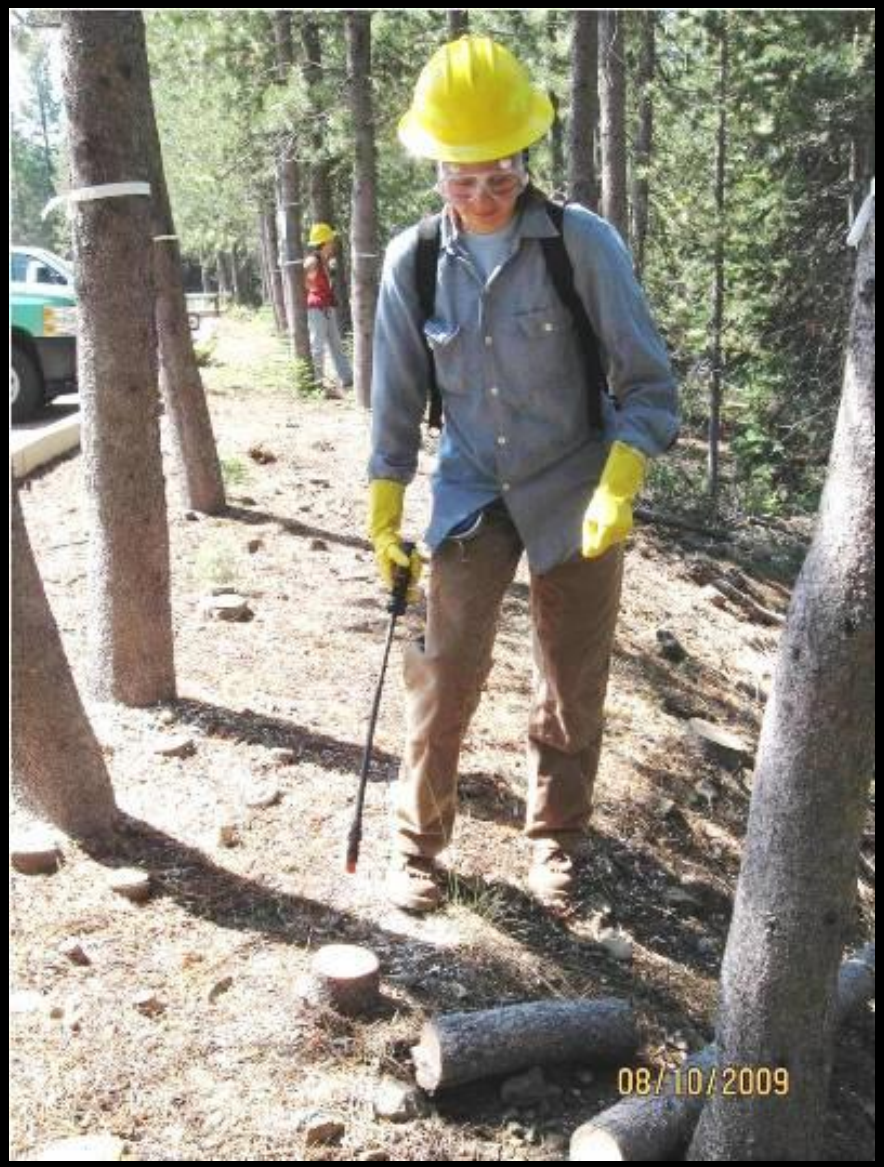

E
A

Why Heterobasidion root disease is such a problem

- Strong Saprophytic Abilities
  - Colonizes dead and dying stumps out to roots
  - Decays heartwood leaving stringy white rot
  - Other fungi can't compete
  - Occupy root systems for up to 35 yrs!

Both species can colonize (*dead*) stumps of the hosts of the other type!

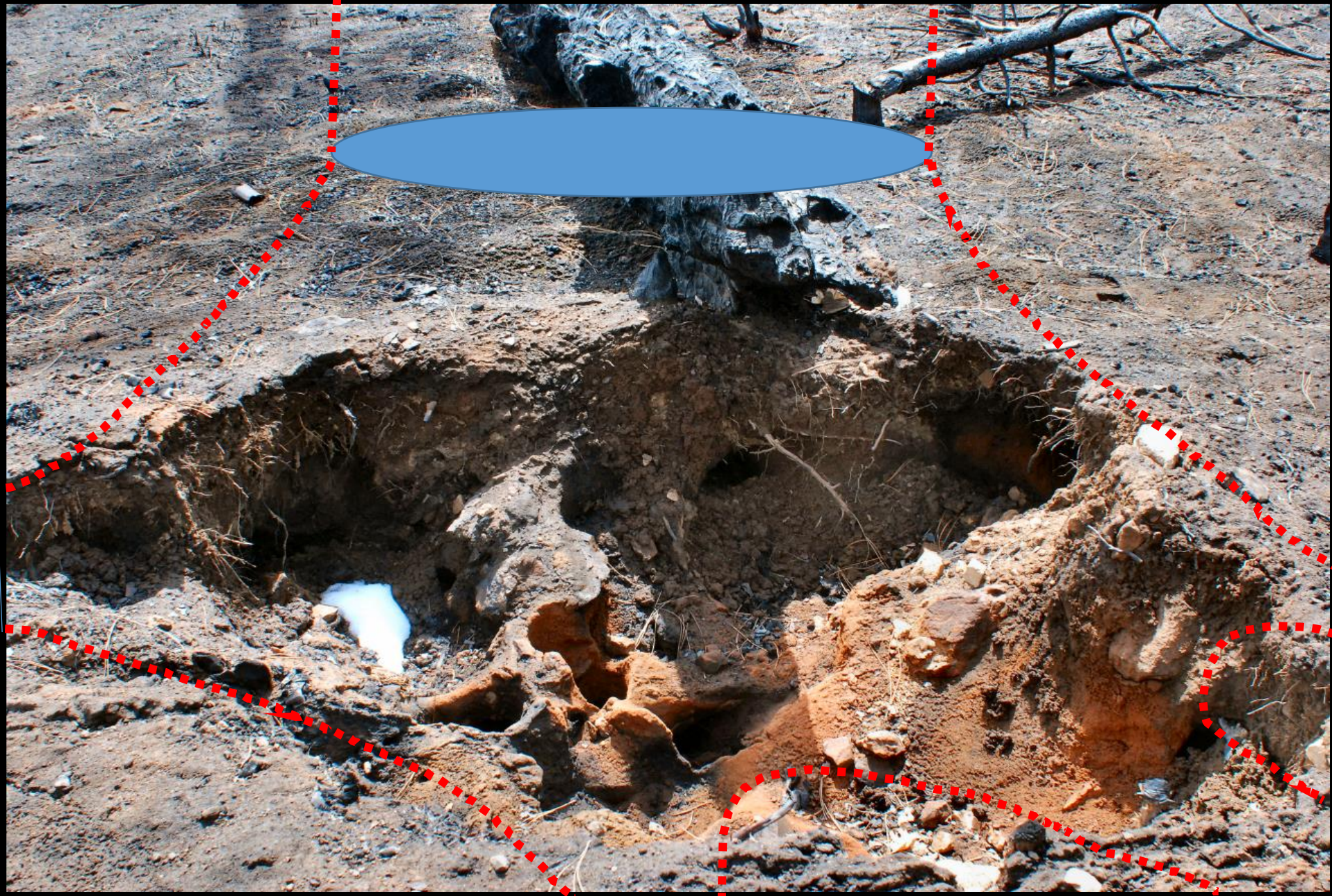
Cellu-Treat application on Plumas NF using back-pack sprayer

