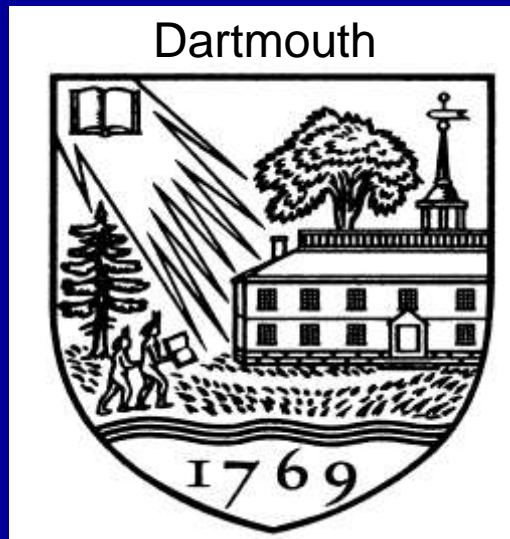


Ecology of southern pine beetle: a smokeless wildfire in the Pinelands?

Matt Ayres, Carissa Aoki, Jeff Lombardo,
Dartmouth, Hanover, NH
www.dartmouth.edu/~mpayres

Brian T. Sullivan, Southern Research Station,
USDA Forest Service, Pineville LA

Ronald F. Billings, Texas Forest Service,
College Station, TX



United States
Department of
Agriculture

National Institute
of Food and
Agriculture



Southern pine beetle
Dendroctonus frontalis



e.g., *Dendroctonus* in North America



Ron Billings
TX Forest Service



on Billings
K Forest Service

New Jersey Pines, Dec 2010

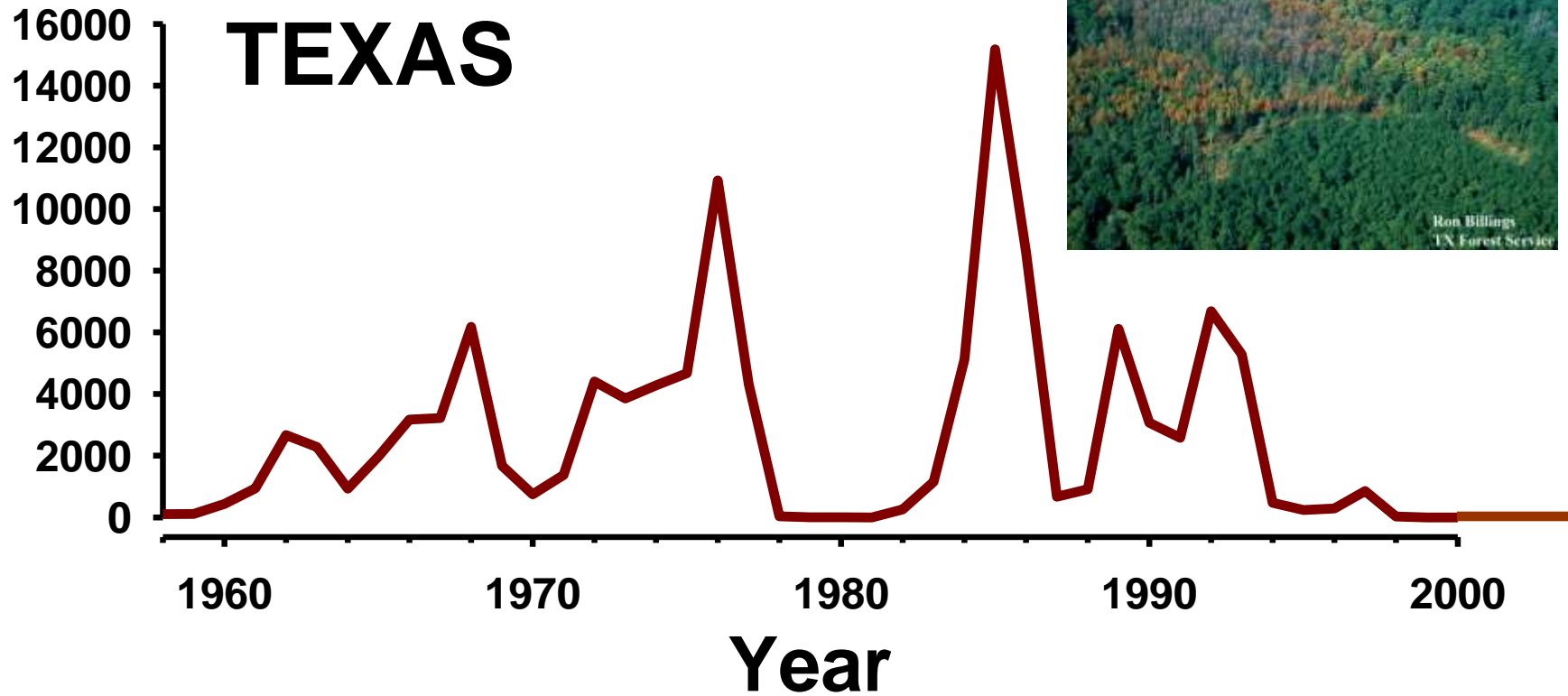




Whitehall Road October 2011 (Bob Williams)

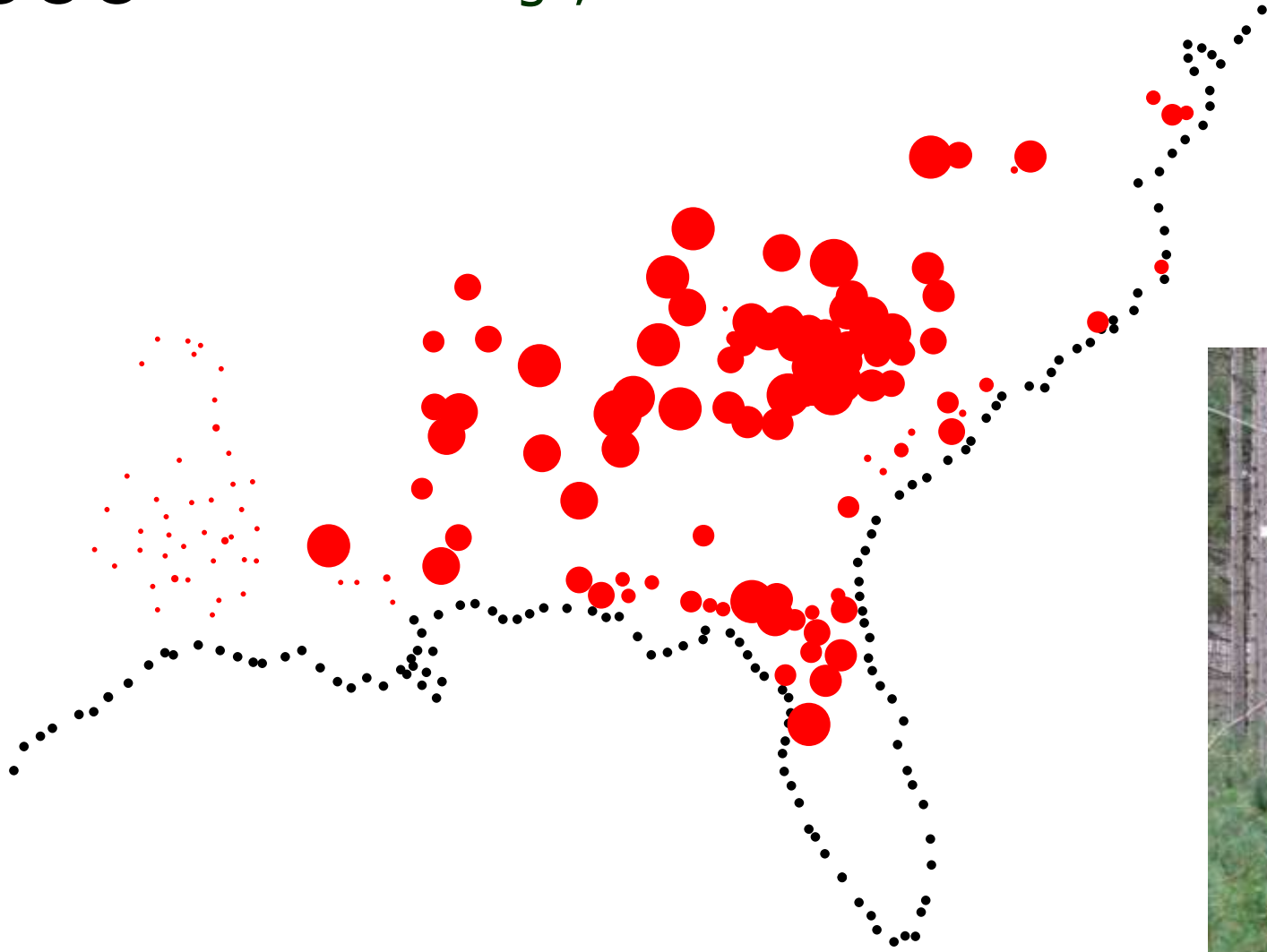
Episodic outbreaks

No. of infestations

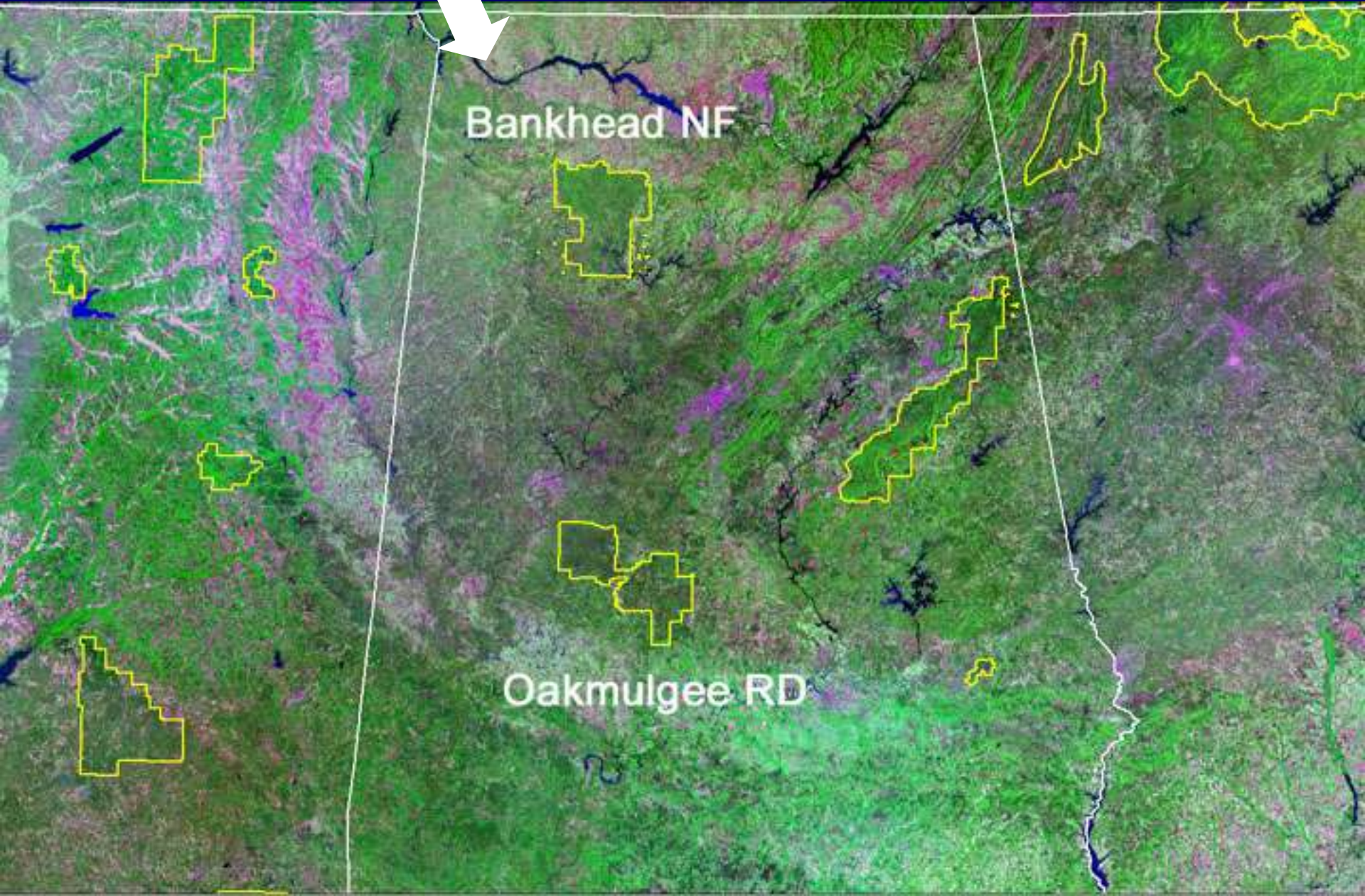


2000

Standardized pheromone trapping survey
Ronald Billings, Texas Forest Service



Bankhead National Forest, AL: 80 km² infested during 1998-2000

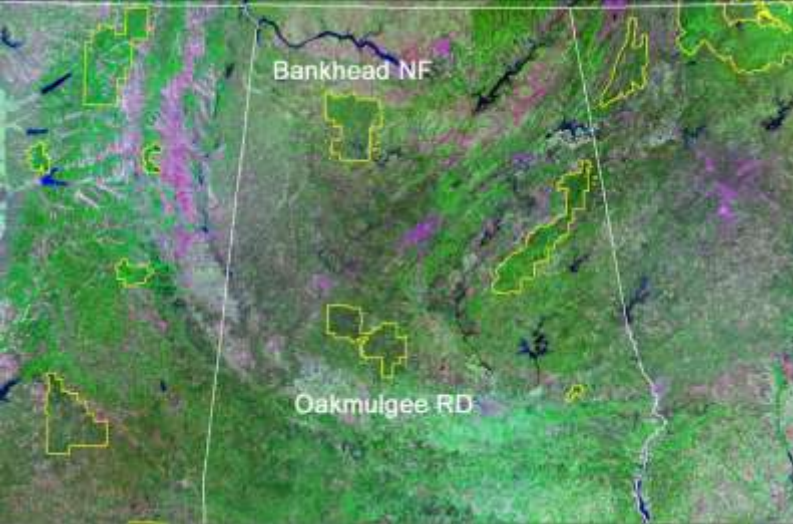


Bankhead National Forest, AL

80 km² infested during 1998-2000

~10,000 truckloads of finished lumber
worth \$50-80 million

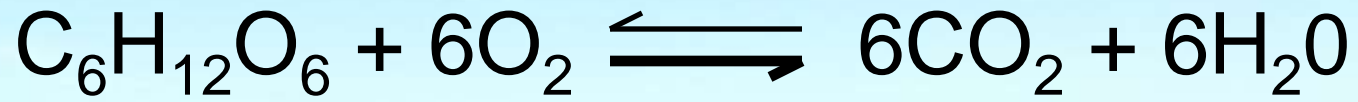
[Link to Ylioja et al. 2005. *Forest Science*.](#)



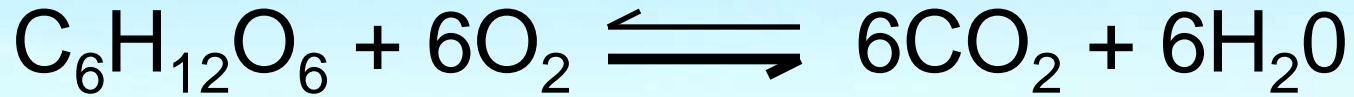
Smokeless wildfires?