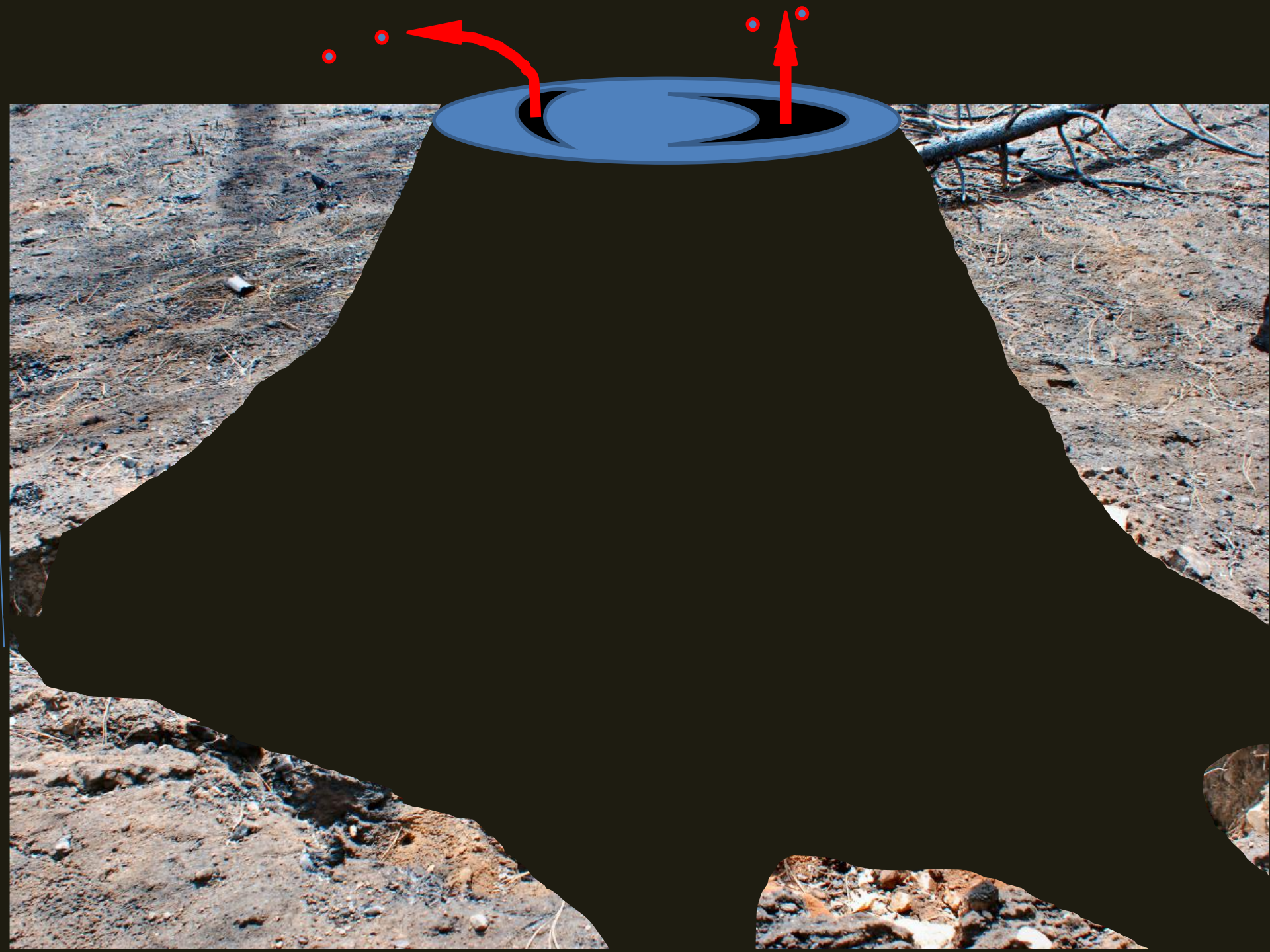


5% a.i. solution

1 lb in 2 gals + dye

Covers 400 sq ft = 500 x 12 inch stumps





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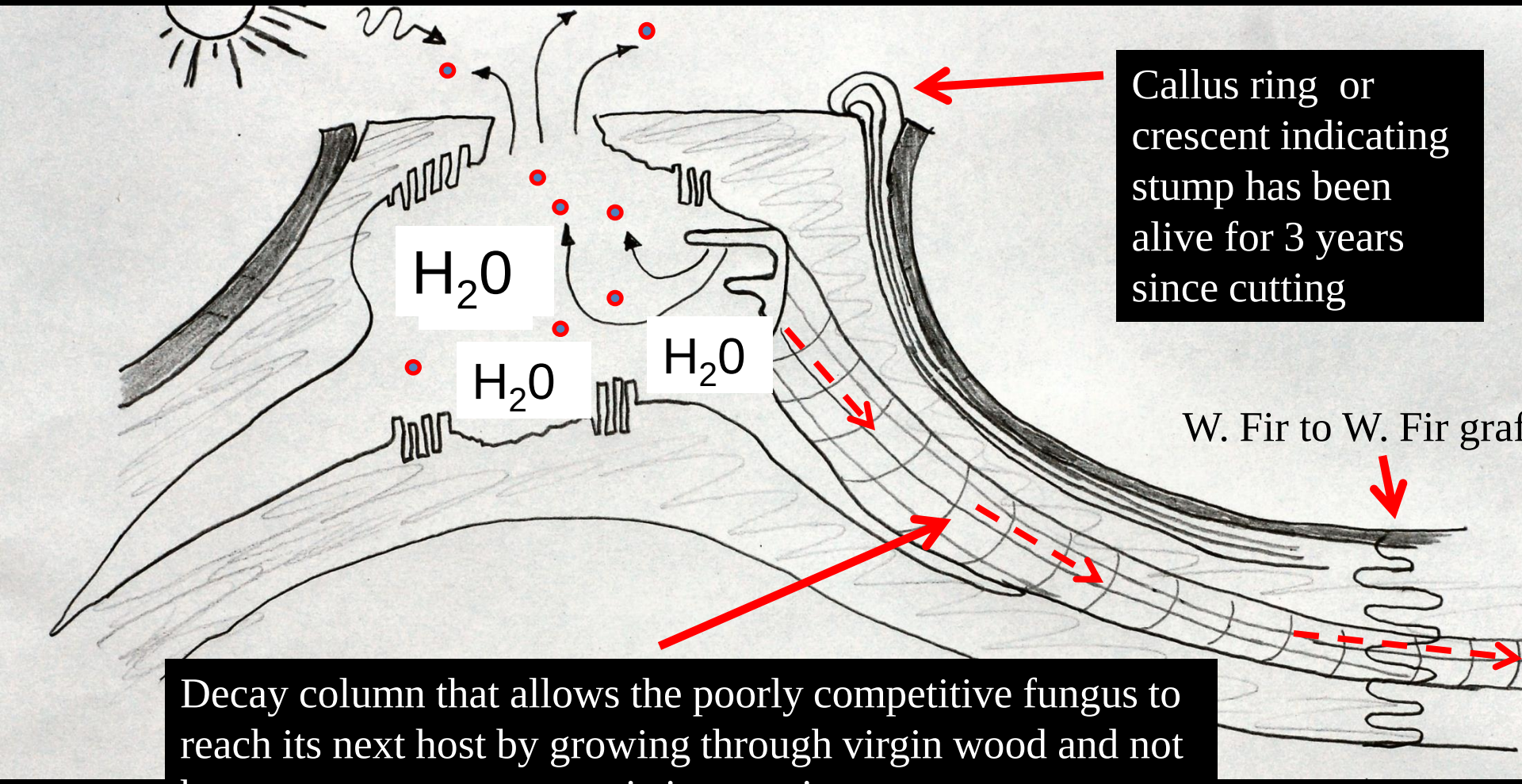
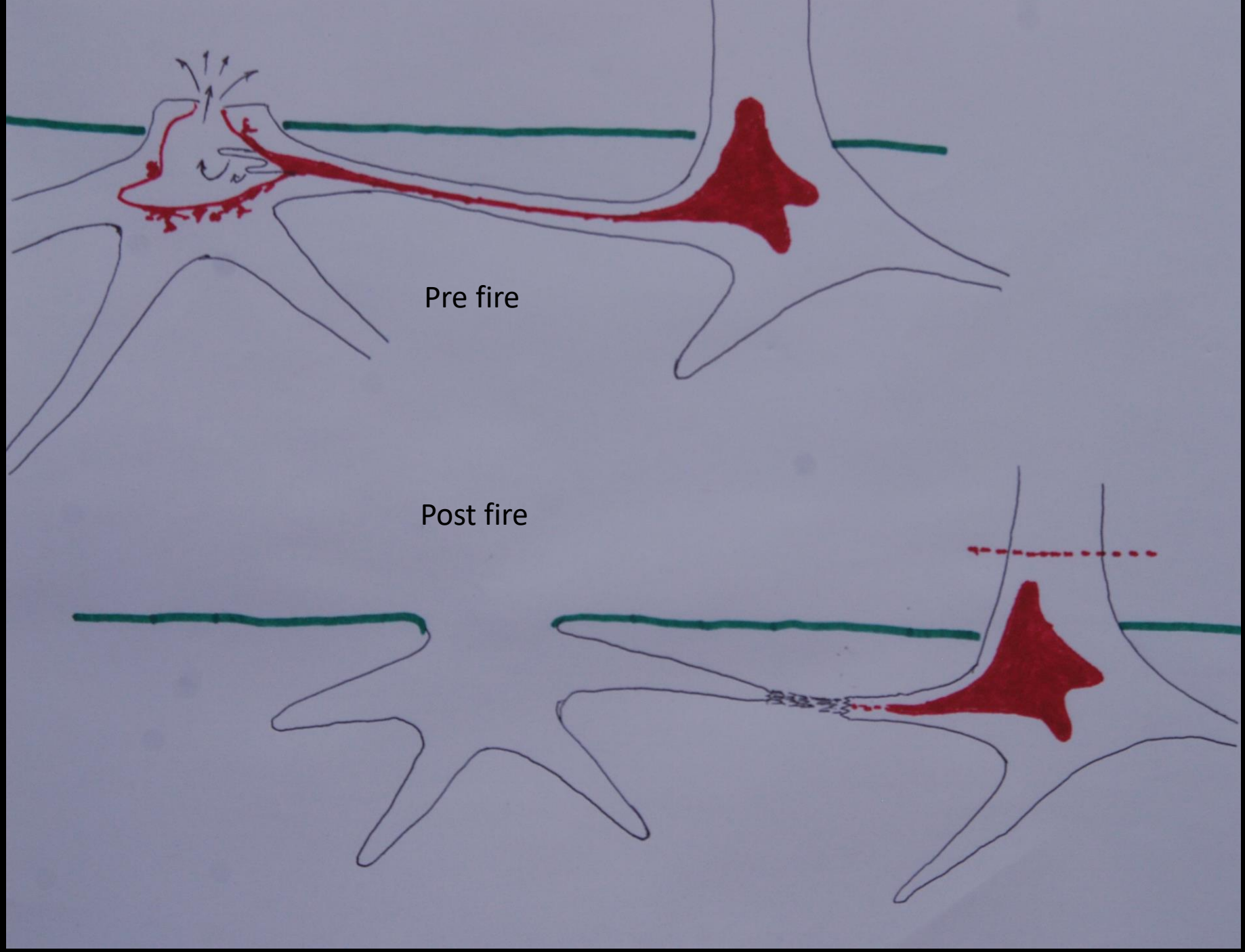
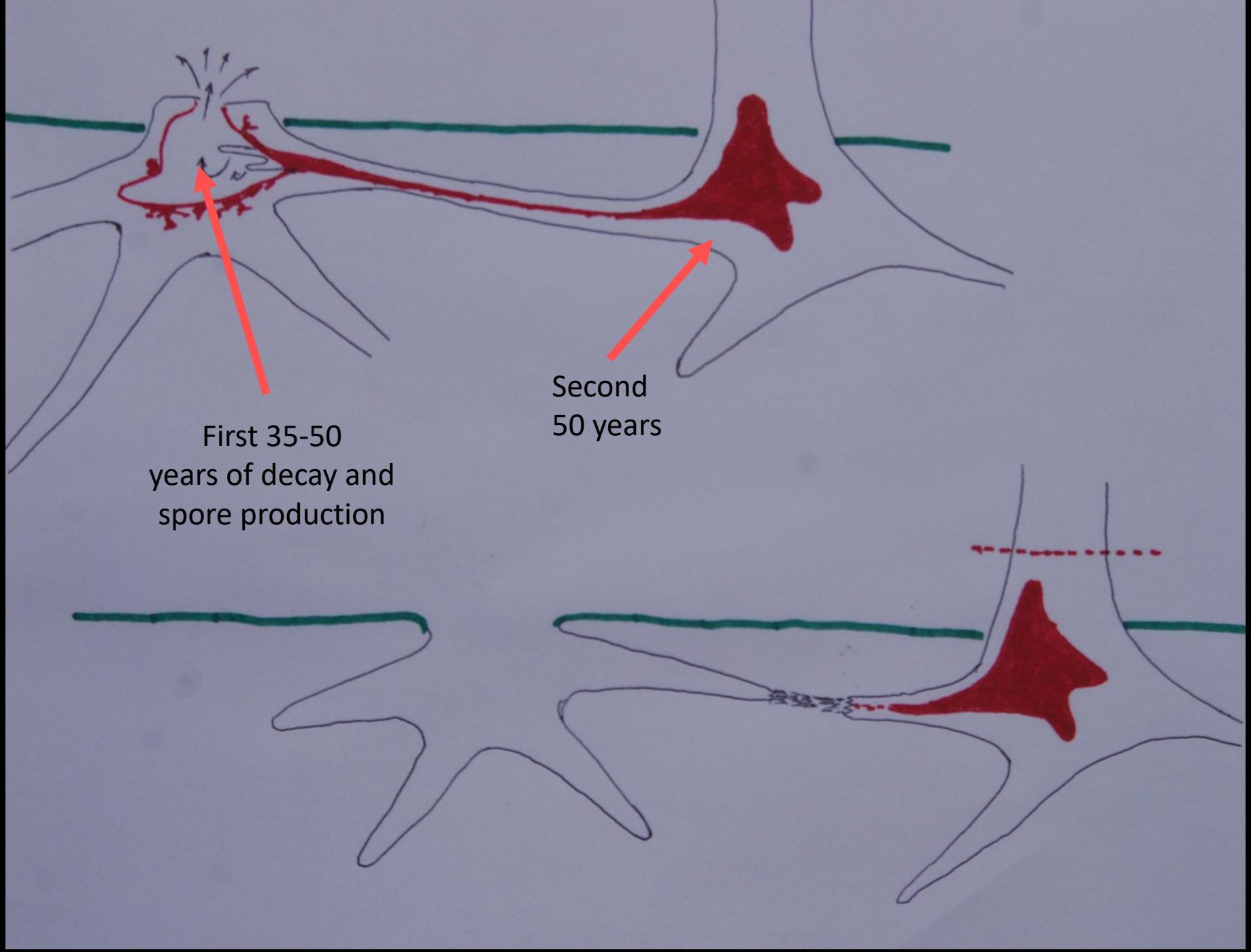
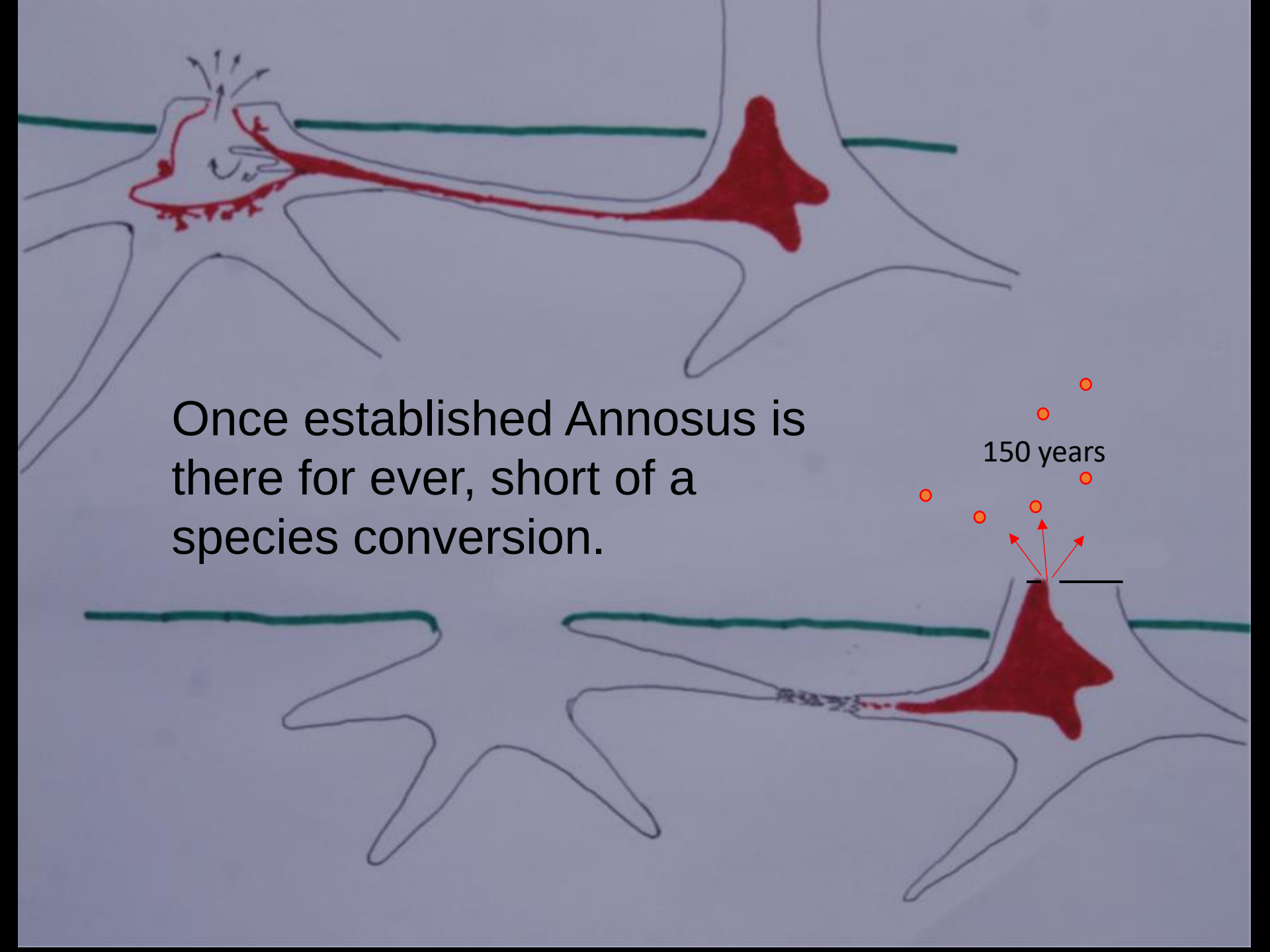



Pre fire
Post fire


First 35-50
years of decay and
spore production
Second
50 years


Once established Annosus is there for ever, short of a species conversion.
150 years

Major General Mark W. Clark commanding the 85th (Custer) Division of the 5th US Army captured the walled Presidential Estate of Castelporziano, Italy in June 1944.

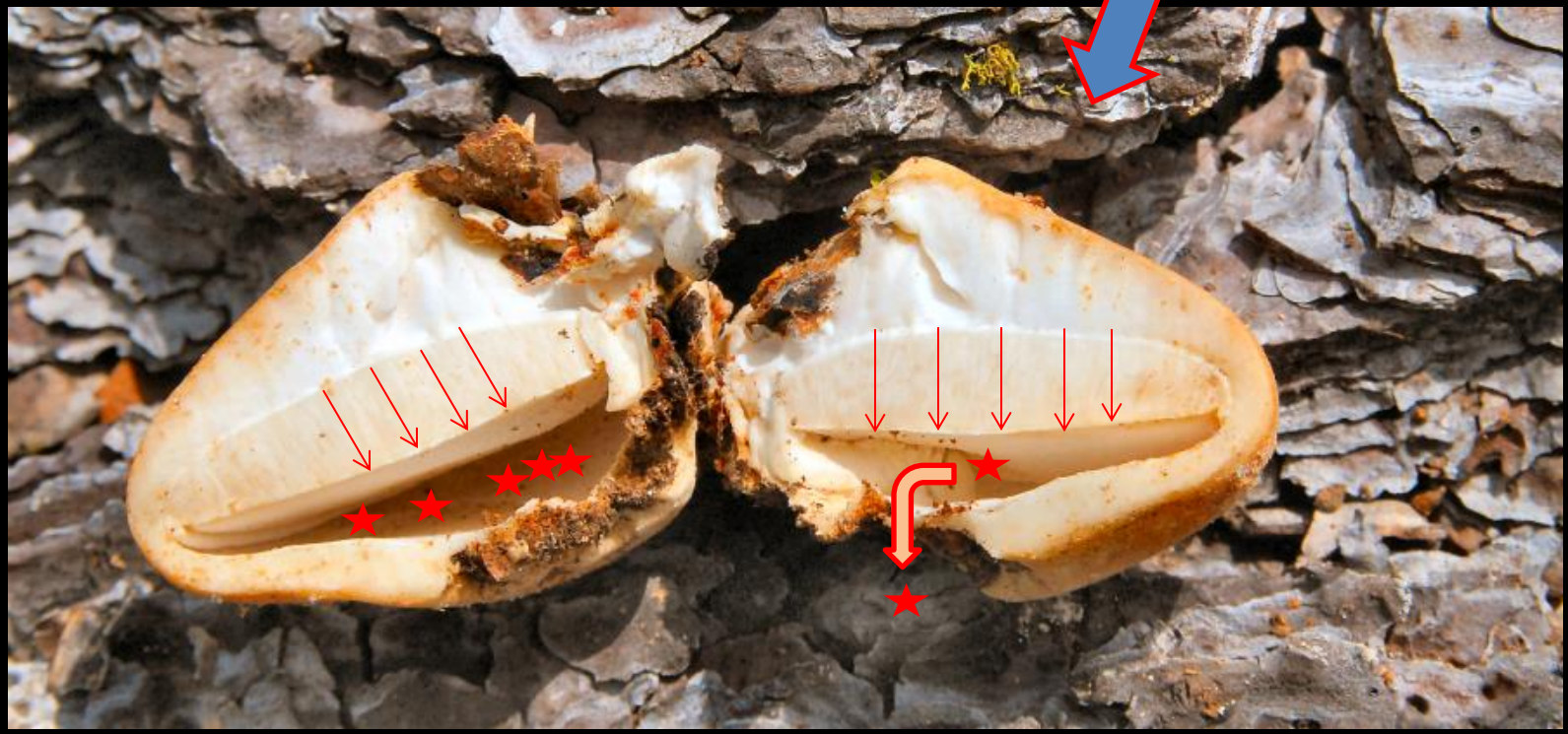
The Custers had trained in MS, LA, & AL They left for Europe from Fort Dix in NJ. And took *H. irregulare* along with them, in their packing materials.

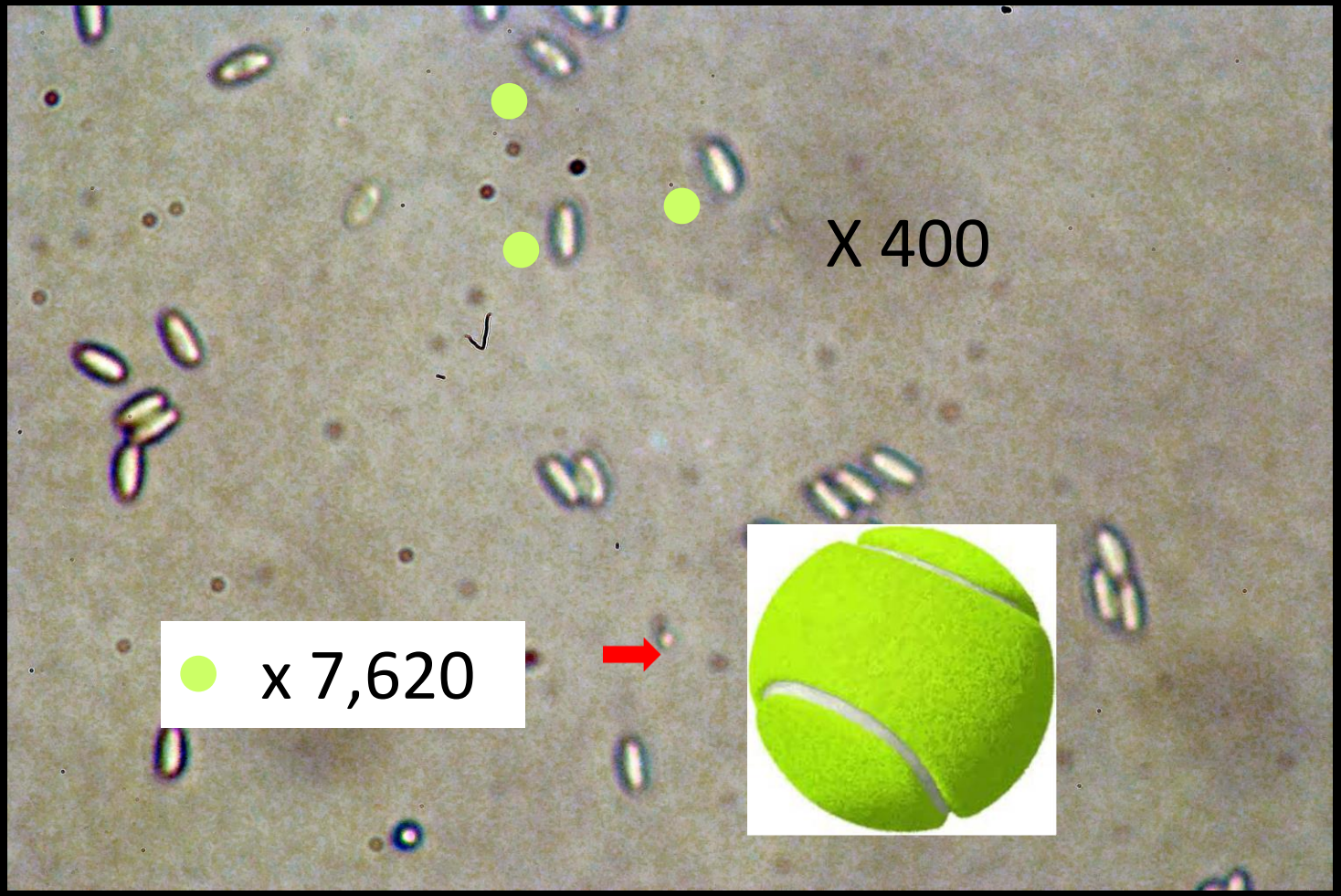
Hybrid of the 2 "P" types
NA x European

Gray-brown Sap Rot
Cryptoporus volvatus

(Crypto = “hidden” + “pores”)