Smokeless wildfires?



Smokeless wildfires?

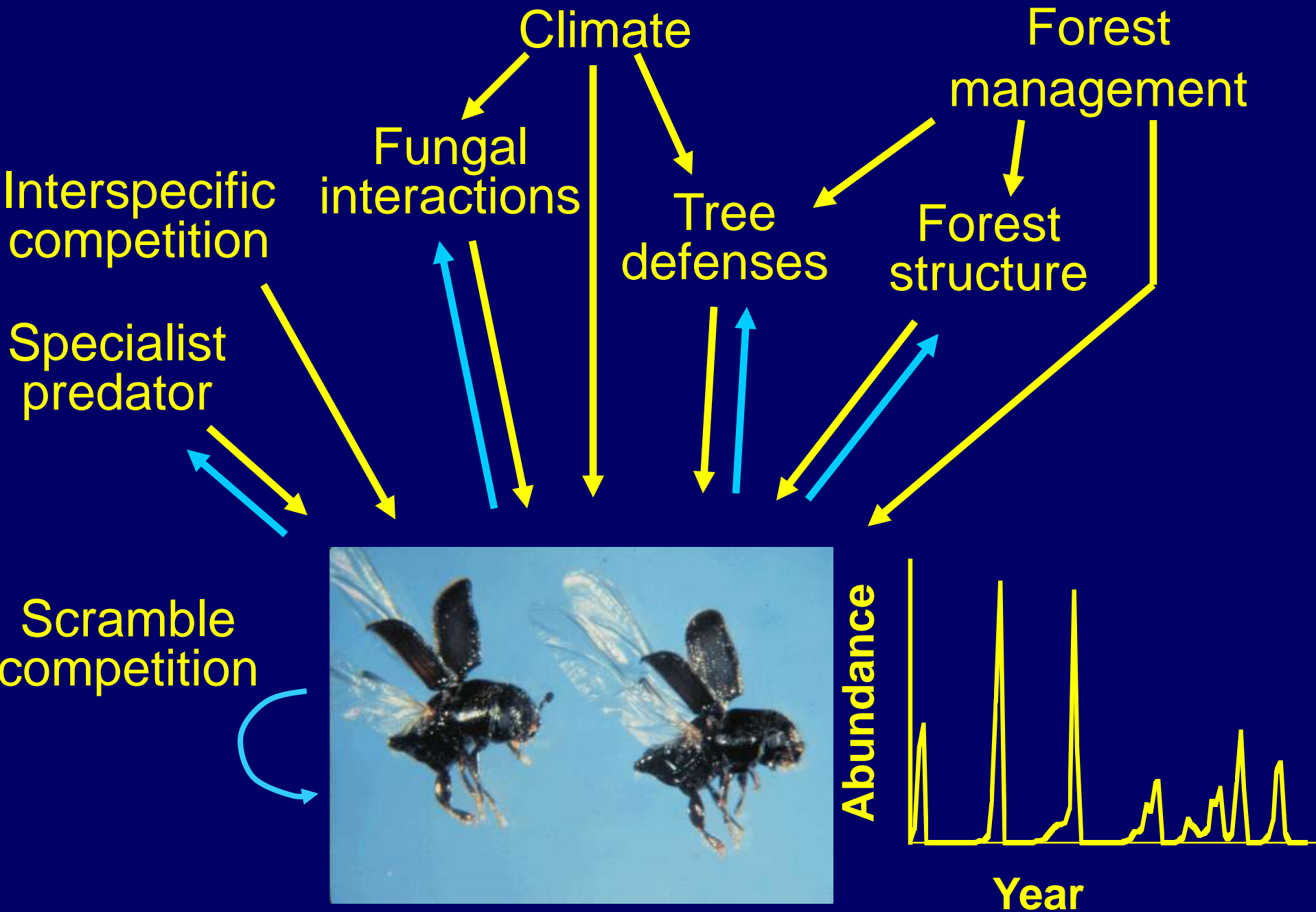


- Episodic and contagious.
- Kills small to very large tracts of trees.
- Reduces extent of mature forest.
- Alters biodiversity.
- Creates hazard trees.
- Lowers property values.
- Reduces recreational opportunities.
- Destabilizes hydrology.
- Alters N cycling.
- Releases stored carbon from ecosystem.
- Can change forest type (e.g., pines to hardwoods; forest to scrub).

Relevant to:

biodiversity, wildlife, recreation
aesthetics, conservation biology,
fire management, water quality,
economics, carbon storage ...



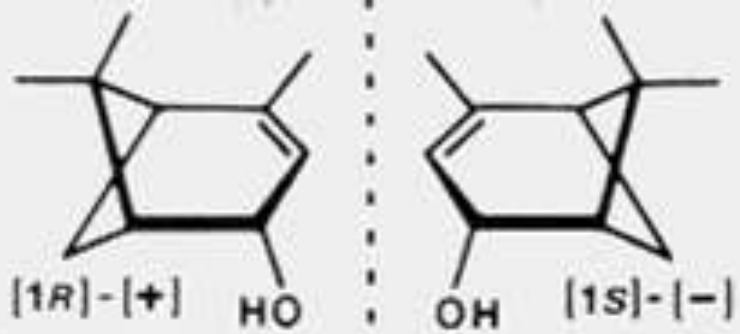




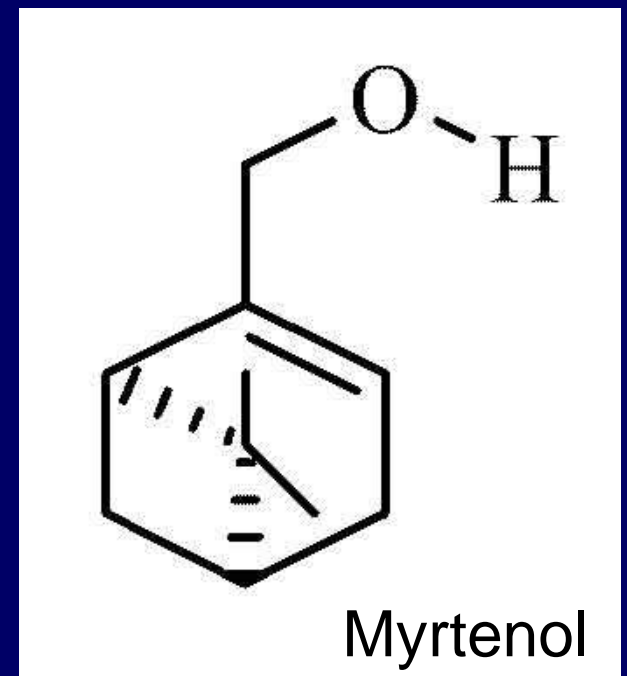
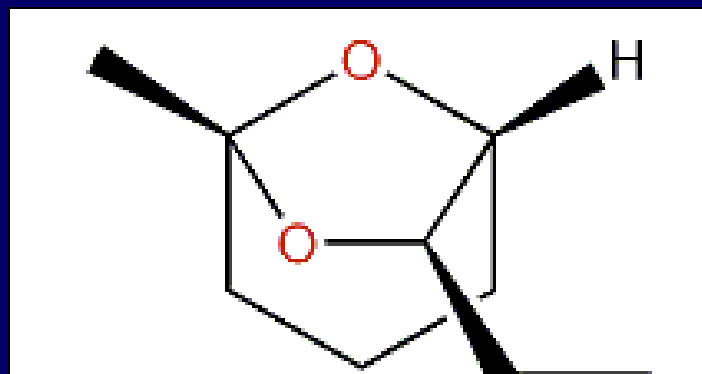
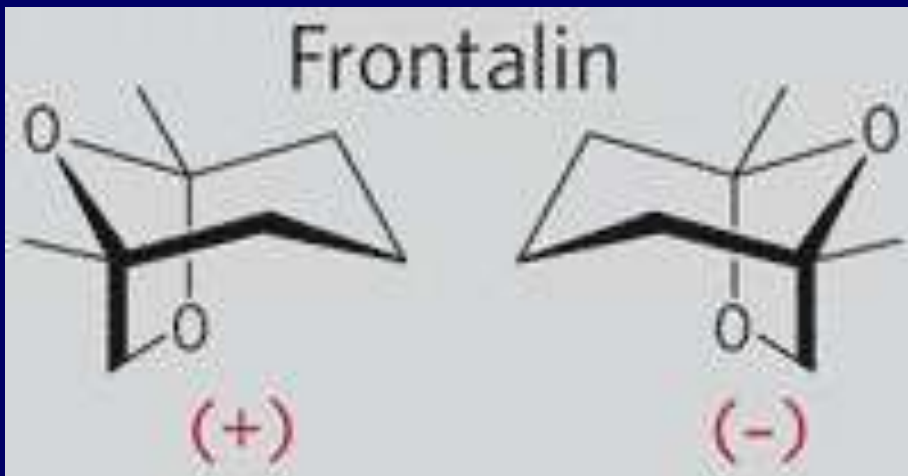
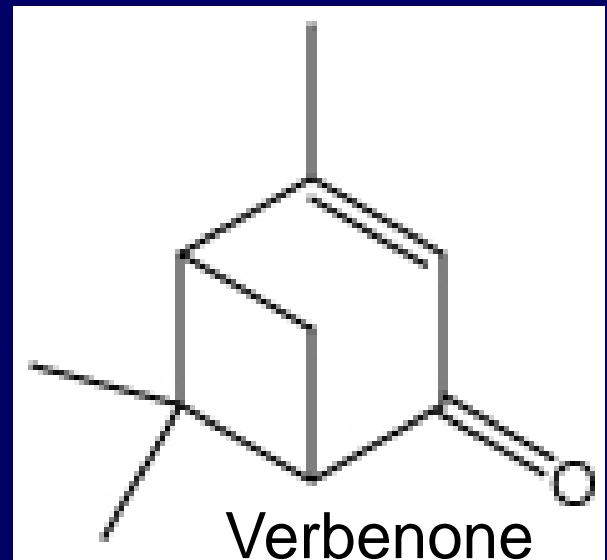
Aggregation pheromones -> Mass attack