Pouch fungus




X 400
x 7,620

Magnify
a 10 µ spore by
7,620 x times

3 inch ball
now equals

Magnify
a 2 mm beetle exit
hole 7,620 times

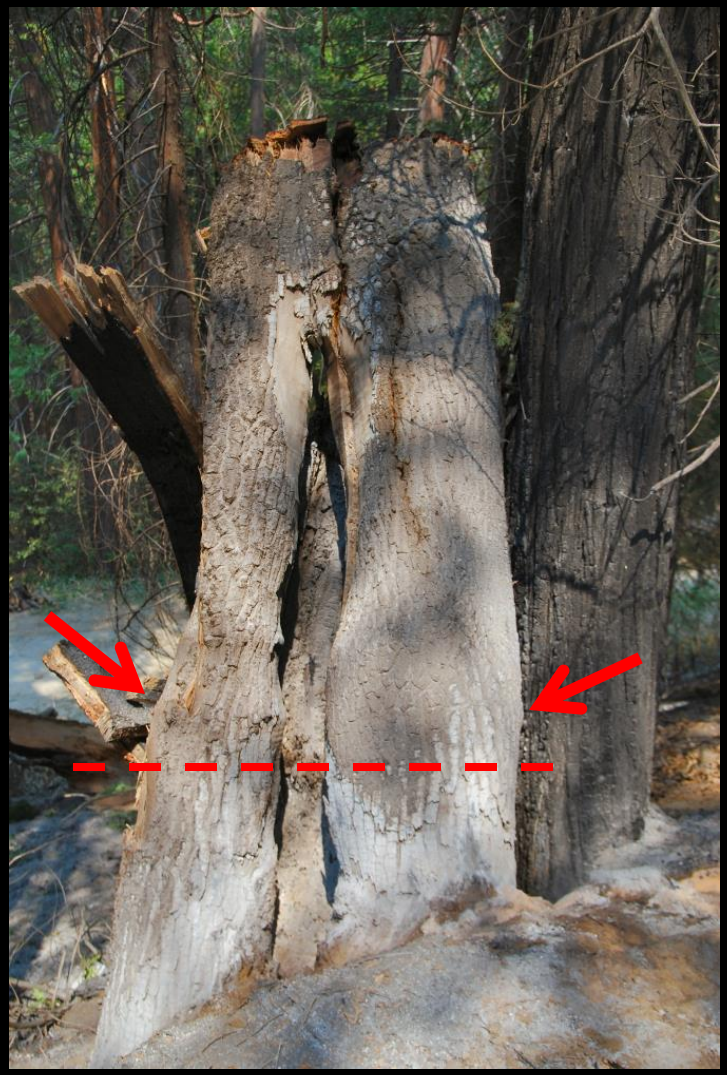
50 foot
culvert

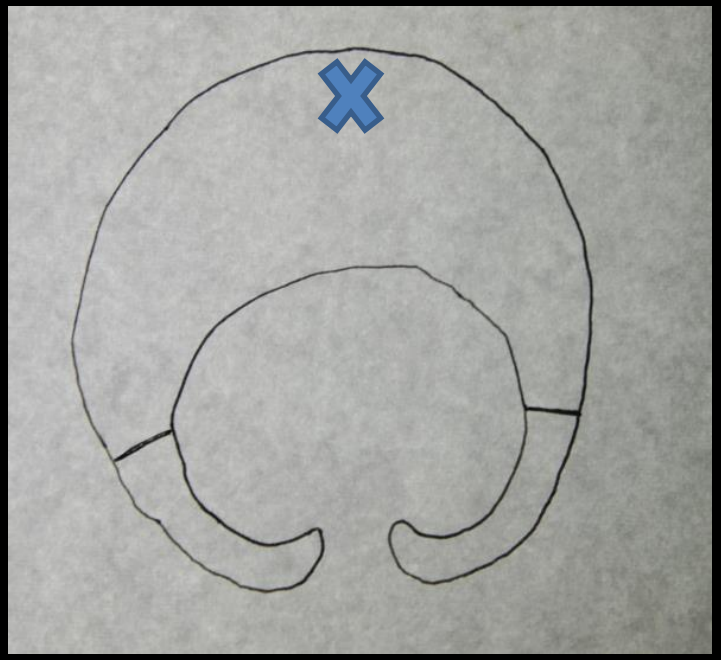

UGA1241533

Engine # 4475 Power Fire, STF, 2013

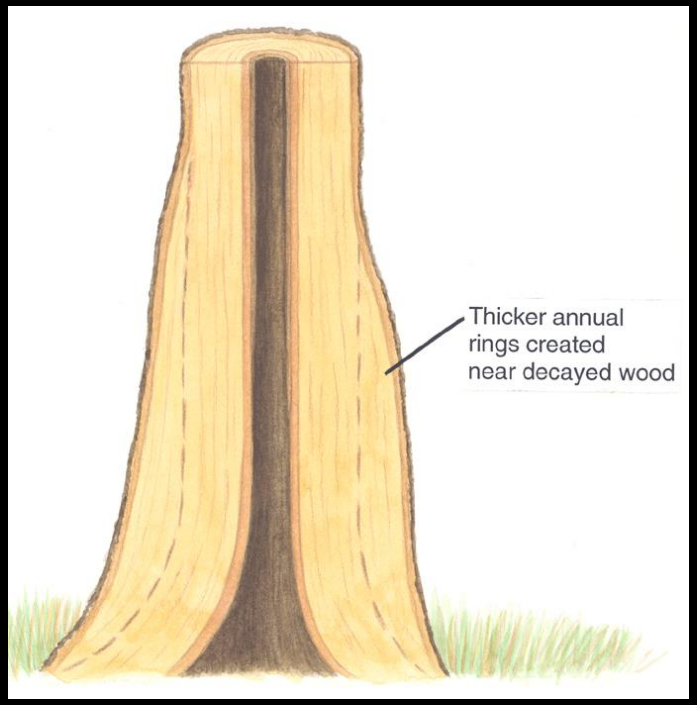

4700
DT466E

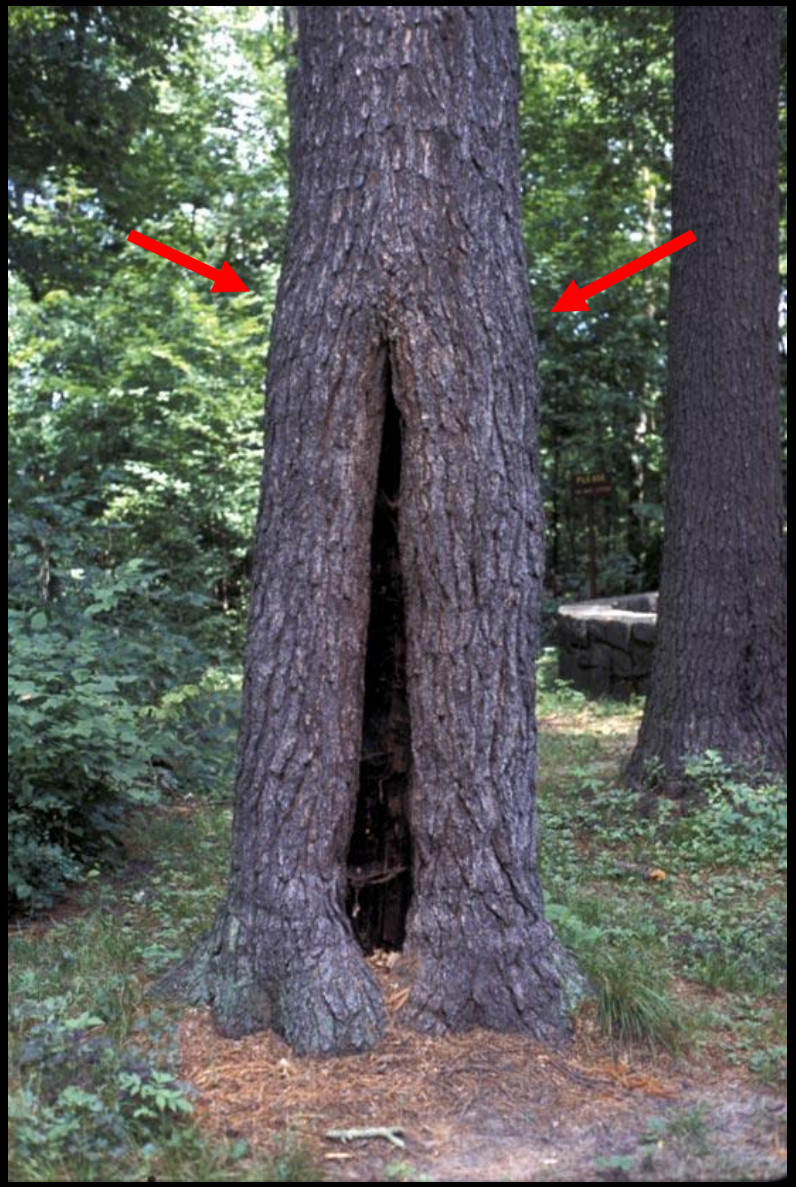

CAL FIRE

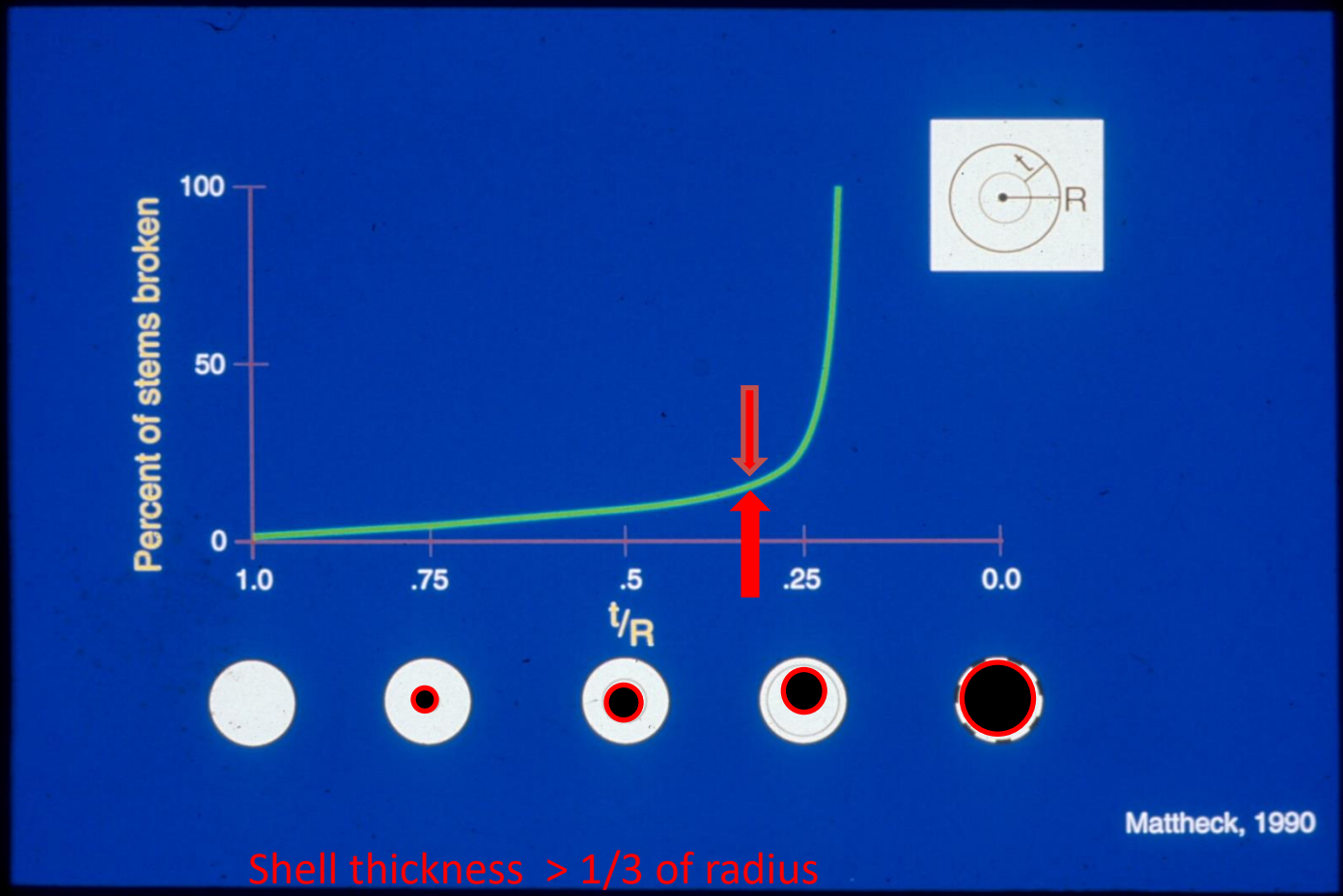




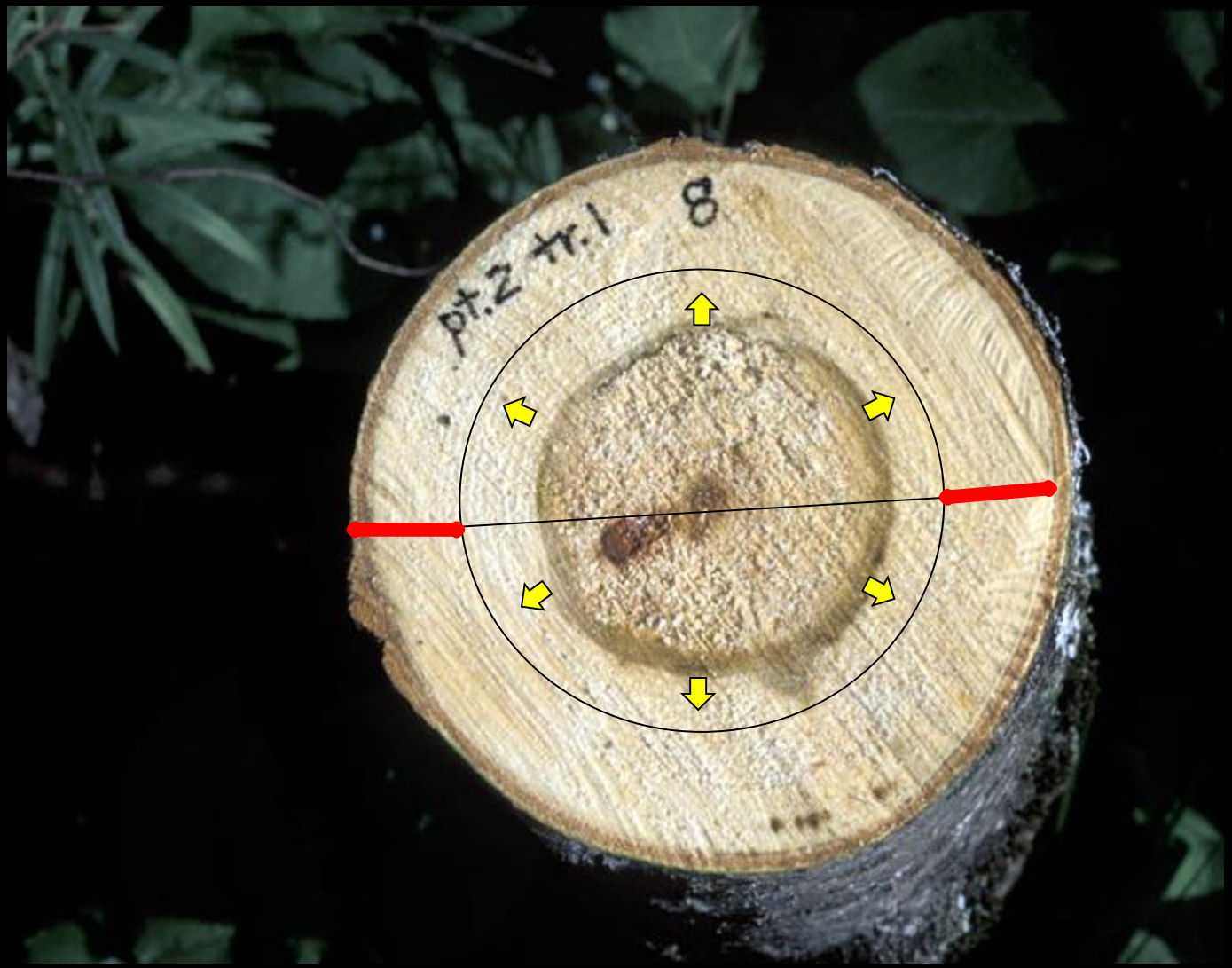
Shell thickness can be affected by bulges/ swellings that sometimes surround columns of decay.