Tree oleoresin





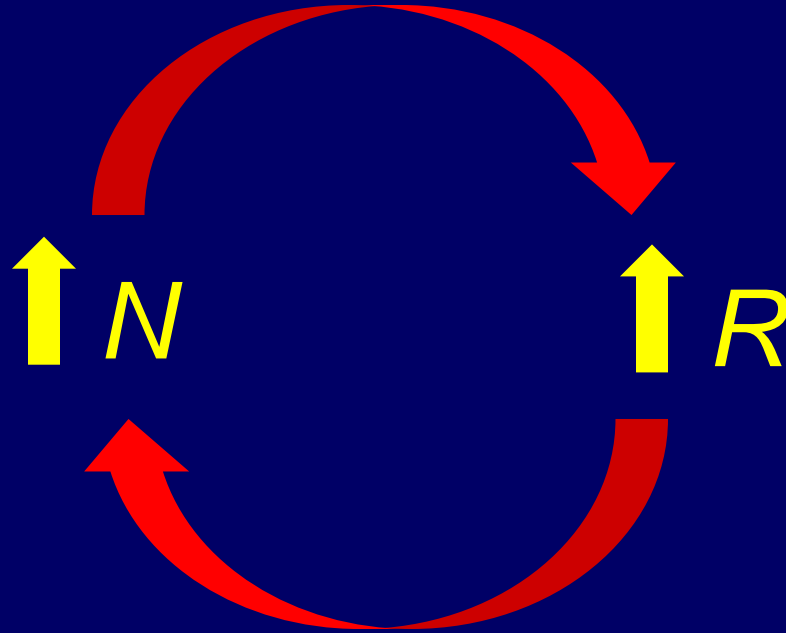
trans-Verbenol





N = beetle abundance

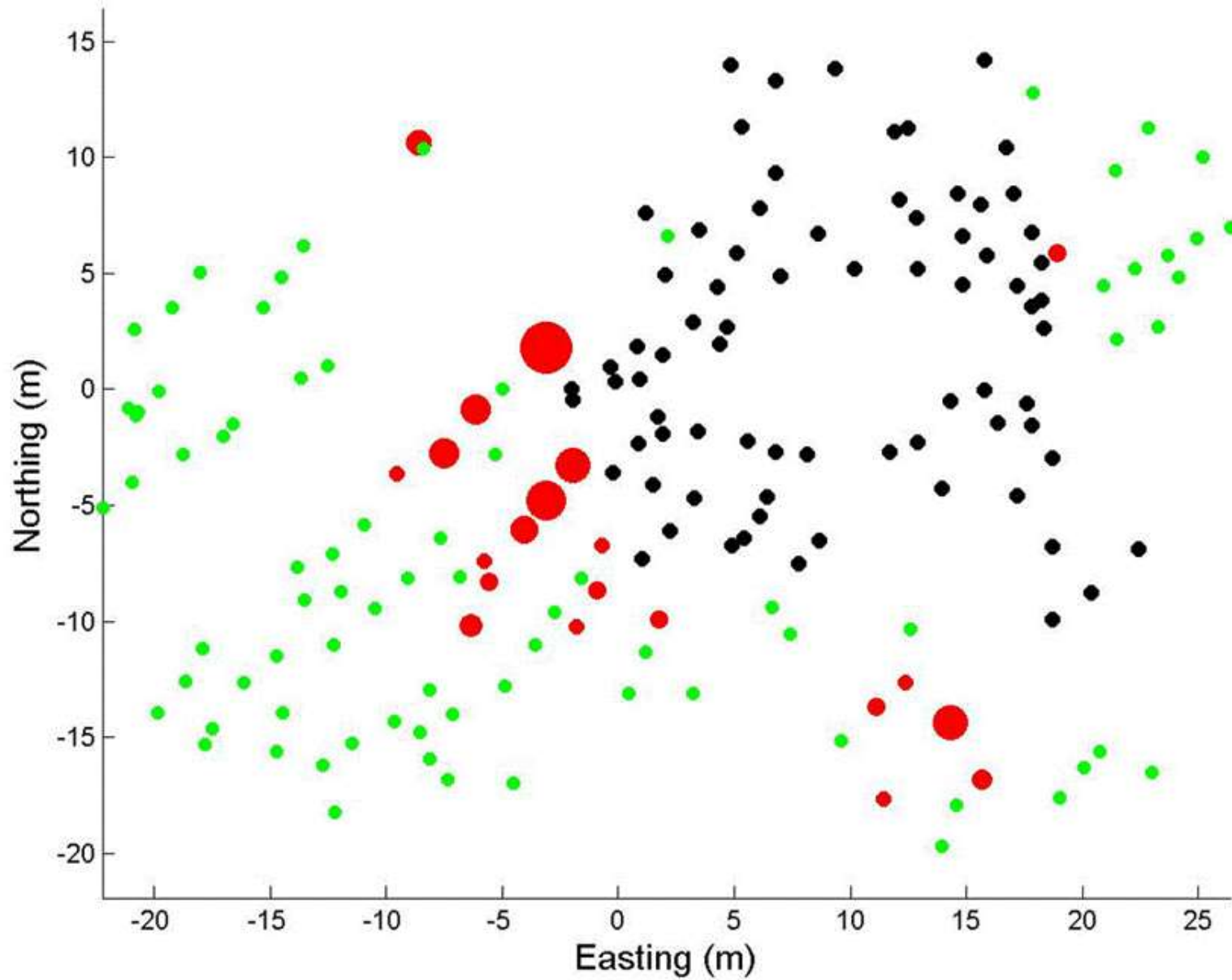
R = per capita population change





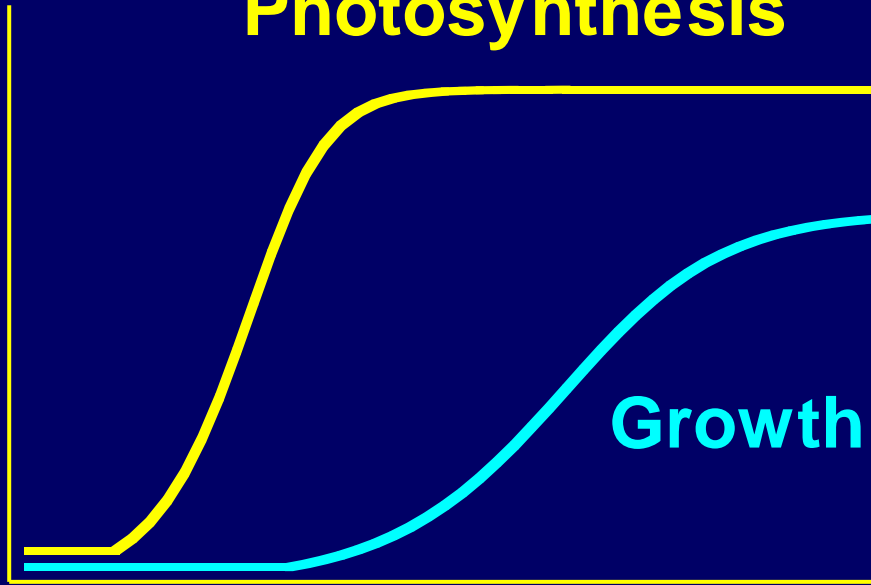
Ron Billings
TX Forest Service

Site 39: 07-17

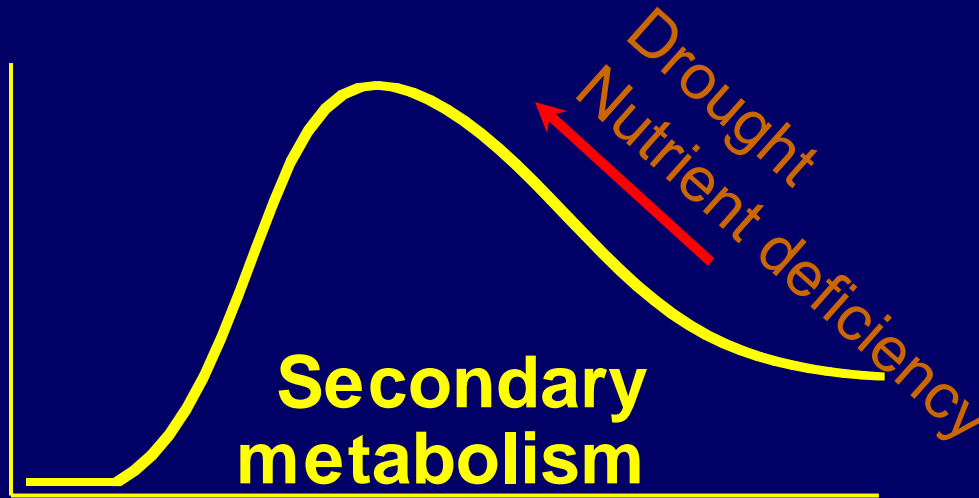


Photosynthesis

Carbohydrates (g / tree)



Pete Lorio



Water or nutrient availability

Growth-differentiation balance hypothesis

Loomis 1932, Lorio 1986, Herms and Mattson 1992, Wilkens et al. 1997, Warren et al. 1999, Lombardero et al. 2000

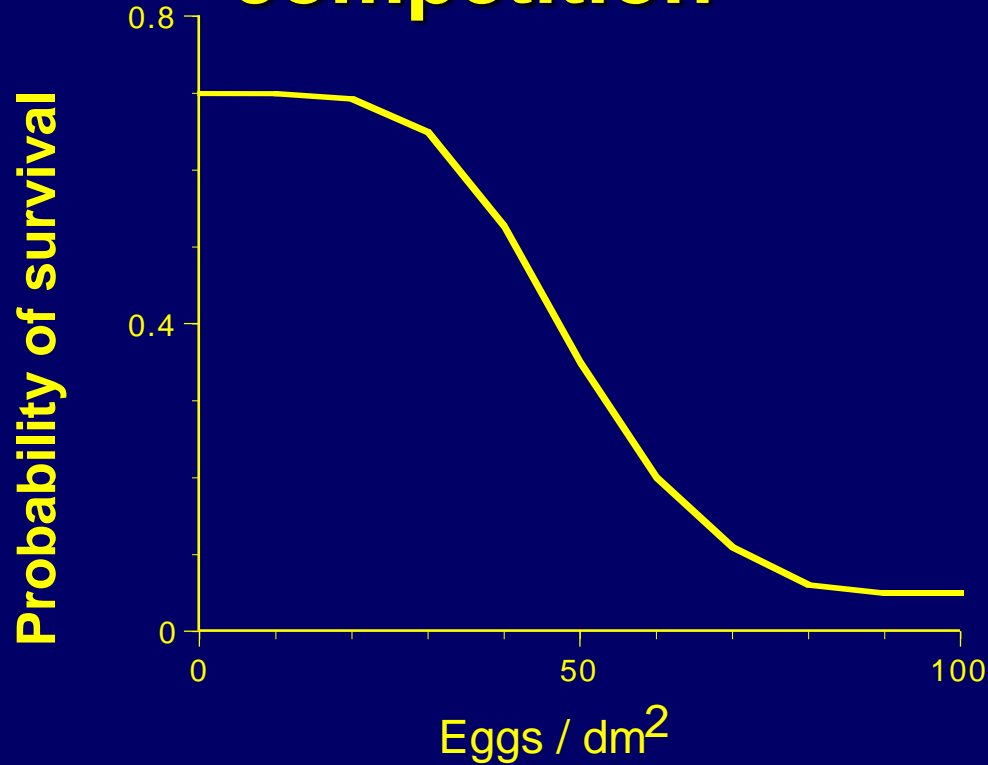
Predation



Turchin, P., A. D. Taylor, and J. D. Reeve. 1999. Dynamical role of predators in population cycles of a forest insect: an experimental test. *Science* 285: 1068-1071.



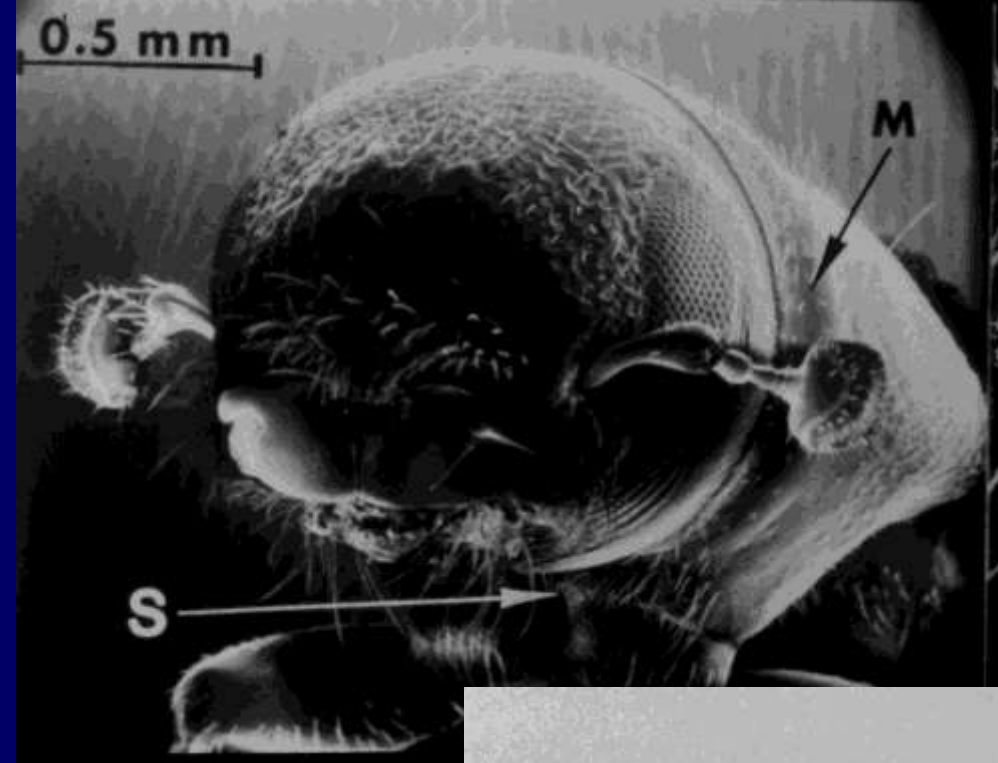
Intraspecific competition



Reeve, J. D., D. J. Rhodes, and P. Turchin. 1998. Scramble competition in southern pine beetle (Coleoptera: Scolytidae). *Ecol Entomol* 23: 433-443.

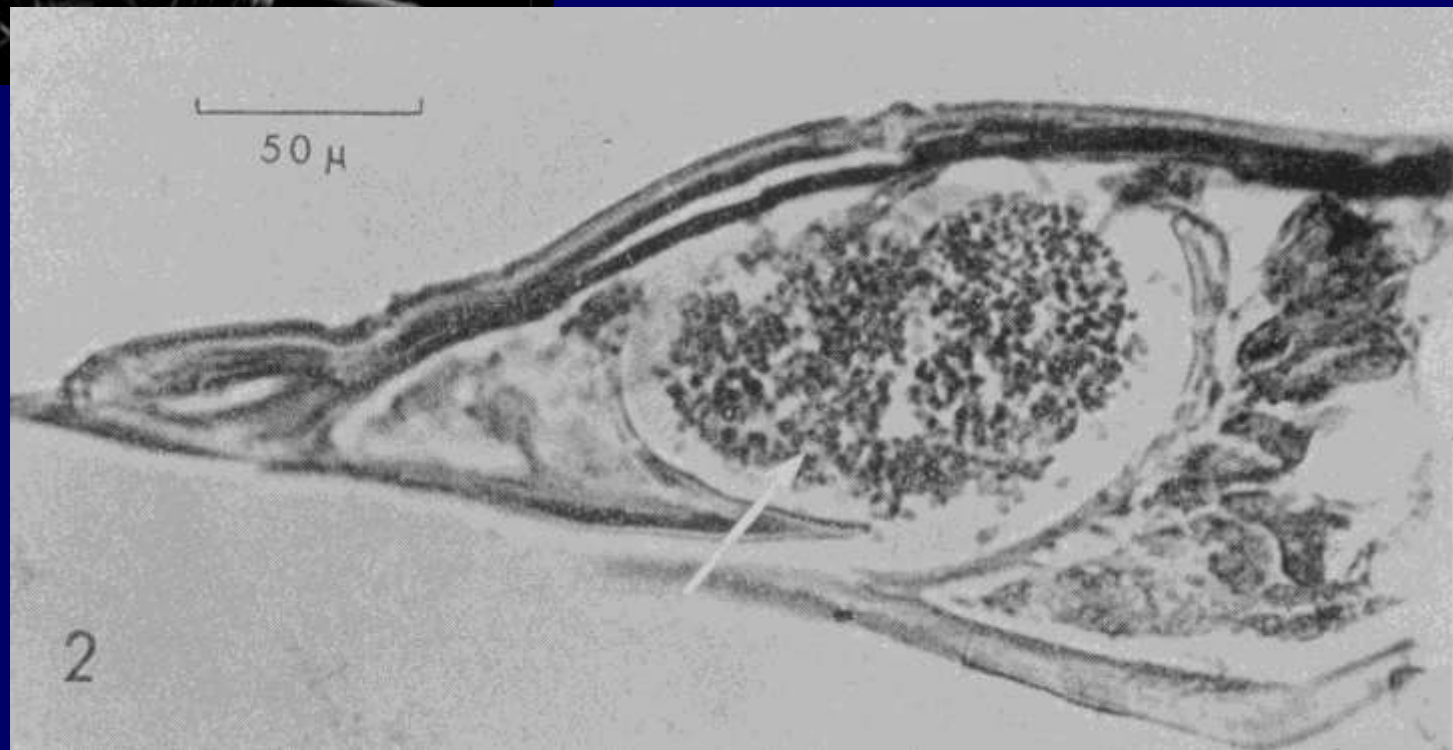


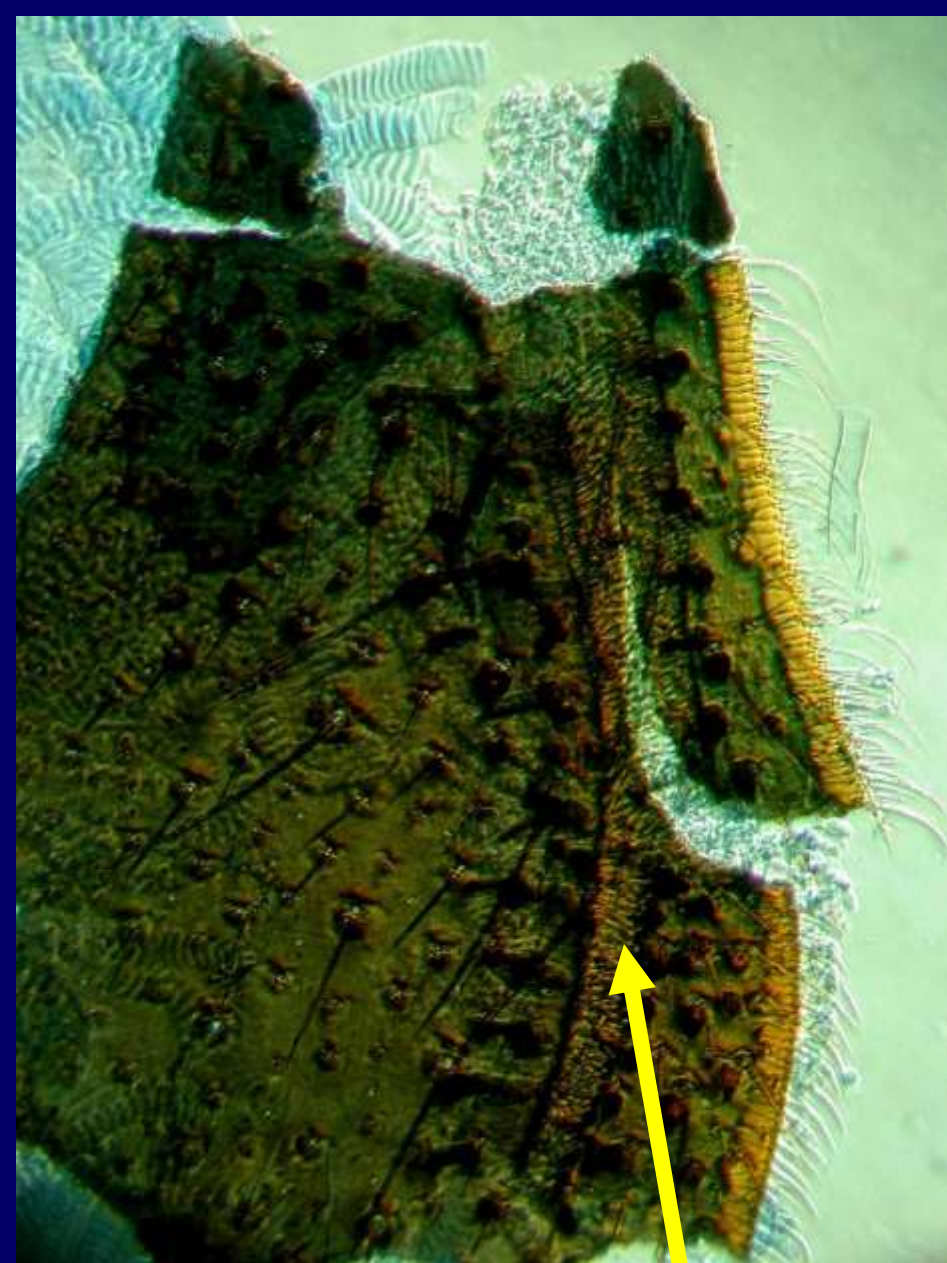
Oviposition and inoculation



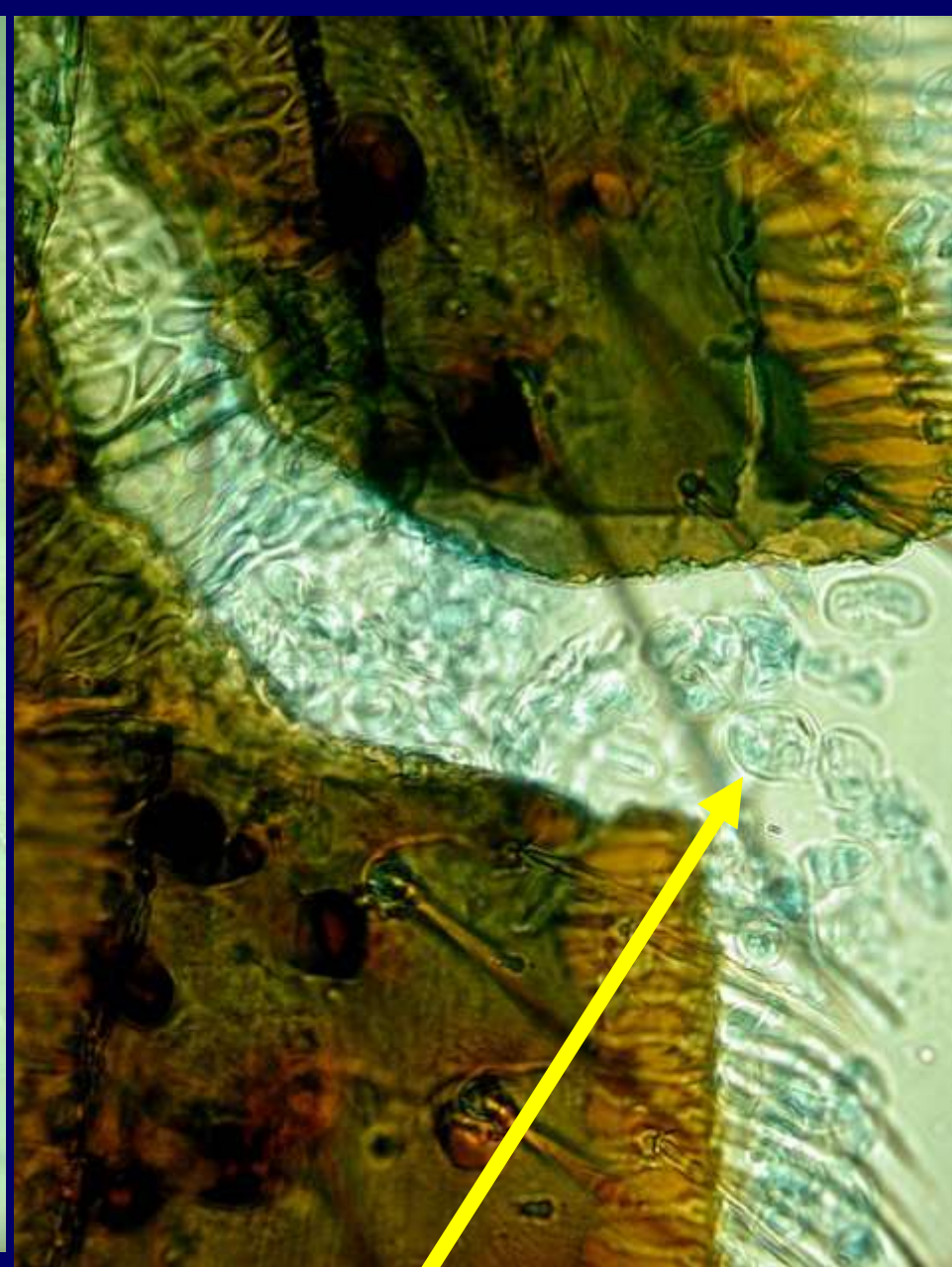
Mycangium of *D. frontalis*

Photomicrographs
by Stan Barras





Mycangium



Mutualistic fungus



Insect – fungal interactions



Ophiostoma minus & *Dendroctonus frontalis*

Ayres et al. 2000. *Ecology*

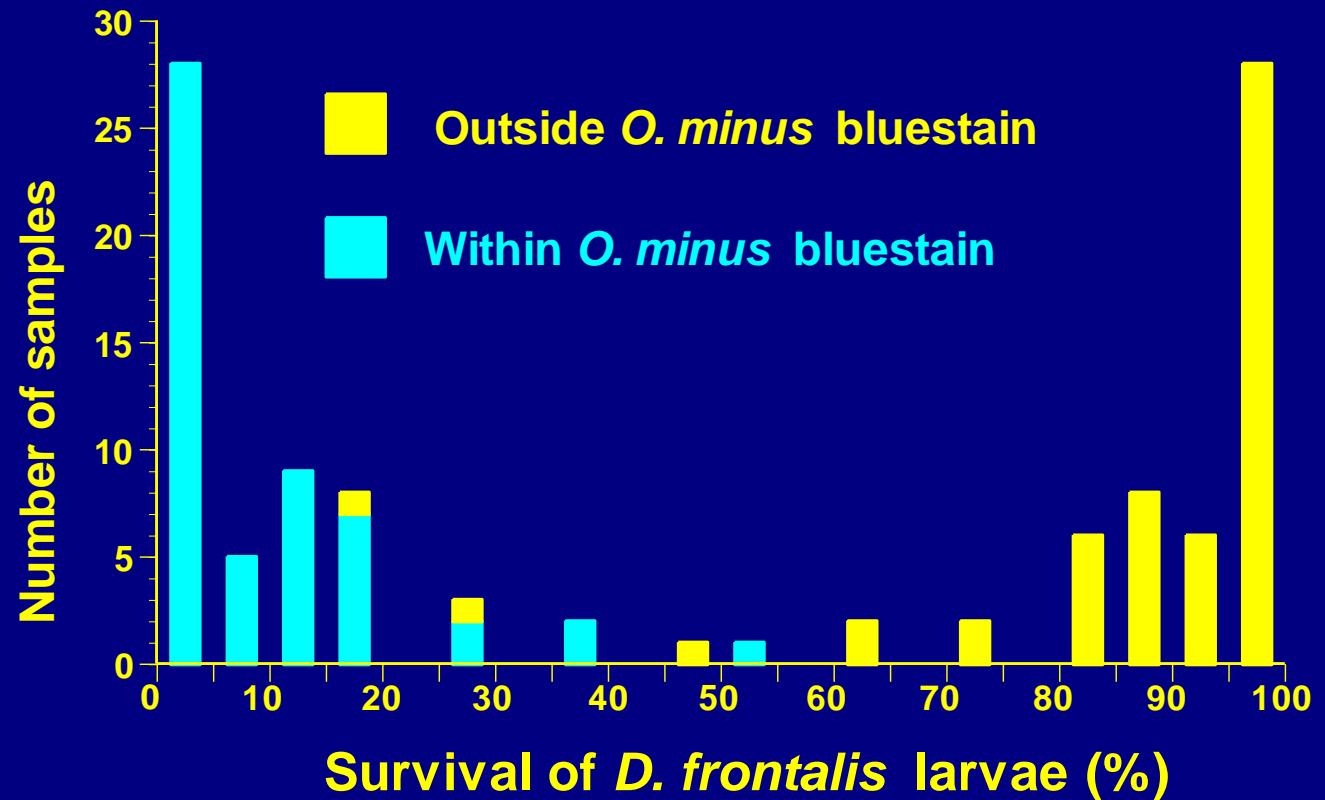