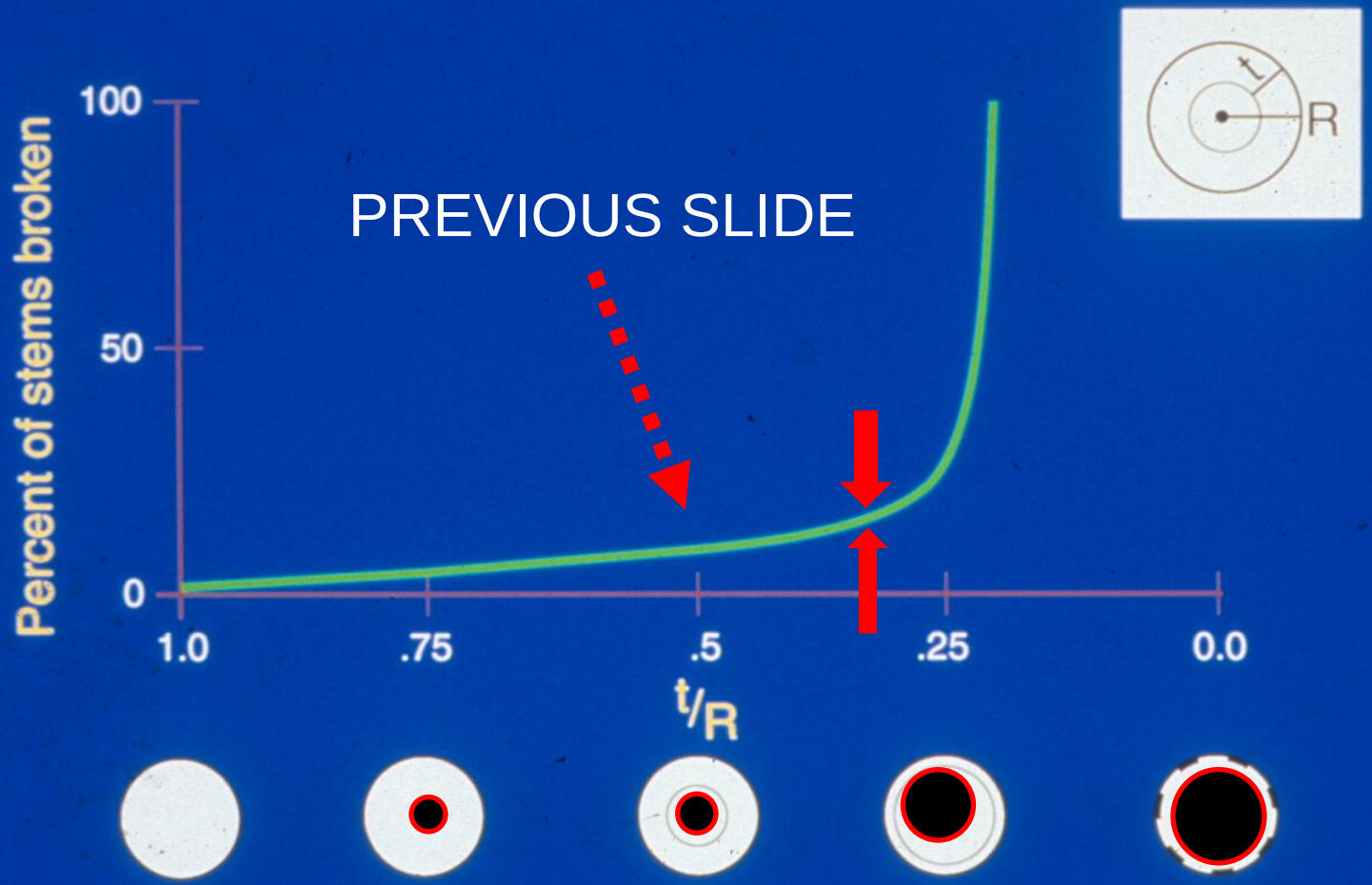




Shell thickness > 1/3 of radius


pt.2 tr.1 8

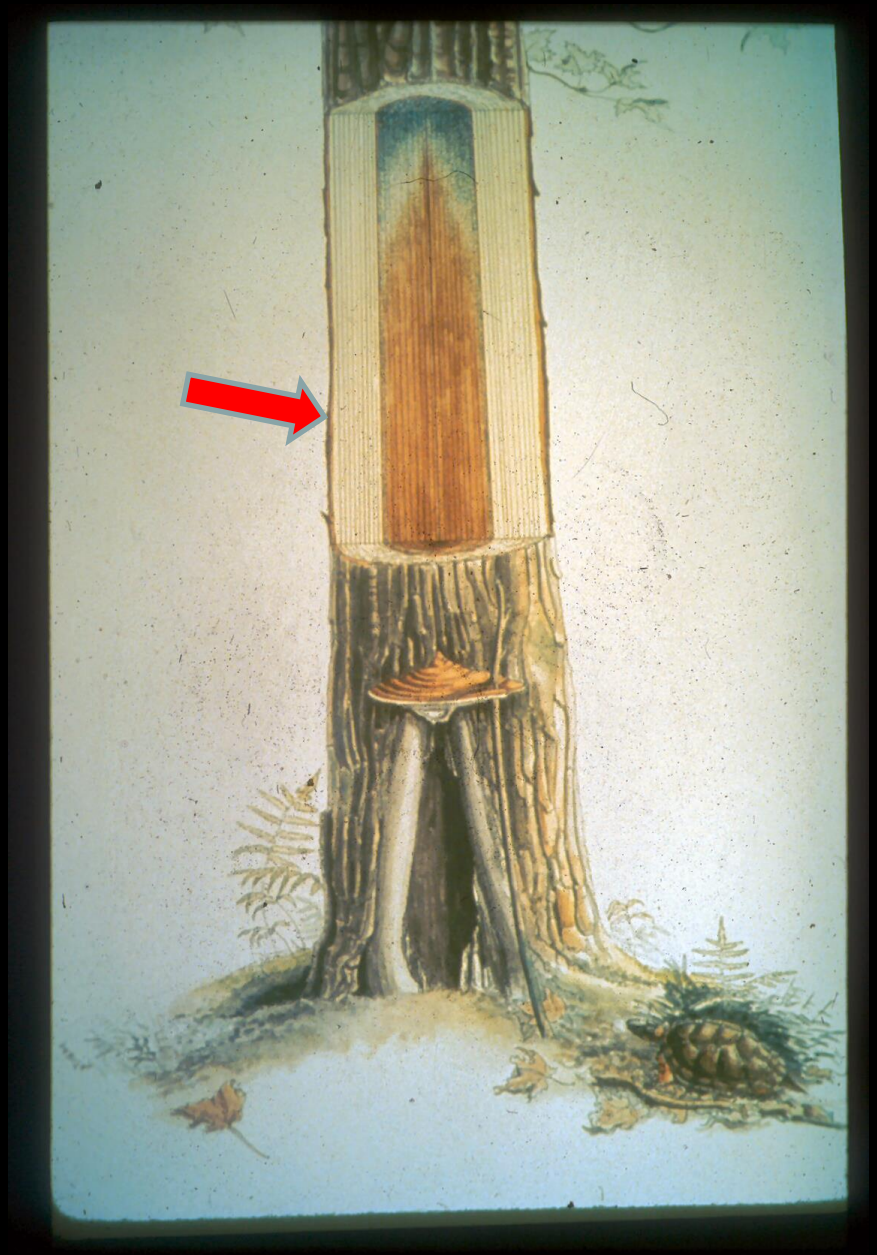

pt.2 tr.1
8



Shell thickness > 1/3 of radius

Mattheck, 1990

T = 0.5



Left of the critical point

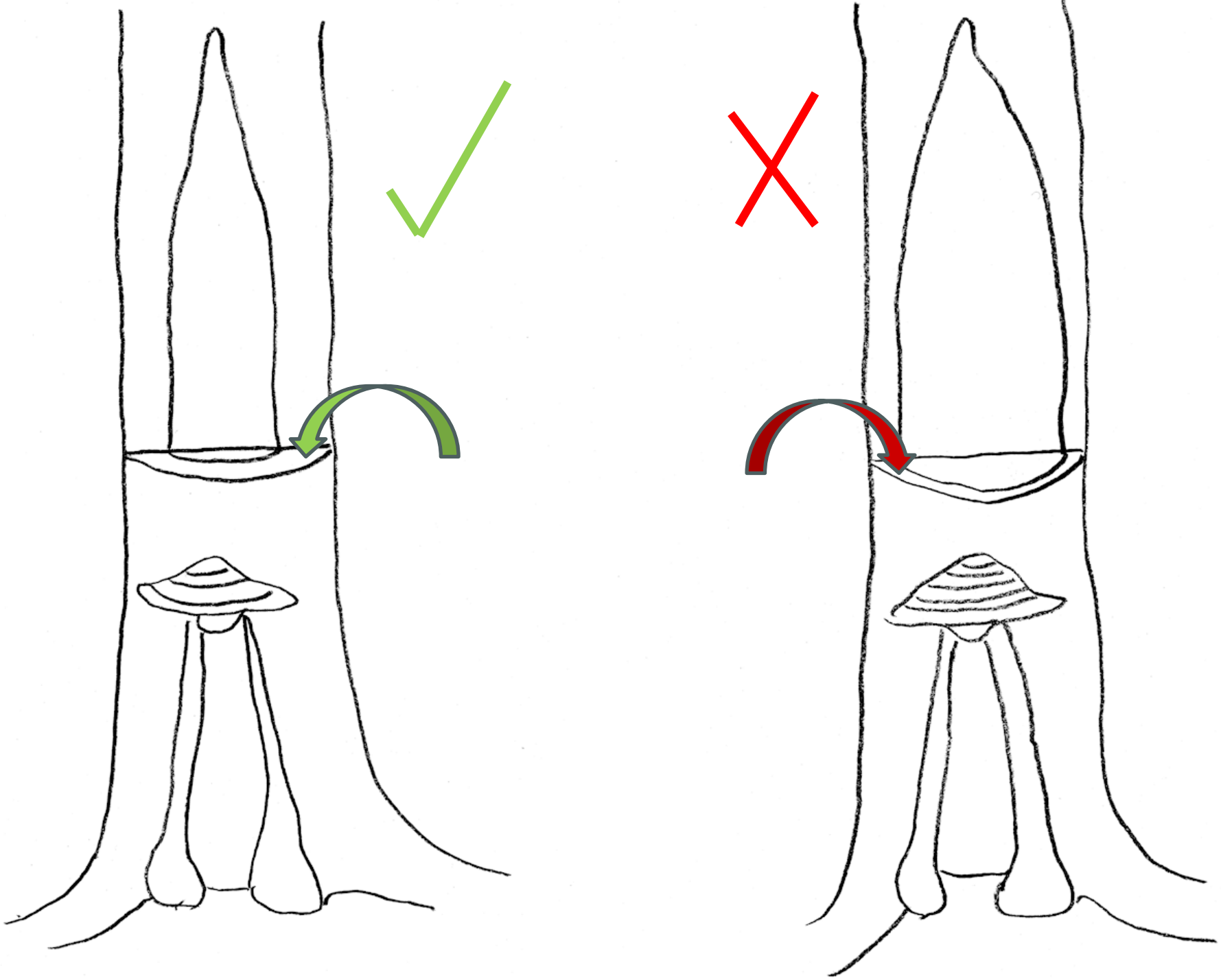
Shell thickness OK

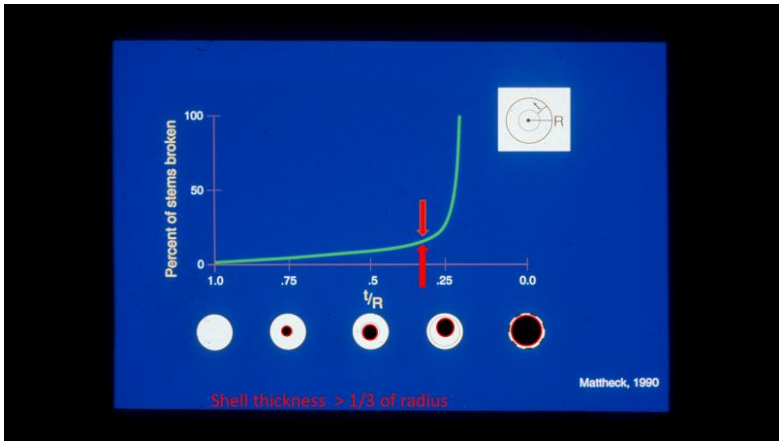
Year 4

Year 7

Conk

Fire scar




Percent of stems broken
100
50
0
1.0
.75
.5
.25
0.0
t/R
R
Mattheck, 1990
Shell thickness > 1/3 of radius

D = 3

D = 3

D = 3

Fomitopsis officinalis

Common Name: Brown Trunk Rot, "Quinine Fungus

Most commonly a trunk rot on old-growth conifers. Stem breakage is common.

Decay is a yellow-brown to reddish-brown cubical rot

Hosts: Douglas-fir, pines, western larch, spruce, hemlock; occasionally true fir

Enters through wounds, branch stubs, broken tops and occasionally through fire scars

Phaeolus schweinitzii

Common Name:

Red-Brown Butt Rot
(Velvet Top Fungus)

Hosts:

Douglas-fir, Pines, True Firs,

Larch, Spruce, Incense-cedar,

Western Red Cedar, Hemlock

Causes a major root and butt decay of older trees
Decay is a brown cubical rot
Enters through root wounds and fire scars

"Cowpie Fungus"

Brown Cubical Butt Rot caused by *Phaeolus schweinitzii*

Paint Fungus

Echinodontium tinctorium

Rust red stringy rot

True firs and Hemlocks

Paint fungus conks indicate extensive decay

Red Ring Rot

caused by *Phellinus pini*

Most conifers

Common on Douglas-fir

aka Porodaedalea pini

aka Porodaedalea pini

The red ring rot fungus causes a white pocket rot

Pecky Rot of Incense Cedar

Oligoporus amarus

Pecky rot

a brown pocket rot

Sulphur fungus

Laetiporus sulphureus

Brown Cubical rot


W R
BR

What do all these have in common ?

SOD
GSOB
EAB
ALB
GM
PSHB
Pitch Canker
Foamy Bark Disease
Thousand Cankers Disease

What do all these have in common ?

SOD
GSOB
EAB
SHB
Pitch Canker
Foamy Bark Disease
Thousand Cankers Disease

Can be Moved in firewood

Can be Moved in firewood

Clark’s Nutcracker

Height 23 inches

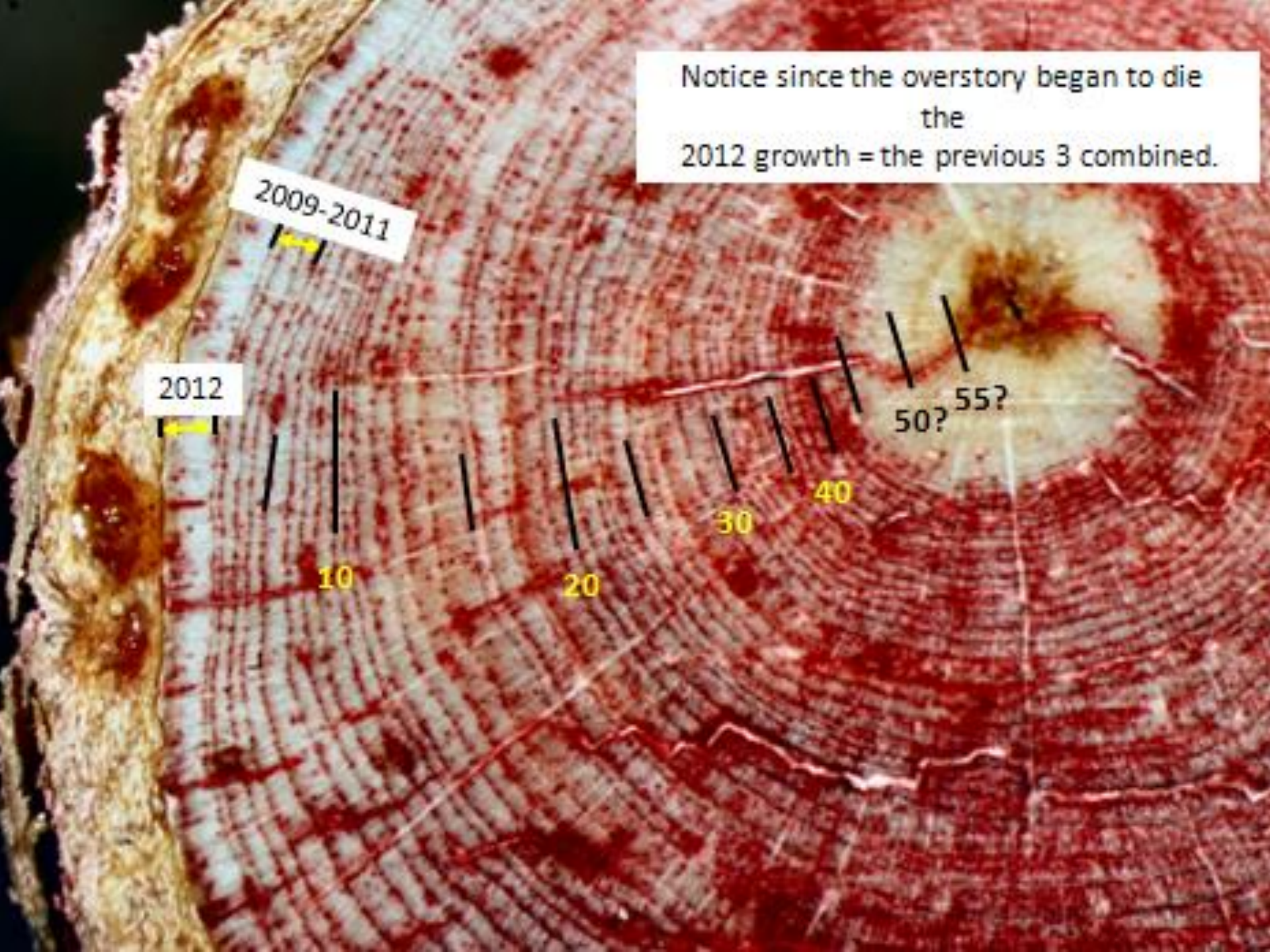
Span 21 inches

Number of stems in cluster 2

Largest diameter 0.79 in.

0.4 inches
height / year

135 years


Notice since the overstory began to die
the
2012 growth = the previous 3 combined.
2009-2011
2012
10
20
30
40
50?
55?

Along came WPBR & eventually the ESA
Well, the rust has been here since 1900
and in WBP since 1926.

White Pine Blister Rust.

We are moving towards a rust resistance breeding program for WBP

Characteristics of Rust Diseases

Not Domesticated, or Co-evolved

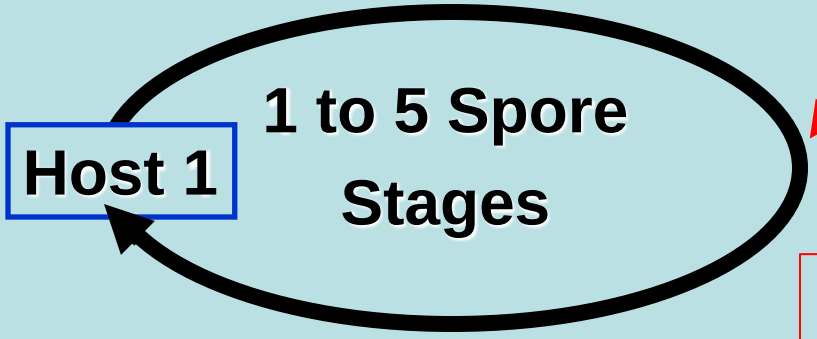
- **Rust fungi grow *only* in living plant tissues**
- **Abundant, colored spores**
- **Complex, multi-year life cycle**
- **Can diagnose western rust diseases on conifers easily by**
  - **Host species**
  - **Spore stage on host**
  - **Shape of infections**

Coleosporium
Pine needle rust

Types of Rust Life Cycles

- Single-host

e.g. Western gall rust

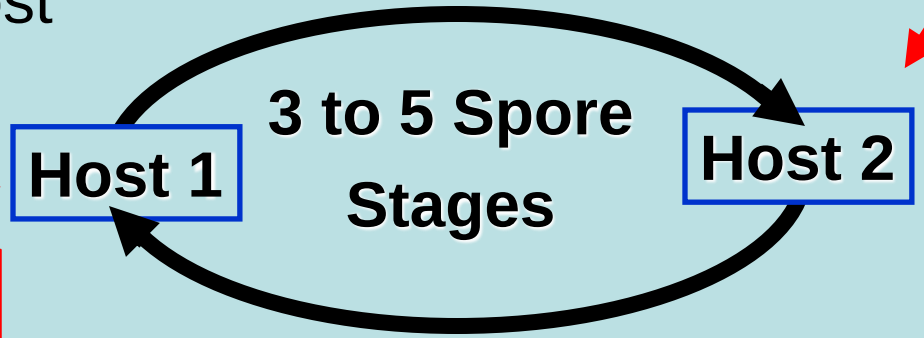


More Evolved

Ribes Eradicatrion

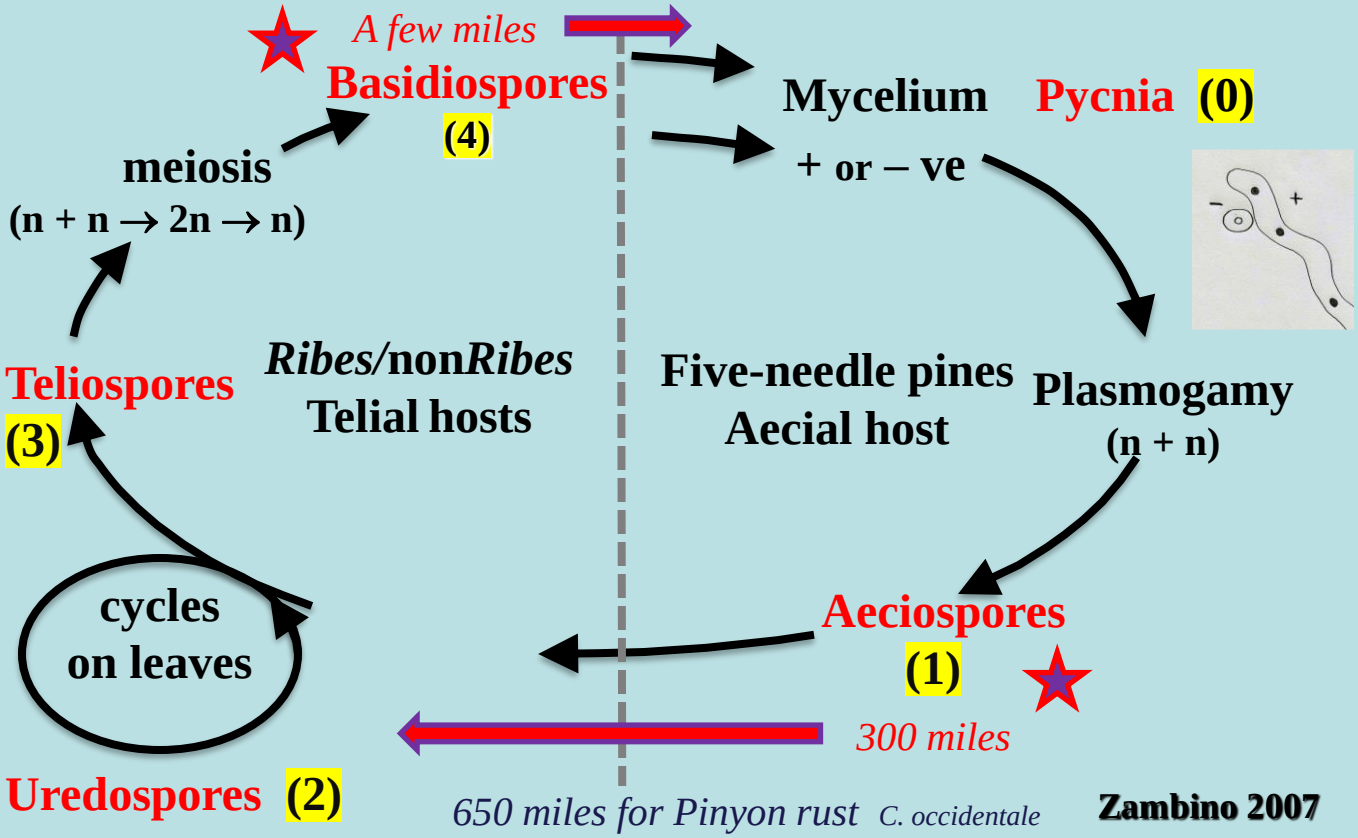
- Alternate-host

White pine blister rust
Pinyon Blister rust
I.C. Broom rust



1 Host (Pine) helps the Ribes Rust get through the winter !

Life Cycle of North American *Cronartium ribicola*



As early as 1898, a German Forester, **Dr. Carl A. Schenck**, was demonstrating German Forestry Practices in the United States and advocated against introducing Eastern White Pine seedlings from Europe on the grounds of the risk from WPBR.