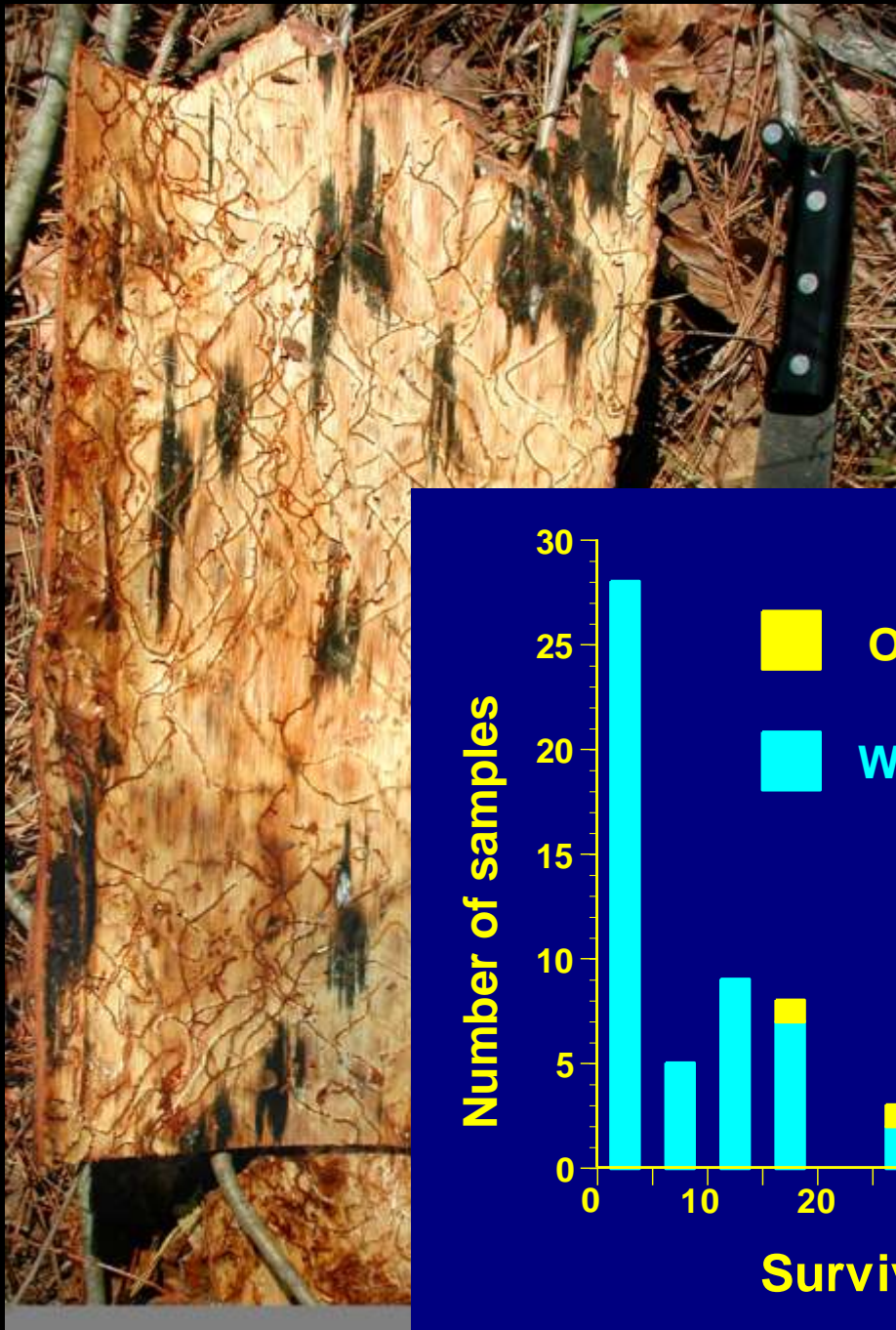
Lombardero et al. 2000 *Ag. & For. Entomol*

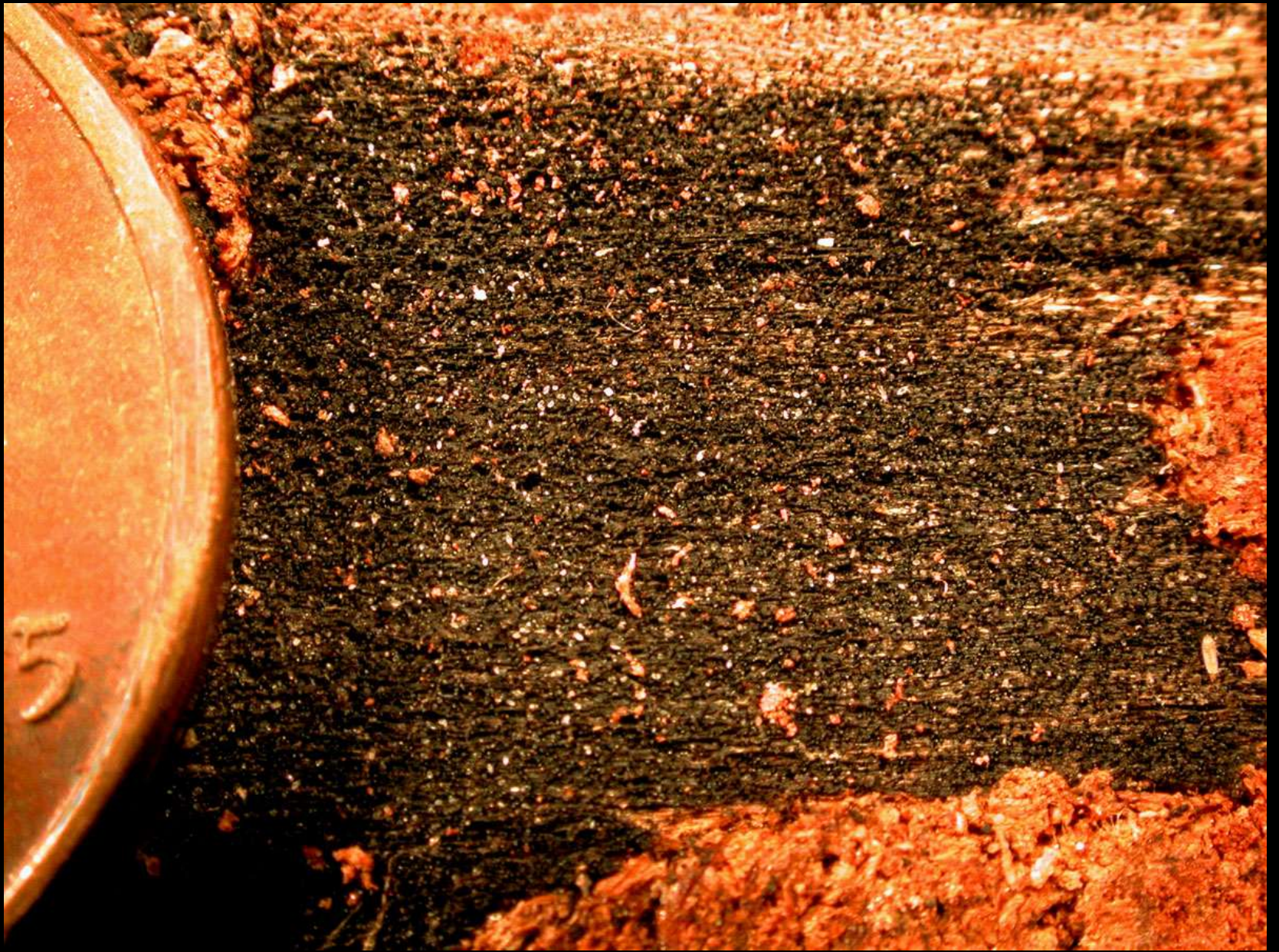
Klepzig et al. 2000. *Symbiosis*

Lombardero et al. 2002 *Oikos*

Hofstetter et al., *Oecologia*, in press

O. minus is an antagonist of *D. frontalis*

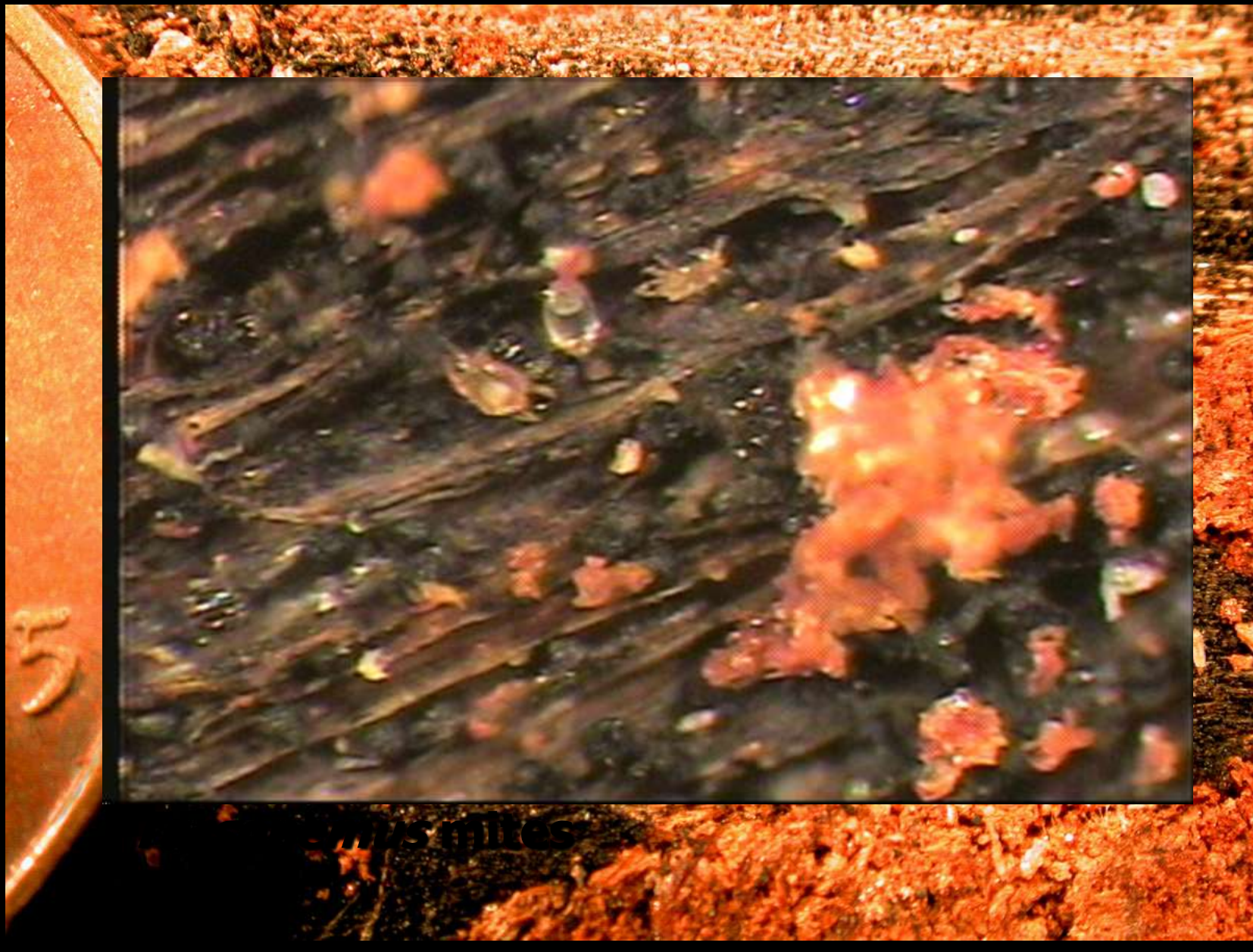




Tarsonemus mites are mutualists with *O. minus*



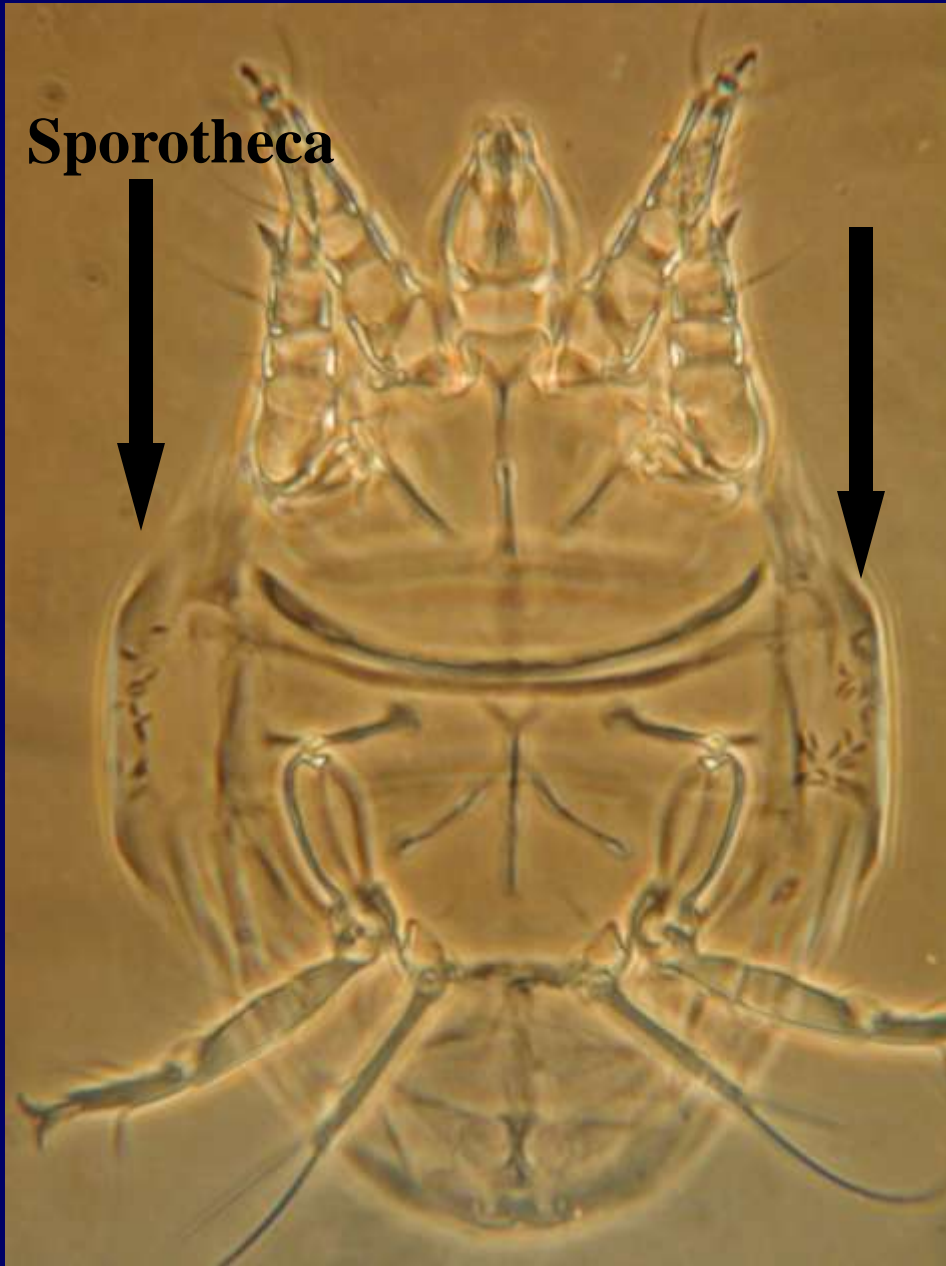
[Link to video](#)



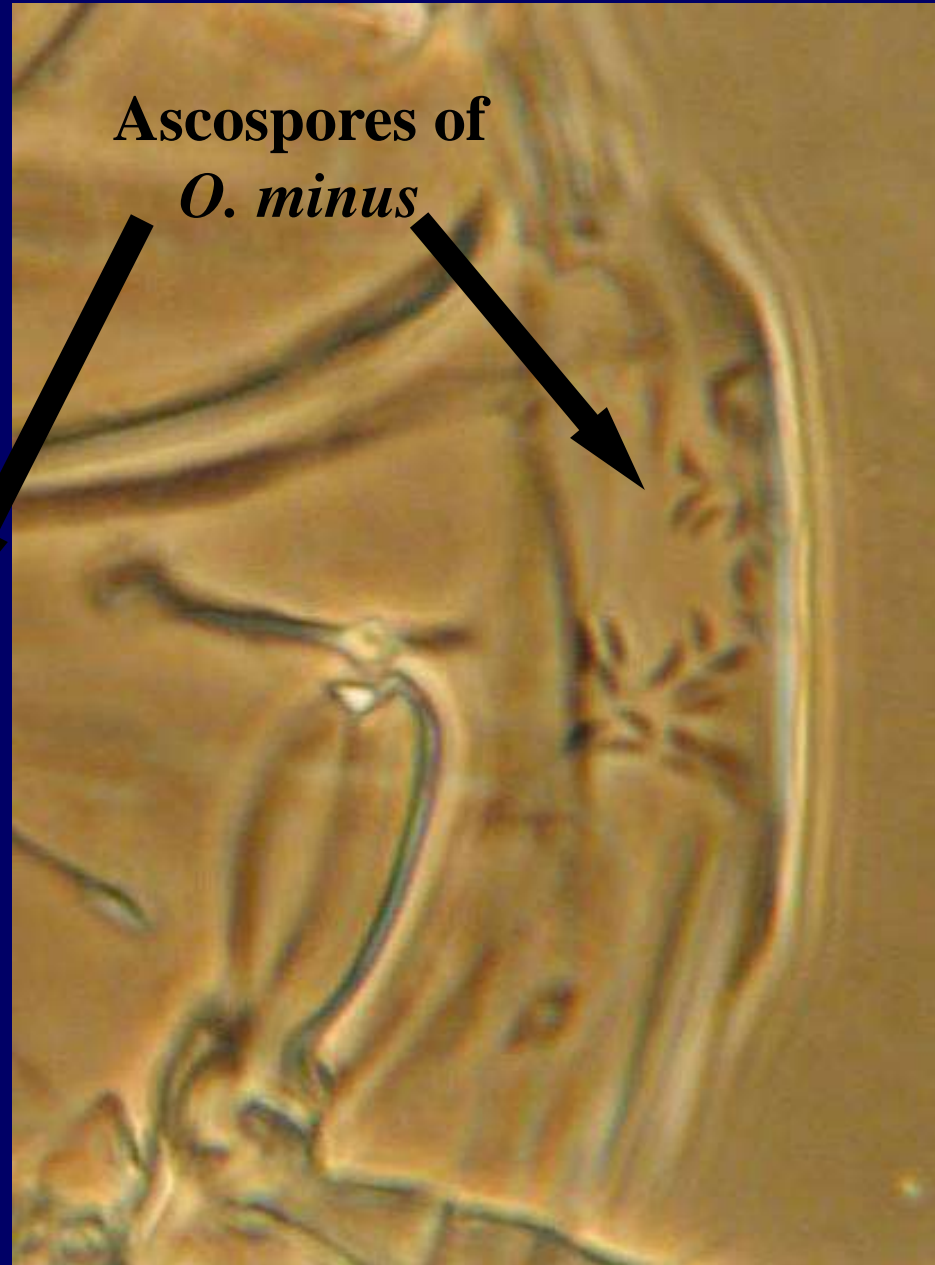


Tarsonemus krantzi

Sporotheca



Tarsonemus krantzi



Ascospores of
O. minus

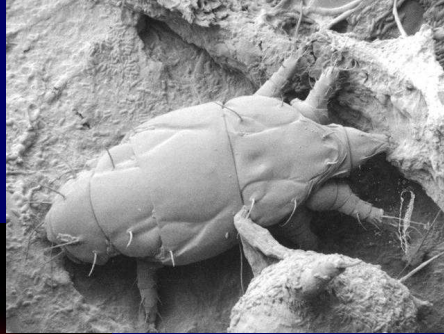
Other phoretic micro-associates



[Link to video](#)

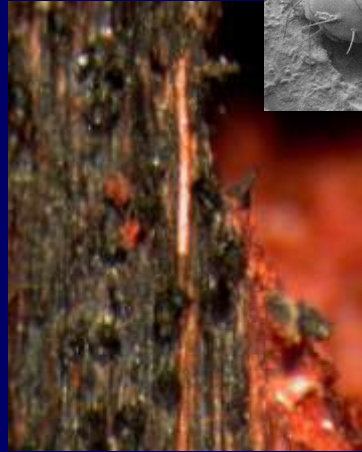
Tarsonemus
mites

+ ↑ ↓ +



Ophiostoma
minus

- ↑ ↓ -



Mycangial
fungi

+ ↑ ↓ +



D. frontalis

+ ↑ ↓ -

Pine tree

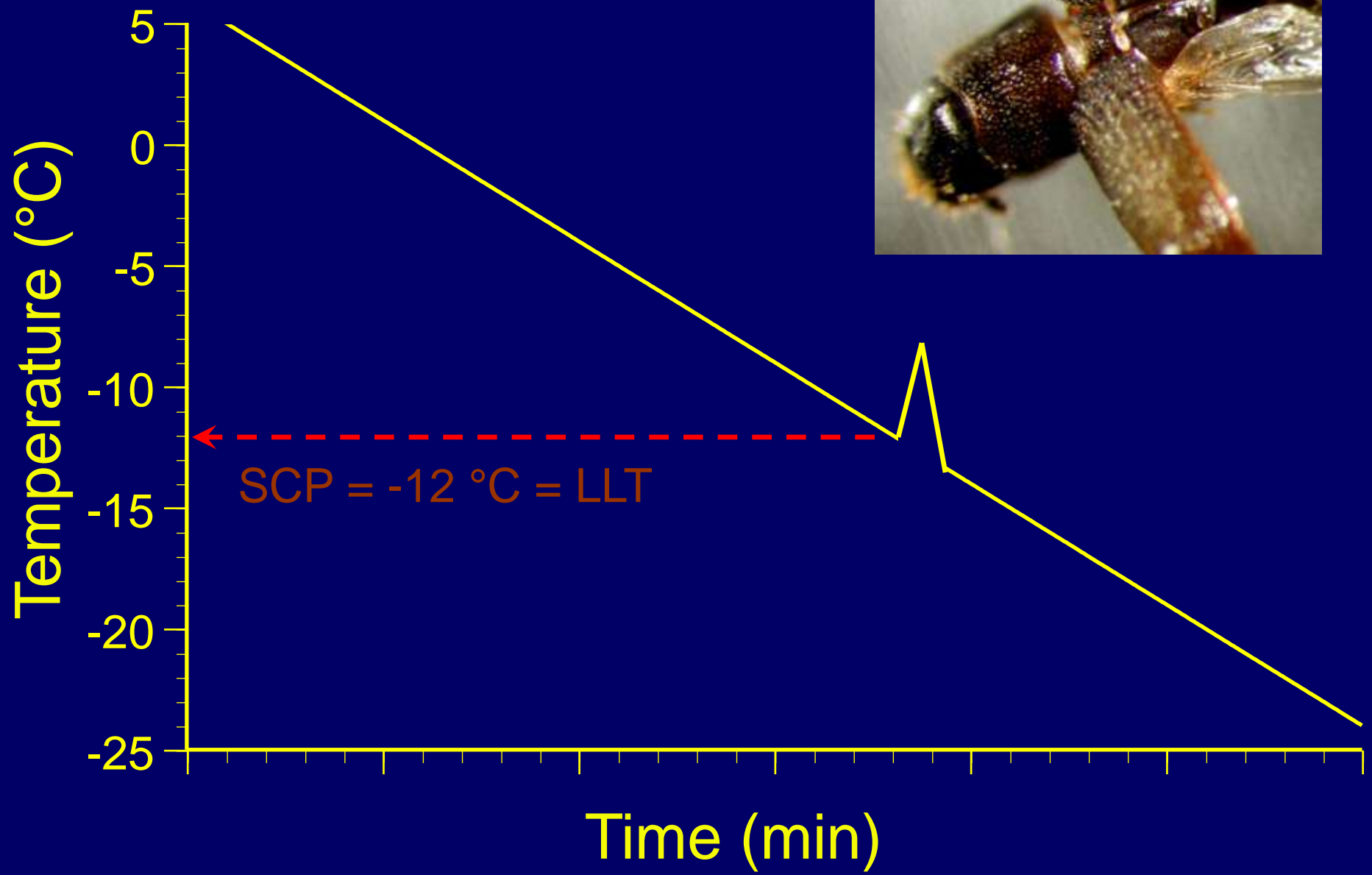


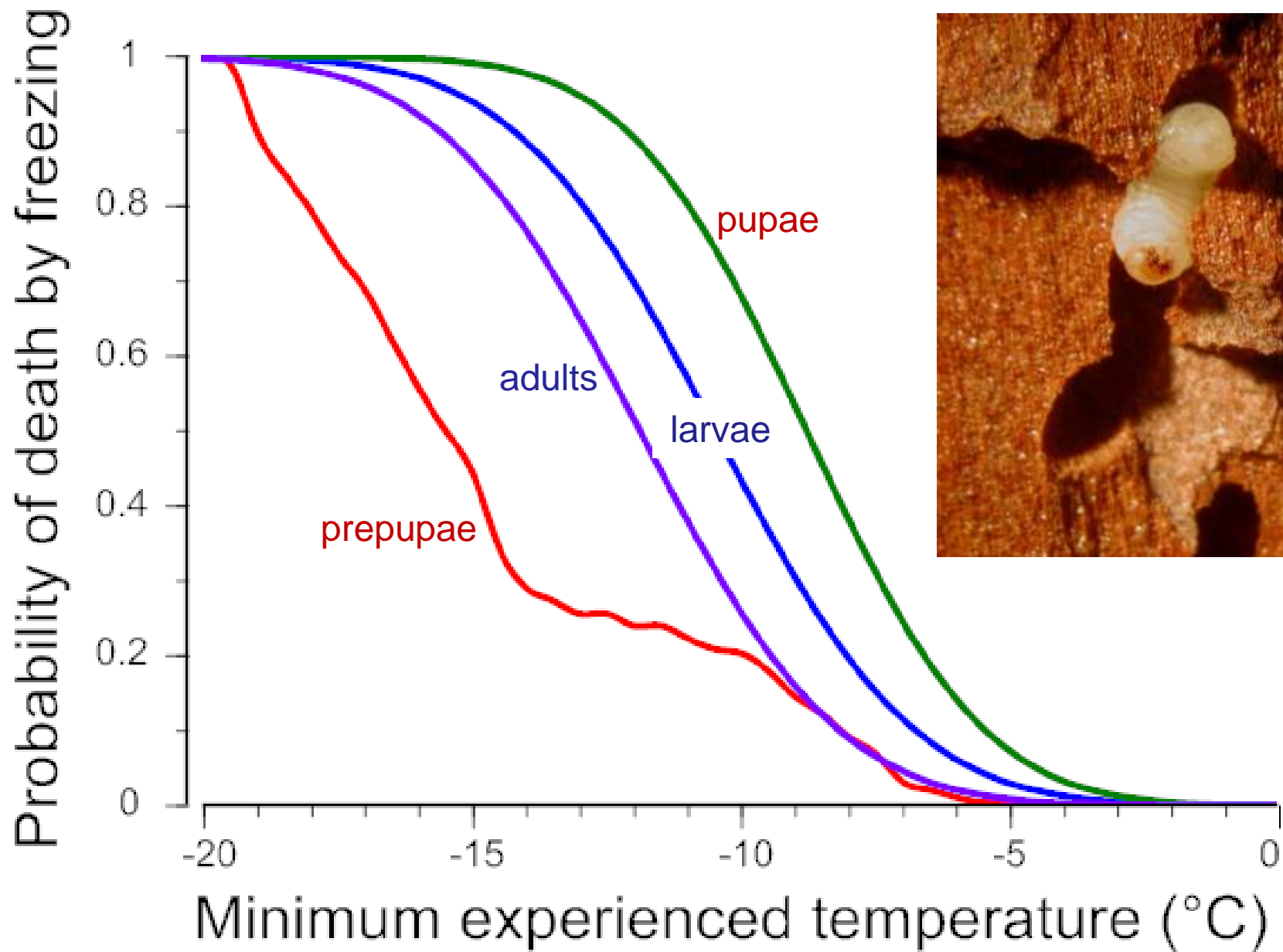
**An interaction
chain**



Whitehall Road October 2011 (Bob Williams)