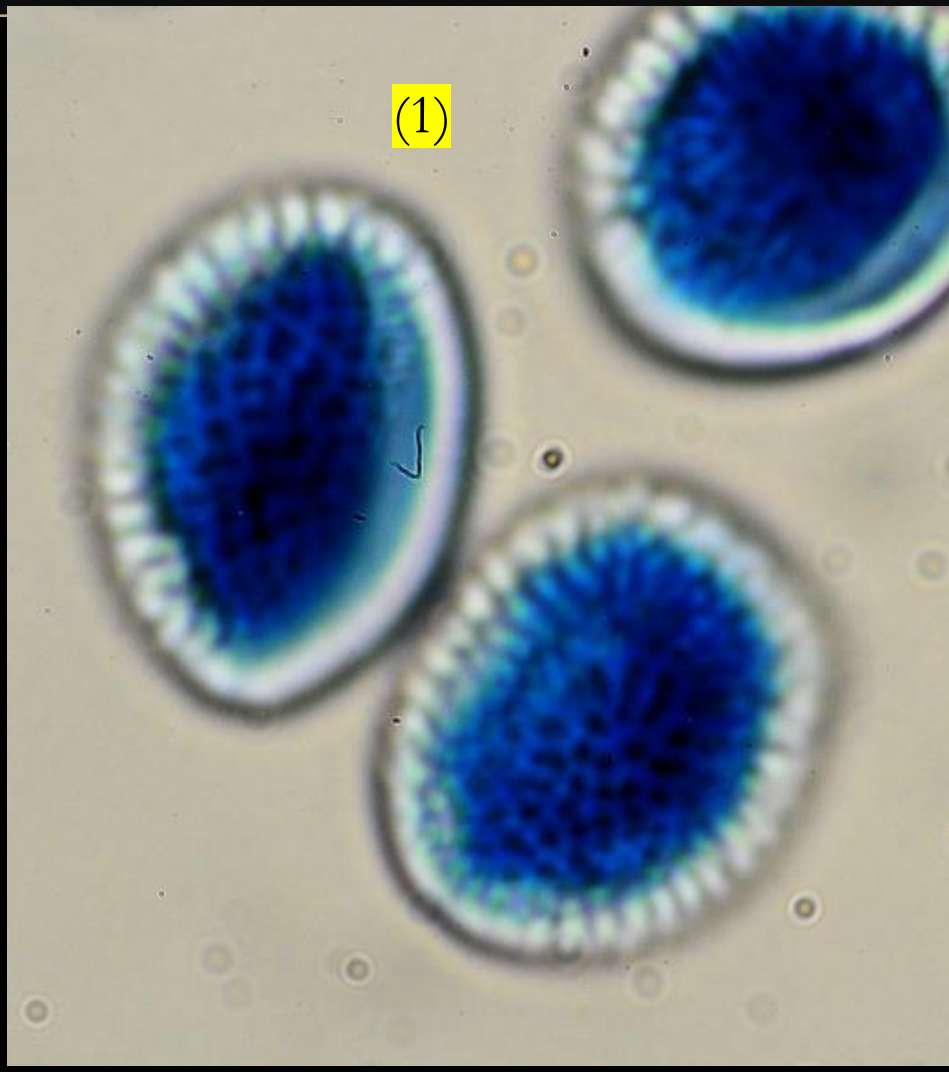
In 1900 around 95% of European households grew Black Currant bushes, the number one Ribes host.

Annosus 1909 Chestnut blight 1904, Rust in Ribes 1904

Prof Robert Hartig and Meinecke R05 regional pathologist

Ribena drink NHS (UK NIH) Tariffs relaxed early 1900's


Cronartium ribicola
White Pine Blister Rust


(1)

Managing *Ribes spp.:* Fire-adapted Pioneers with Long-Lived Seeds

R. lacustre

R. hudsonianum var. *petiolare*

R. viscocissimum

R. inerme

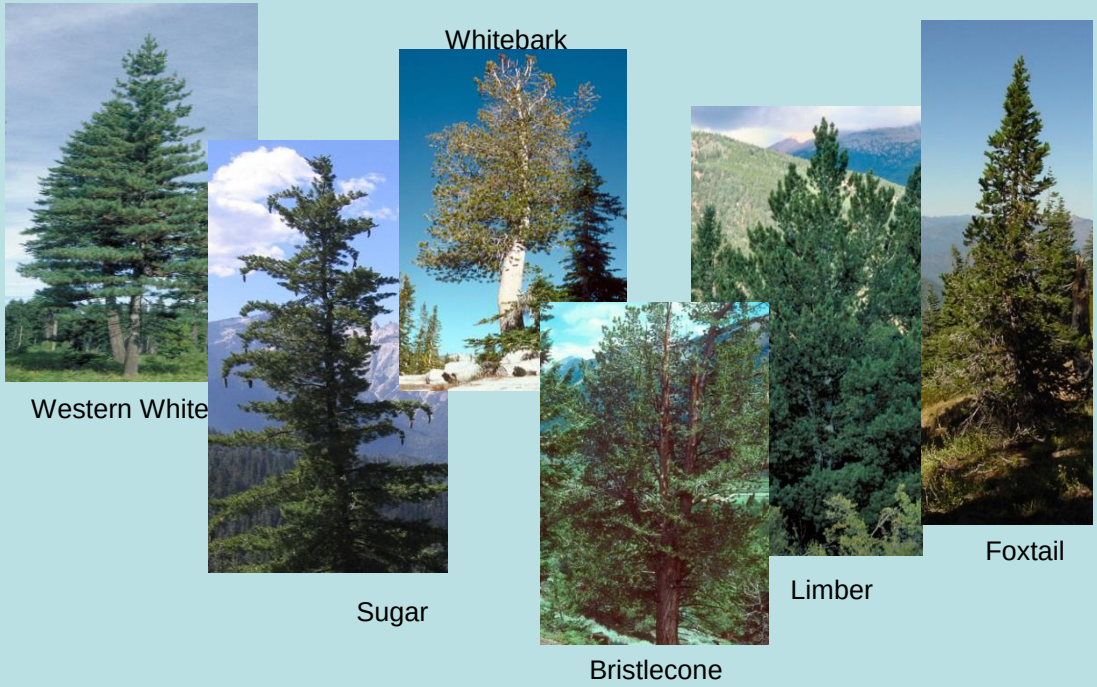
Some of the 90 spp

Telial hosts: Castilleja miniata Grossularia cynosbati, G. reclinata G. rotundifolia, Grossularia sp., Pedicularis apodochila, P. bracteosa, P. euphrasioides, P. japonica, P. oederi, P. racemosa P. resupinata P. resupinata var. ramosa P. schistostegia, P. spicata, P. yezoensis, Peridermium kurilense, P. strobi,(4)

Ribes acuminatum, R. alpinum, R. altissimum, R. ambiguum, R. americanum, R. atropurpureum, R. aureum, R. binominatum, R. bracteosum, R. cereum, R. coelesta, R. coloradense, R. cruentum, R. cynosbati, R. diacanthum, R. dikuscha var. appendiculata, R. divaricatum, R. divaricatum var. inerine, R. emodense, R. erythrocarpum, R. fasciculatum, R. fasciculatum var. chinense, R. floridum, R. formosanum, R. fragens, R. fuscescens, R. glaciale, R. glandulosum, R. griffithii, R. grossularia, R. himalensis, R. hirtellum, R. hispidulum, R. howellii, R. hudsonianum, R. inerme, R. integrifolium, R. irriguum, R. japonicum, R. klamathense, R. lacustre, R. latifolium, R. laxiflorum, R. lobbii,
R. magellanicum, R. mandshuricum, R. marshallii, R. maximowiczianum, R. maximowiczii,
R. meyeri, R. missouriense, R. moupinense, R. nevadense, R. nigrum, R. niveum, R. odoratum,
R. orientale, R. oxyacanthoides, R. oxyacanthoides var. hirtellum, R. palczewskii, R. pallidiflorum,
R. pauciflorum, R. petraeum, R. pinetorum, R. procumbens,R. prostratum, R. roezlii, R. roezlii var. cruentum, R. rotundifolium, R. rubrum, R. sachalinense, R. sanguineum, R. sativum, R. setosum,
R. sinanense, Ribes sp., R. spicatum, R. sylvestre, R. tenue, R. triste, R. triste var. albinervium,
R. uva-crispa, R. velutinum, R. vilmorinii, R. viscosissimum, R. viscossissimum, R. vulgare,
R. warszewiczii, R. watsonianum, and R. × odoratum-sanguineum (Farr and Rossman, 2022)

90 Ribes spp listed

California White Pine Hosts



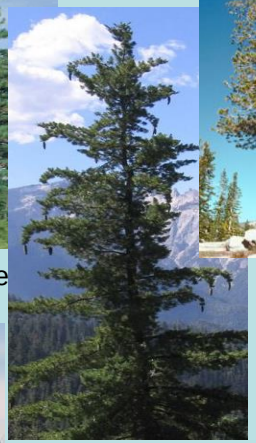
21 conifers
90 spp of Ribes
17 non Ribes

CA Bristlecone not yet a confirmed host.

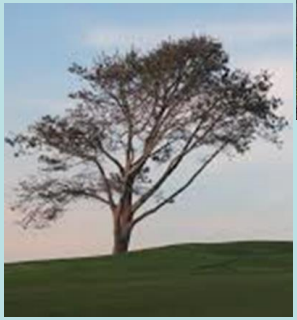
California White Pine Hosts

Western White

Whitebark



Sugar



Torrey *

Bristlecone *

Limber

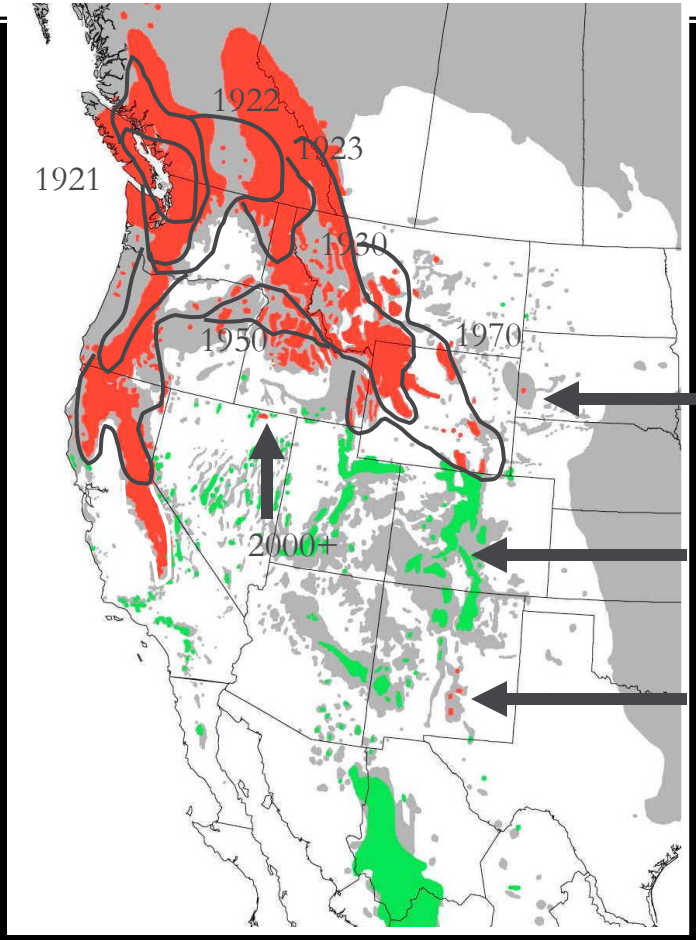
Foxtail

Seven
5-needle pines
In CA

Pinus albicaulis, P. aristata, P. armandii, P. ayacahuite, P. balfouriana, P. cembra Swiss EU, P. cembra var sibirica Siberian, P. flexilis, P. flexilis var. reflexa, P. koraiensis, P. lambertiana, P. monticola, P. parviflora, P. peuce EU, P. pumila, P. sibirica, Siberian, P. strobiformis, P. strobus, ~~P. sylvestris~~, P. taiwanensis, and P. wallichiana.

21 spp Nation wide

WESTERN NORTH AMERICAN SPREAD



Dates of detection
Distribution by
Eric Smith, 2003

2004- Bristlecone pine

1998 southwestern white pine

Dead Branch “Flags” in Sugar Pine

(1)

By inoculation

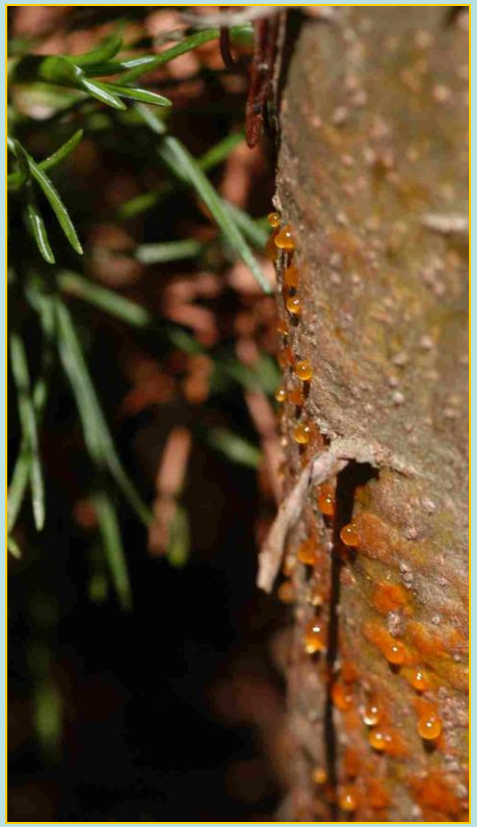
Young Blister Rust Canker

- Yellow margin
- Centered on branch
- Elongated

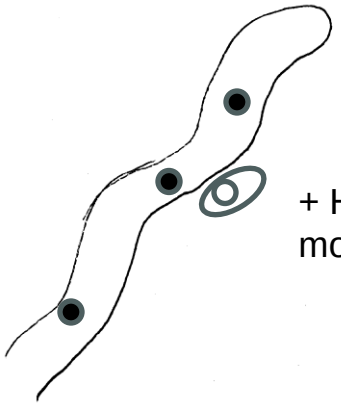
(0)

Pycniospores (0)

- Sticky yellow to orange
- Smelly
- Sugary
- Spread by flies
- Sexual function

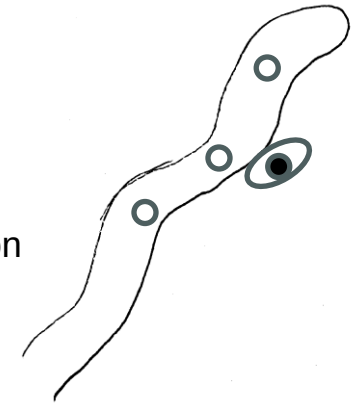


(0)