Lower lethal temperatures

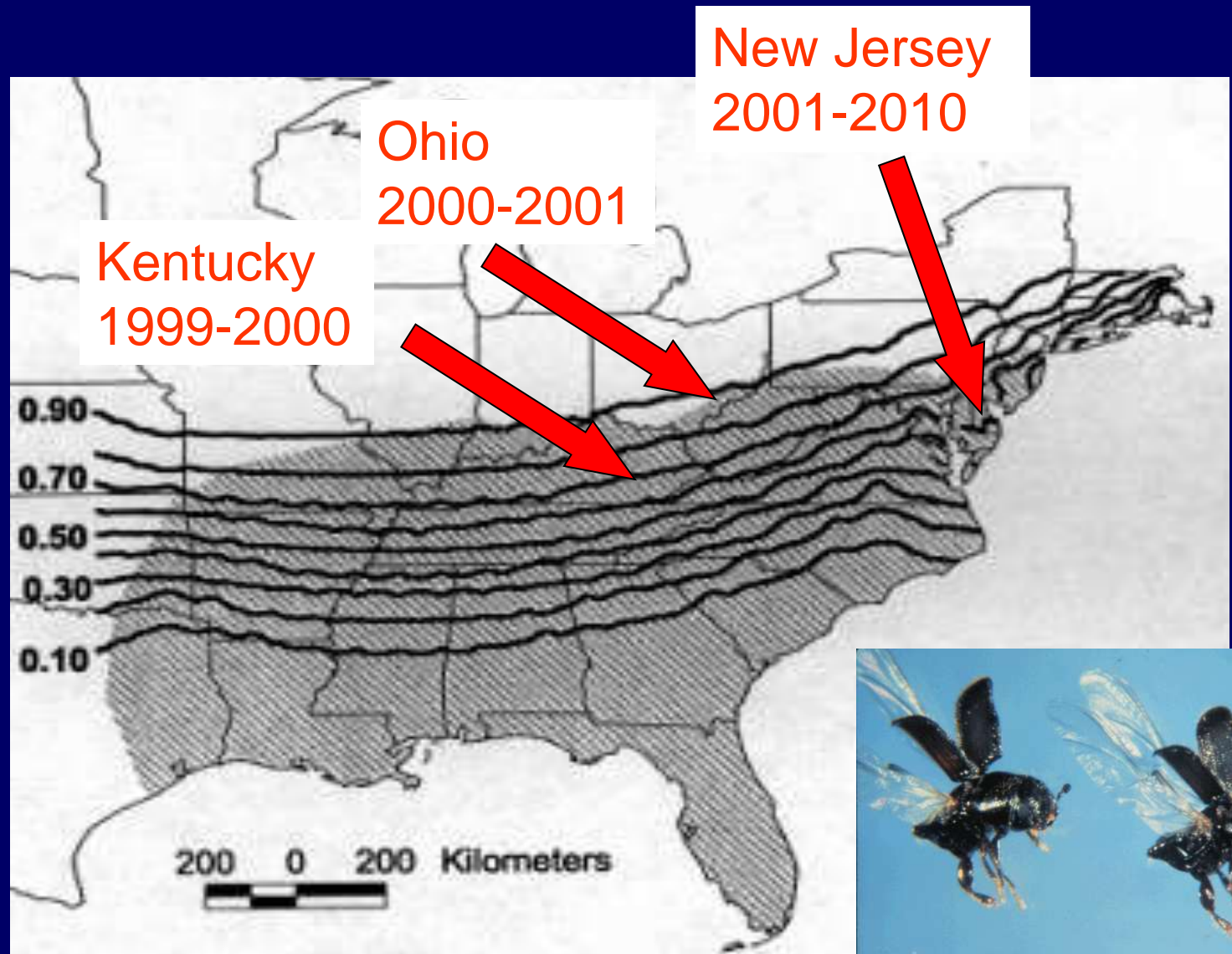




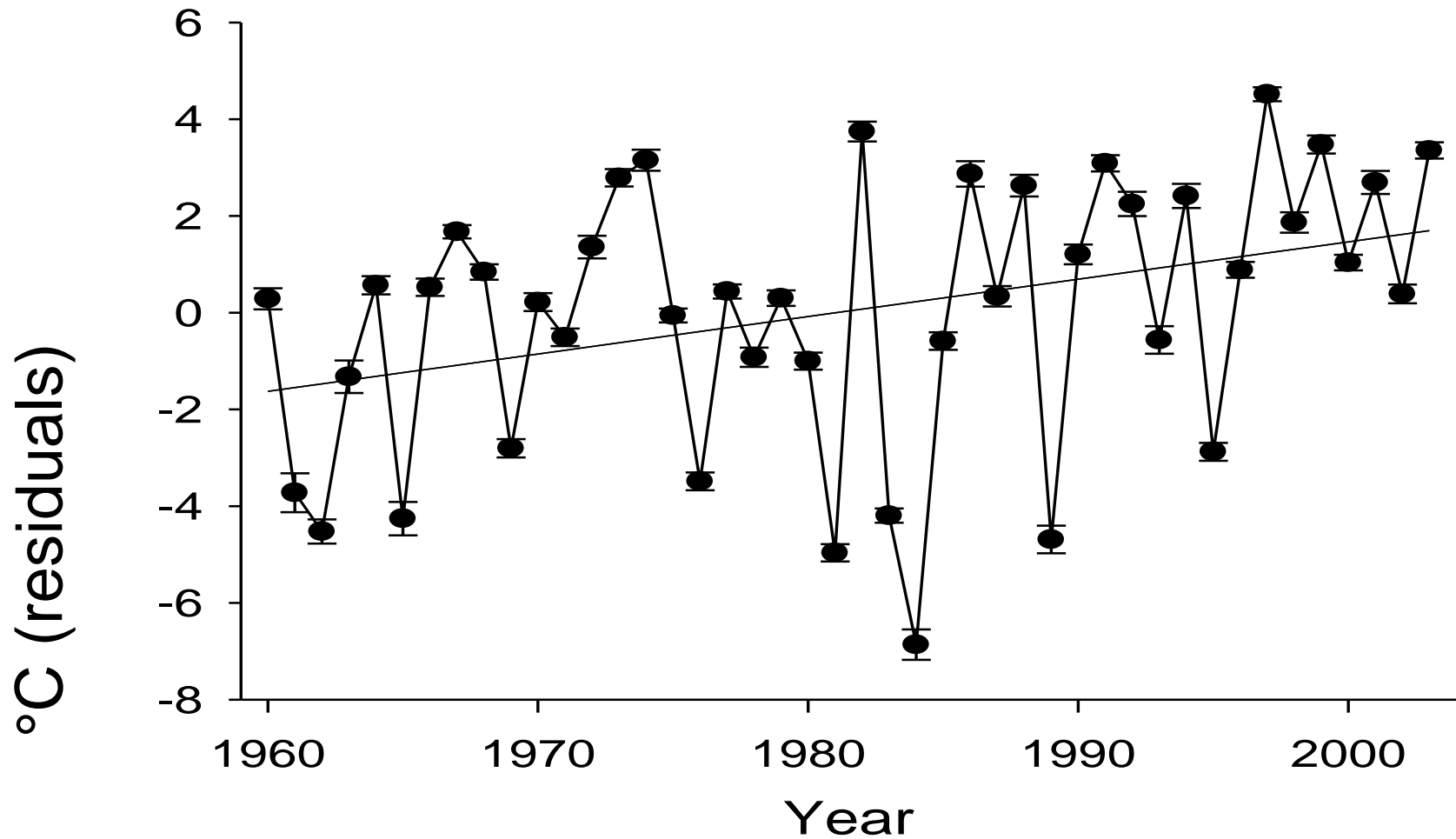
Lombardero, Ayres, Ayres, Reeve. 2000. *Env. Entomol.*

Tran, Ylioja, Regniere, Billings, and Ayres. *Ecological Applications*, 2007

Recent epidemics in north



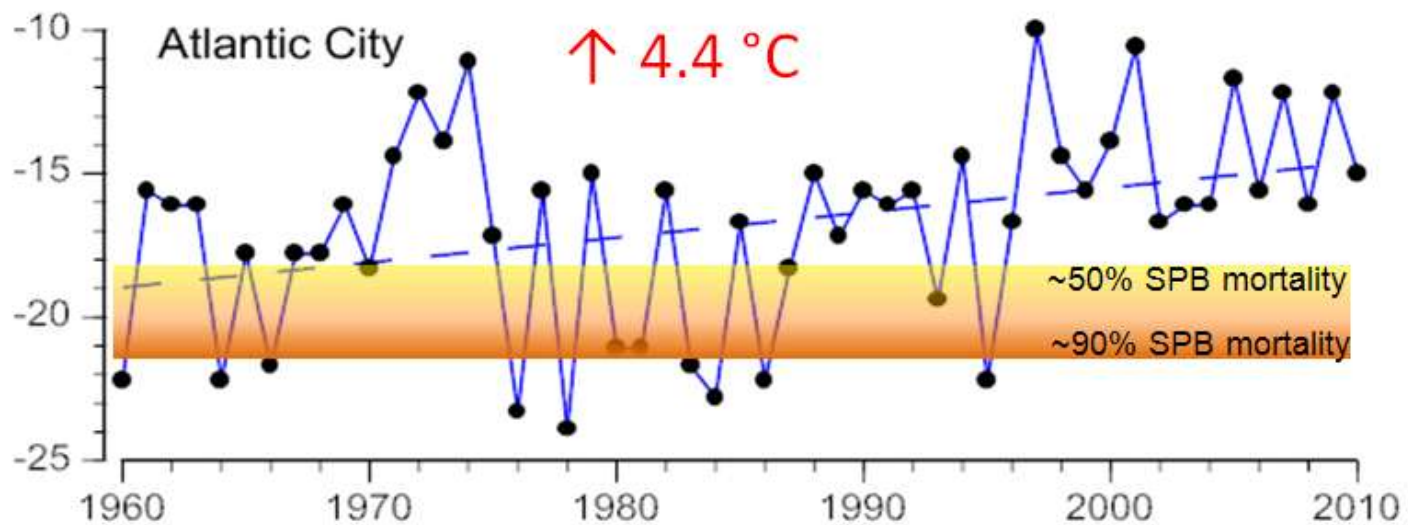
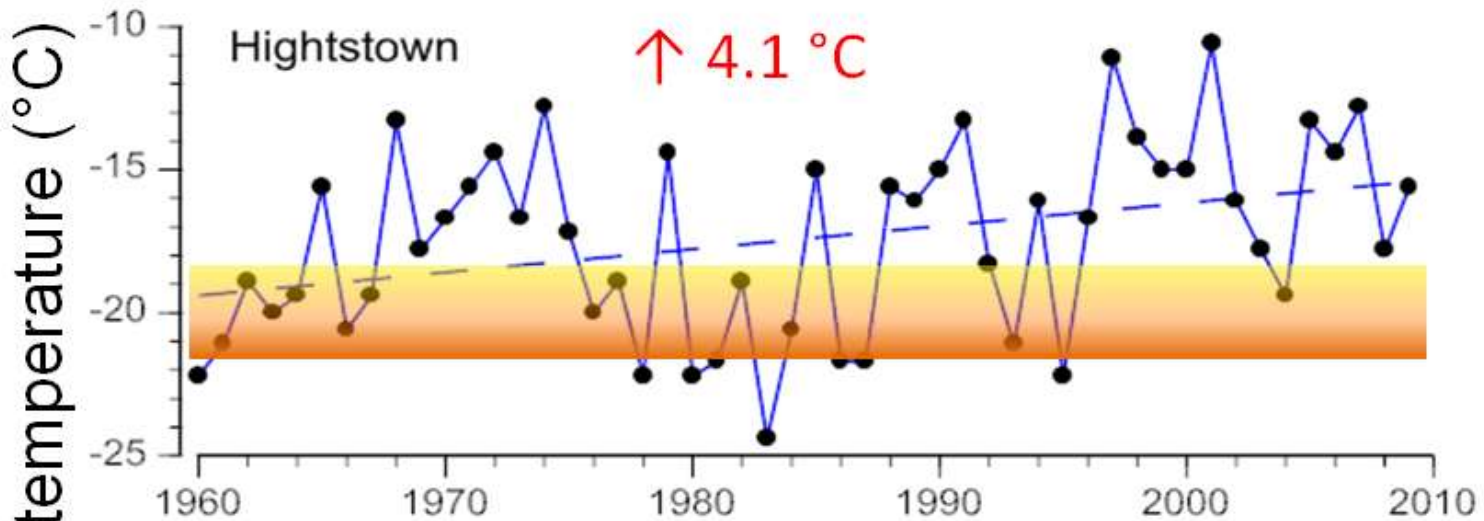
Minimum winter temperature in southeastern U.S. has increased ≈ 3.3 °C in 40 years