+ Haploid monokaryon

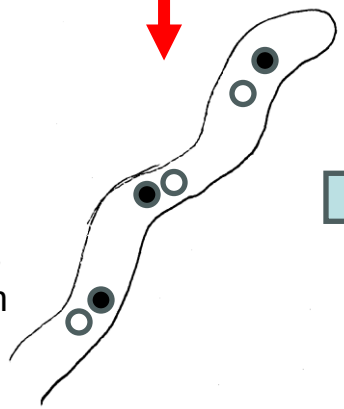
-- Haploid monokaryon



Fly induced sex

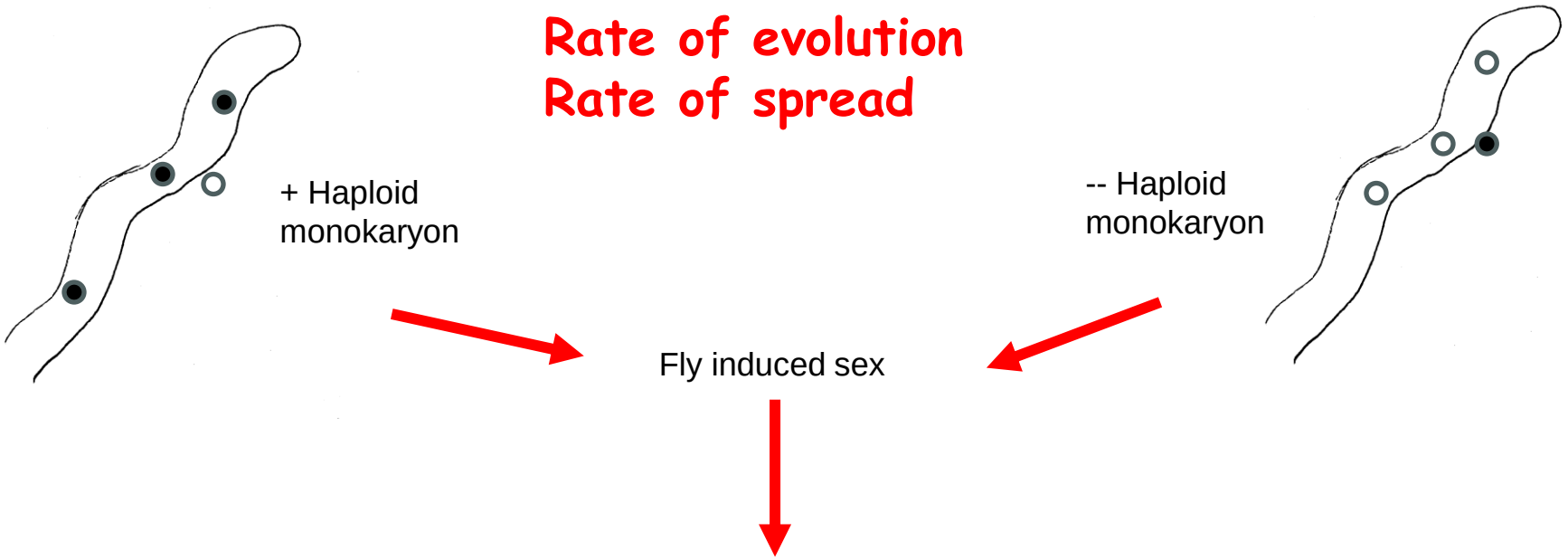
Still on the White Pine

+/-- Dikaryon
Two sets of chromosomes
n + n Dikaryon



Only the dikaryon can produce Aeciospores, Uredospores or Teliospores (1) (2) (3)

The nuclei do not fuse while in the pine or Ribes



A Darwinists point of view. Breeding equals Domestication, and a good obligate parasite does not kill its host! So, its balanced arms race, as the host tries to get one or two genes ahead of the pest and the pest tries out variations to get ahead of the host. Either way change, spread, and or evolution are slow.

Aecia

Aeciospores (1) take the rust to Ribes
Aeciospores are coloured and thick walled.
Aeciospores resist desiccation and UV
Aeciospores may travel 300 miles

Powdery Urediniospores for Cycling; (2)
Then Hair-Like Teliospores (3)→ Basidiospores (4) →Pine

Ribes alternate hosts

Ribes to Pine late in the summer

Teliospores (3 is 2n)

Basidiospores (4 is 1n)

Before shedding of leaves

1 Host (Pine) helps the “Ribes Rust” get through the winter !

Urediniospores (n + n) (2)

Ribes to Ribes

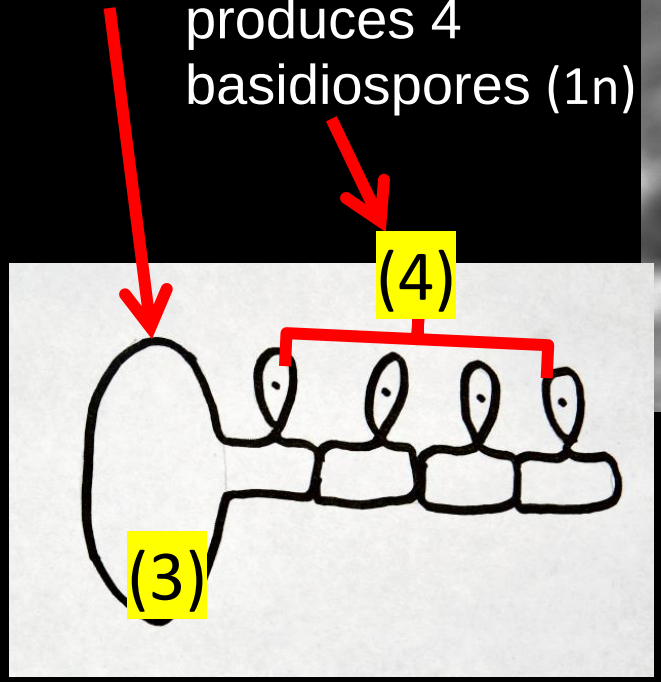
Urediniospores (2)

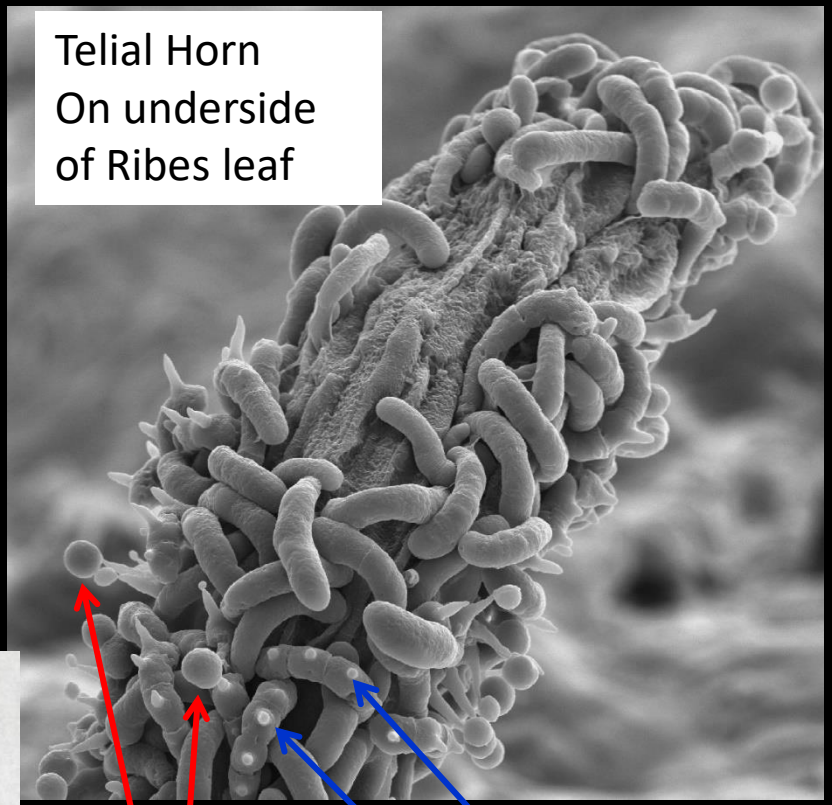
Telial (3) horns that produce basidiospores (4)

Photos by Joan Dudney

Basidiospores shot from Teliospores infect pine needles

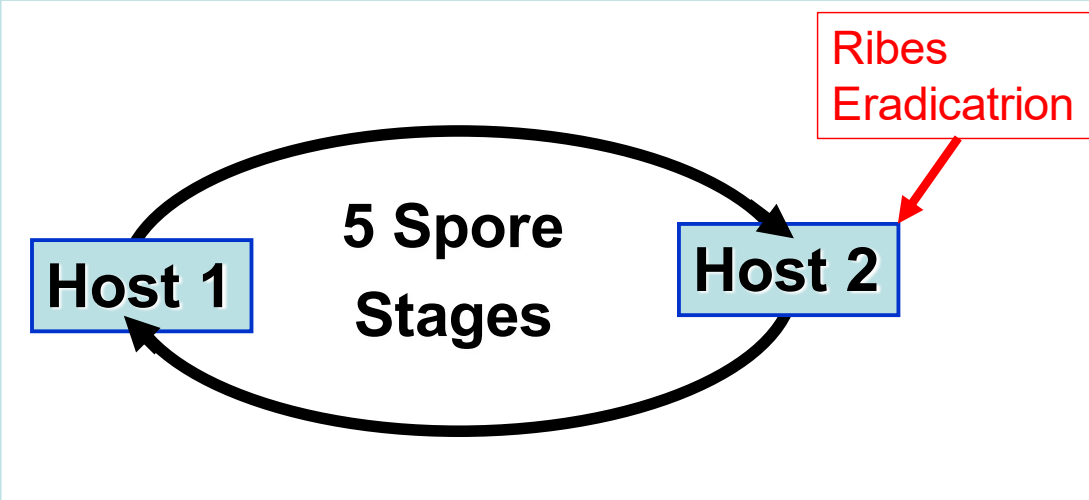
(2n) germinated teliospore produces 4 basidiospores (1n)

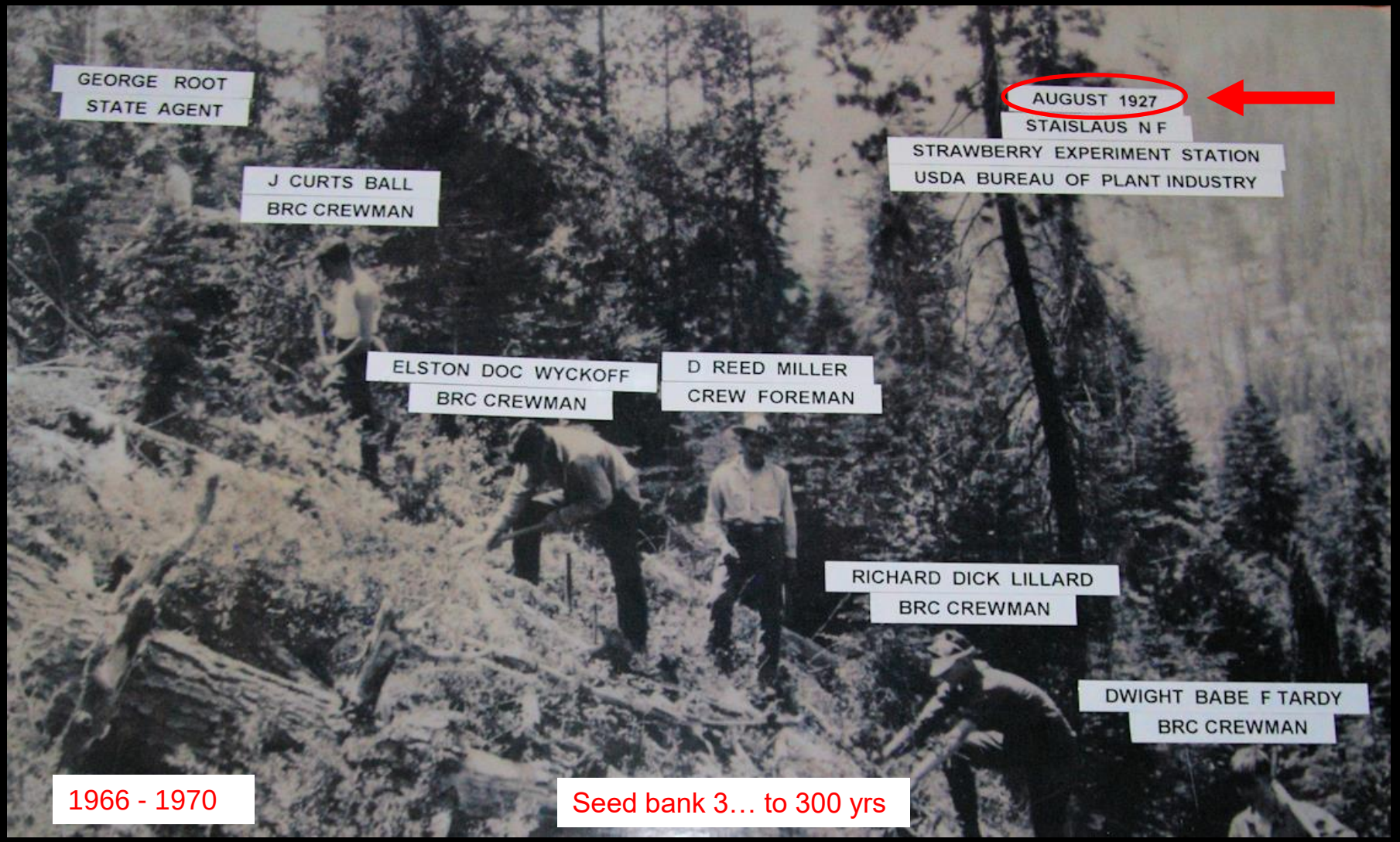




Ribes Eradication

- Historically Tried
- Still Done in Some Selected Eastern Areas
- Doesn’t Work in the West




GEORGE ROOT
STATE AGENT
AUGUST 1927
STAISLAUS N F
STRAWBERRY EXPERIMENT STATION
USDA BUREAU OF PLANT INDUSTRY
J CURTS BALL
BRC CREWMAN
ELSTON DOC WYCKOFF
BRC CREWMAN
D REED MILLER
CREW FOREMAN
RICHARD DICK LILLARD
BRC CREWMAN
DWIGHT BABE F TARDY
BRC CREWMAN
1966 - 1970
Seed bank 3… to 300 yrs

FIRST ERADICATION MAP

- INITIAL ERADICATION
- SECOND ERADICATION
- THIRD ERADICATION
- FOURTH ERADICATION
- FIFTH ERADICATION
- 34-41 YEAR OF ERADICATION
- Brown —— BOUNDARY OF YEAR'S WORK
- Blue —— CONTROL UNIT BOUNDARY

CONCENTRATION AND STANDARD MAPS

CONCENTRATIONS

- RIBES 0-25 FLS PER ACRE
- 26 FLS-30 RIBES PER ACRE
- 31-150 RIBES PER ACRE
- 151-1000 RIBES PER ACRE
- OVER 1000 RIBES PER ACRE

STANDARDS

- RIBES FREE
- WORKED TO 8 FLS PER ACRE
- WORKED TO 16 FLS PER ACRE
- 4 WORKED TO 25 FLS PER ACRE
- 5 WORKED TO NO RIBES OVER 25 FLS

OWNERSHIP

- FEDERAL
- STATE
- LARGE OWNERS

SECOND ERADICATION MAP

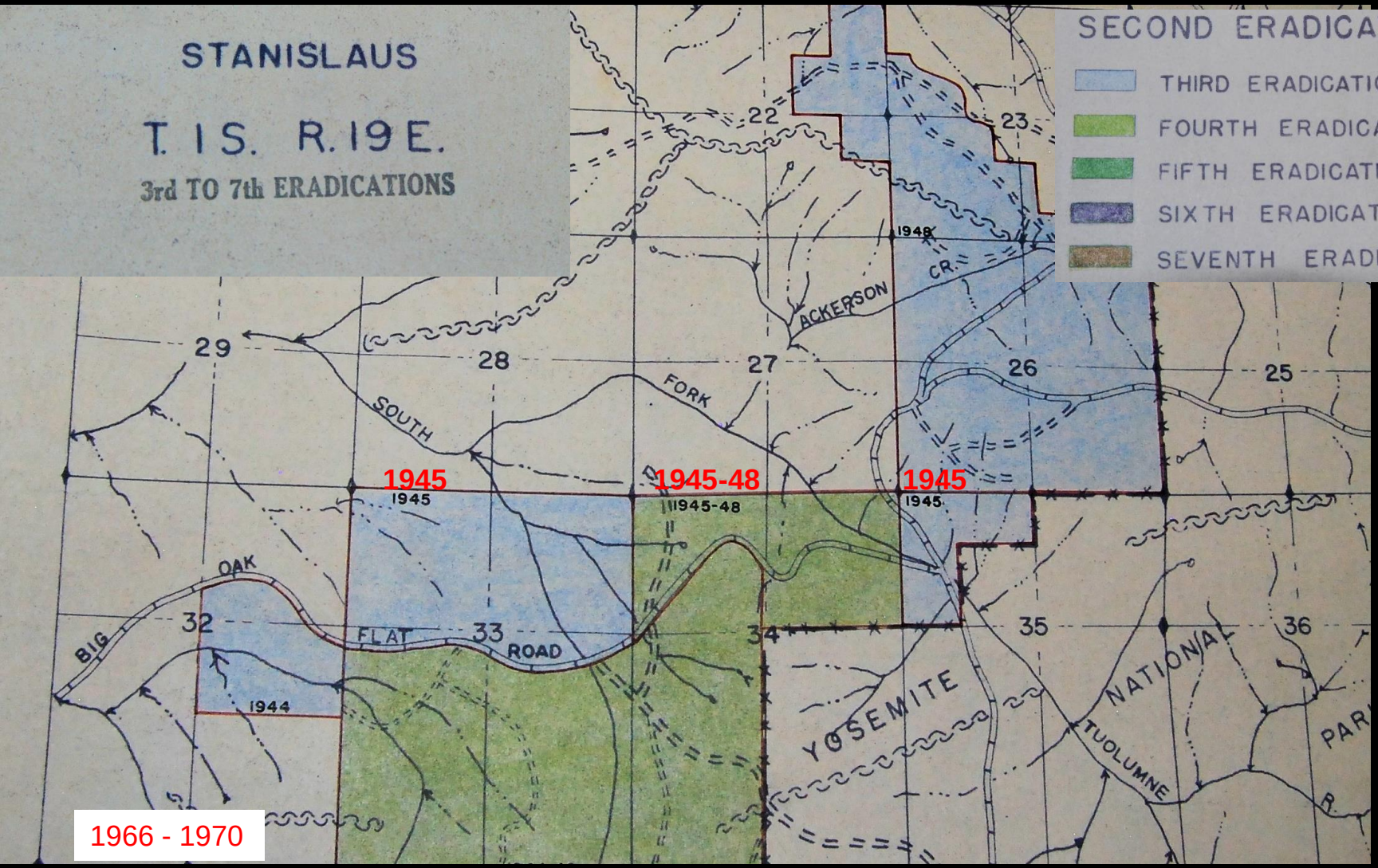
- THIRD ERADICATION
- FOURTH ERADICATION
- FIFTH ERADICATION
- SIXTH ERADICATION
- SEVENTH ERADICATION

DISTURBANCE

- ---33 YEAR OF DISTURBANCE
- 34-40
- 41-44
- 45-48
- 49-52

FIRE

- Red (YR) 0-10 ACRES
- Red % KILL, YEAR, ACREAGE, % RESTOCKING, ETC. OVER 10 ACRES
- LOG-BURN
- BURN-SALVAGE LOG


STANISLAUS
T. 1 S. R. 19 E.
3rd TO 7th ERADICATIONS
SECOND ERADICATION MAP
THIRD ERADICATION
FOURTH ERADICATION
FIFTH ERADICATION
SIXTH ERADICATION
SEVENTH ERADICATION
22
23
1948
CR.
ACKERSON
29
28
27
26
25
SOUTH
FORK
1945
1945-48
1945
1945
1945-48
OAK
BIG
32
FLAT
33
ROAD
34
35
36
1944
YOSEMITE
NATIONAL
TUOLUMNE
PARK
R.
1966 - 1970

Great depression 1929 - 1939

Bonners Ferry Herald

29th Mar 1934

34 WHITE PINE BLISTER RUST CAMPS IN AREA

Concentrated Campaign Against Plant Disease to Be Started in Pend Oreille National Forest.

CCC CAMPS ARE COMING

At Least Three and Possibly Four for Boundary County.

Thirty-four white pine blister rust control camps, employing 1020 men, will be established in the Pend Oreille national forest from May 25 to May 1, it was learned last Friday when J. E. Ryan, forest supervisor, returned from Spokane, where he attended a conference of western forest supervisors, to his headquarters at Sandpoint.

There will be 30 men to a camp, it is said, and the men will work on the 40-hour per week basis, with pay at 50 cents per hour for inexperenced men and 60 cents an hour for experenced workers. Board will be charged at $1 per day.

Of the 34 camps in the Pend Oreille forest, three will be located on the east side of Priest lake in state timber, while the balance w throughout the Priest r the virgin white pine ti

The men will be selec ner and Boundary coun and Pend Oreille county ton, according to Mr. R will be employed from by the national re-employment offices in the three counties. Preference will be given to experiencd men, it is said.

Will Be 13 CCC Camps.

It is reported from Sandpoint that the 13 civilian conservation corps camps which were tentatively allocated to the Pend Oreille national forest earlier in the month have been confirmed. Nine of these will be located in Bonner county, three in Boundary county and one in Pend Orille county

which was started last year, t well up toward the headwater stream. The work of contin road has already started. A six men, under Charles Tig who recently resigned his po state engineer on the Porth project to accept employme the forestry department, is pushing construction which w ed last fall. It is understood the road can be built throug

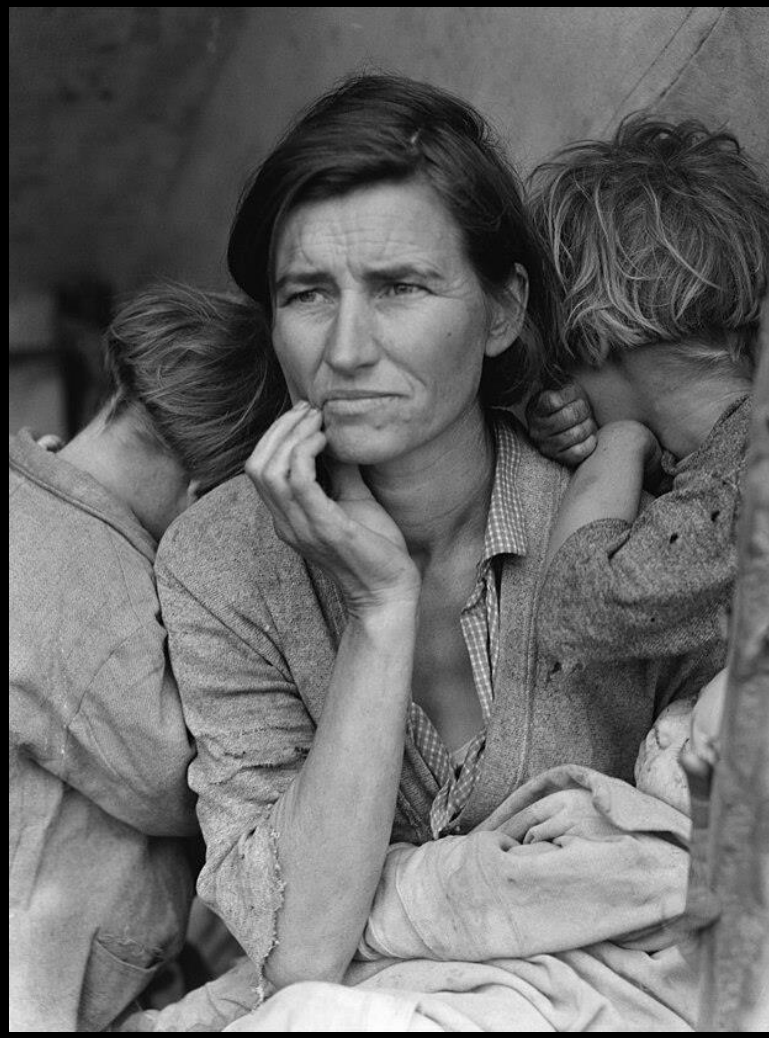
FDR's New deal

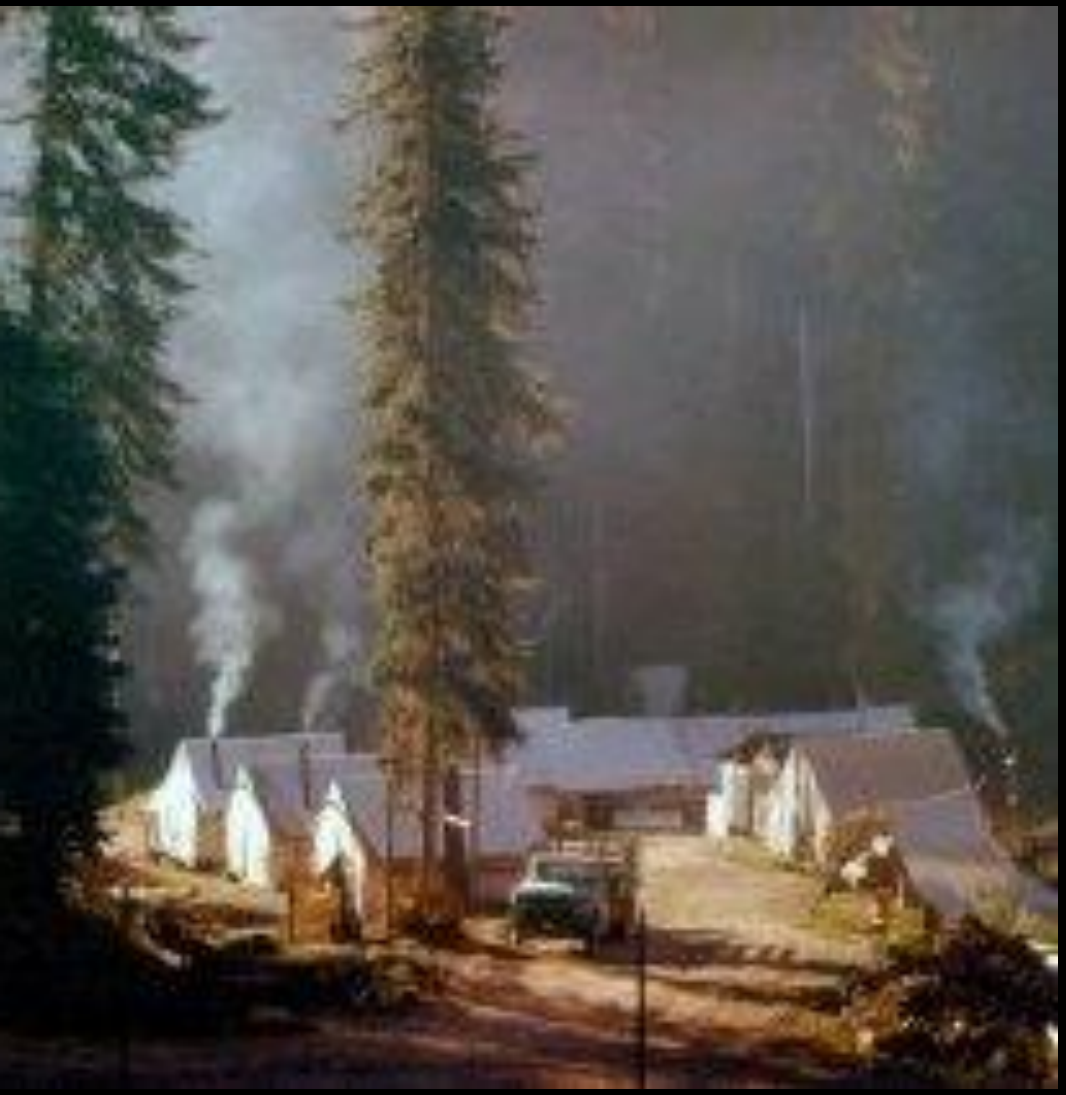
1933 – 1942

$33/mo $25/mo to your family.

The cook house $50 wages minus $1 / day for meals and tent.


FREE
P COFFEE & DOUGHNUTS
OR THE UNEMPLOYED
ALBERT
HORAN
BAILIFF
PARKING 25
FREE SOUP
&





Even-aged management and fuels not a consideration back then!

Mechanical means

USFS BRC worker pulling out Ribes. Photo from Museum of North Idaho / The Spokane Spokesman-Review

$50 for 160 hrs of pulling Ribes

31¼ cents / hr

Antibiotics

Actidione =

Cycloheximide

Benedict 1981

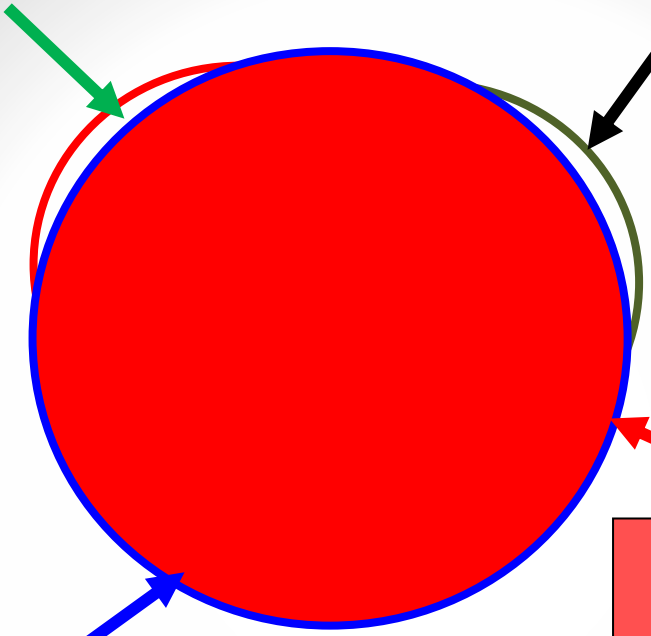
Antibiotics

Phytoactin
Ended 1966

Benedict 1981

Presence of Root Diseases

Disposition of Bark Beetles.



Fate of the individual tree.

i.e, Decline & or Death !

Drought or Climate Change

It's a complex because,

One can not separate the insects from the fungi they facilitate and vice versa!

The 800 lb. Gorilla in the room: Climate Change

"White pines, *Ribes*, and blister rust: a review and synthesis."

Geils *et al* (2010)

"… climate change alone could render many presently occupied habitats in OR, ID, CA & NV unsuitable for whitebark pine!"

cites **Warwell *et al* (2007)**