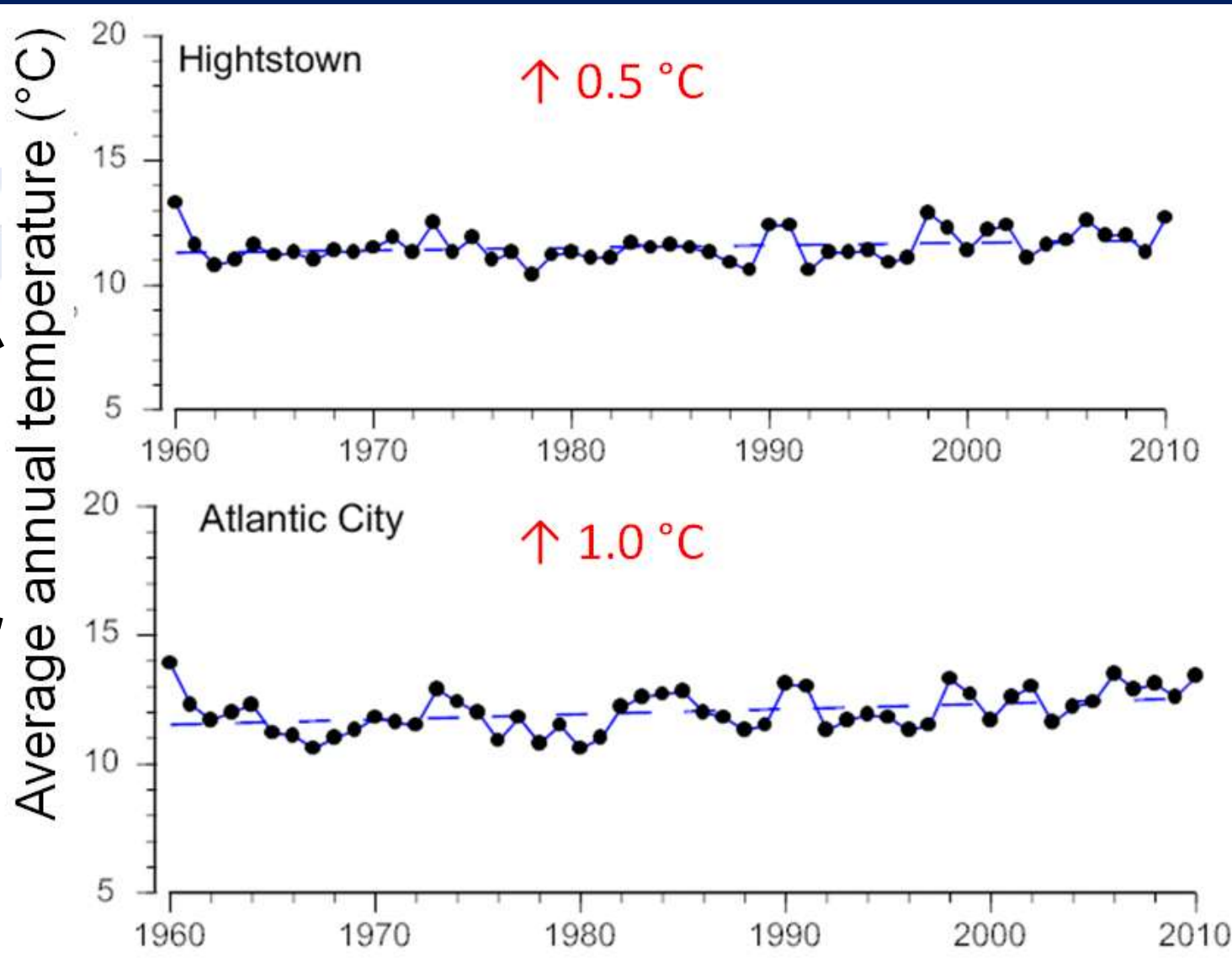


Southern pine beetle New Jersey



2002

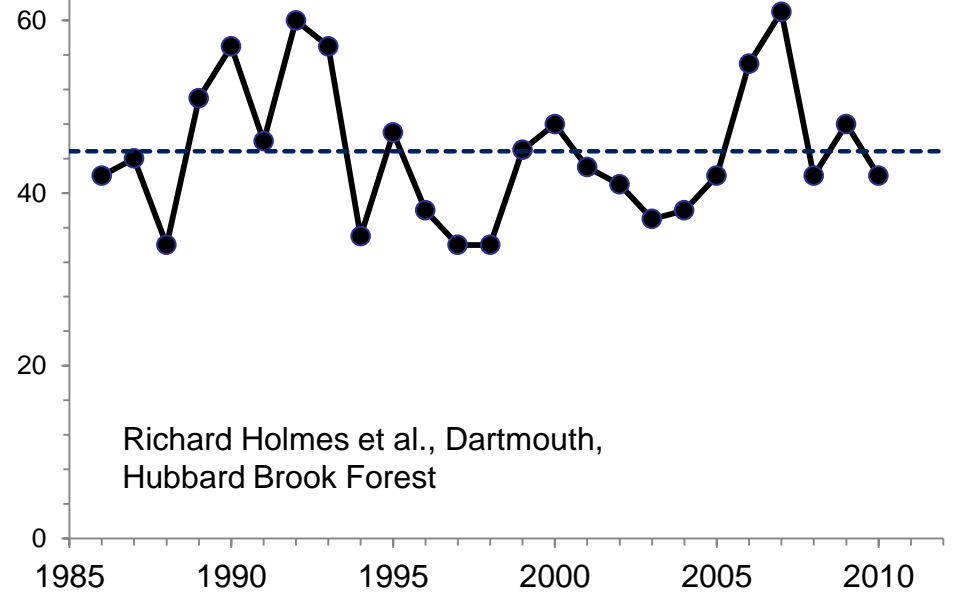




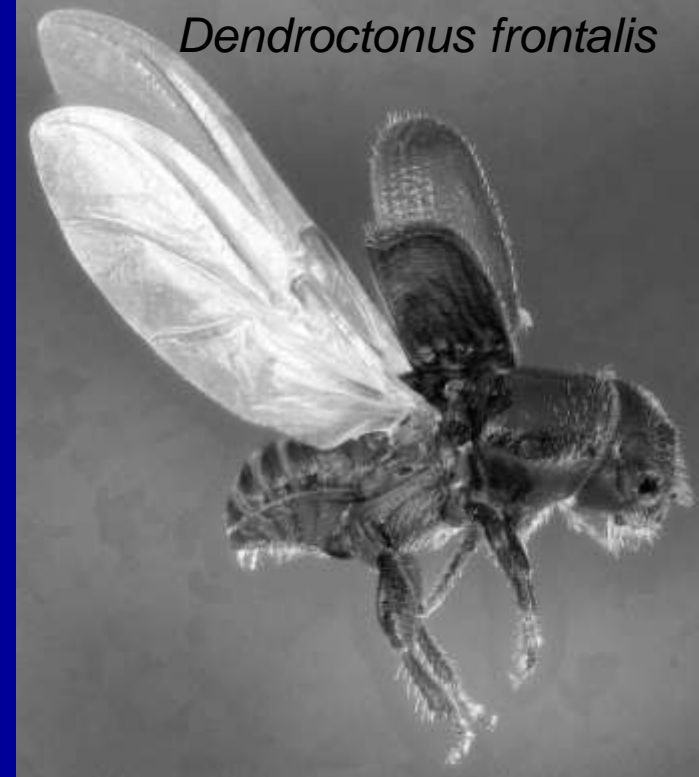
Dendroica caerulescens



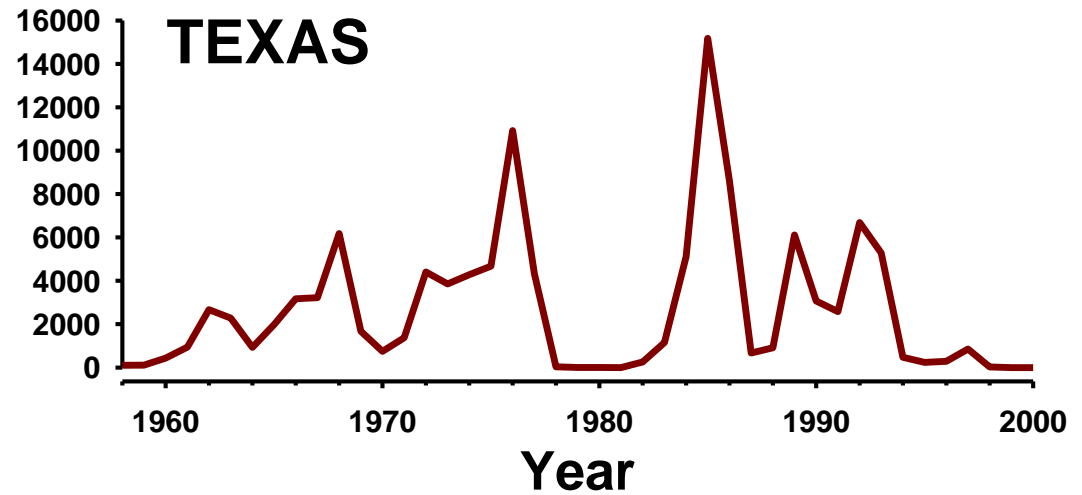
Birds / 64 ha



Dendroctonus frontalis

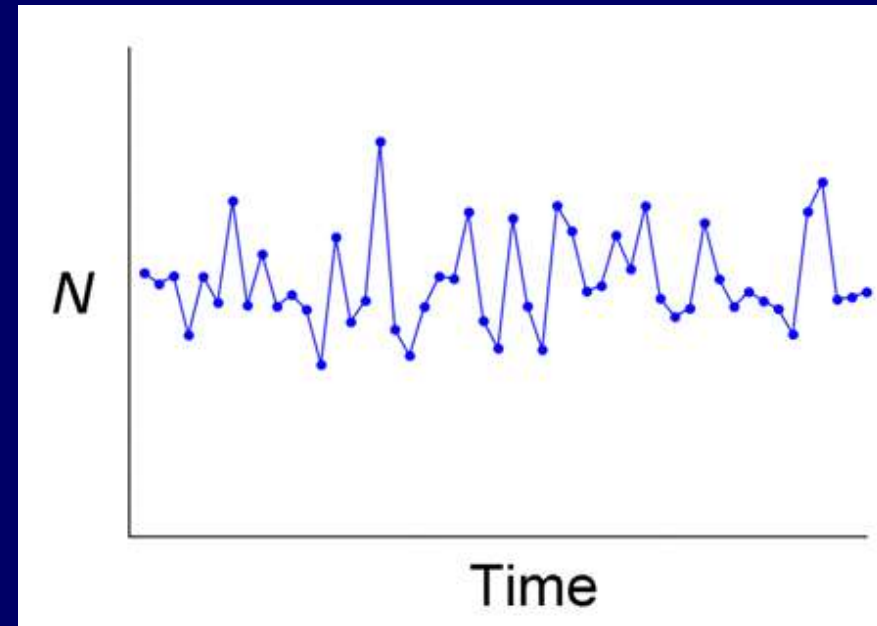
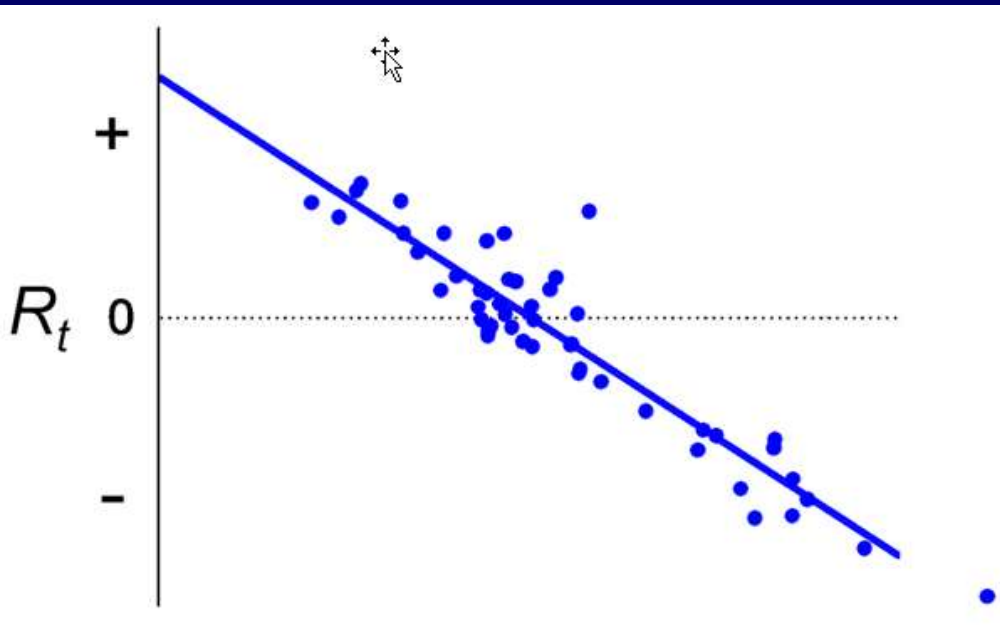


No. of infestations

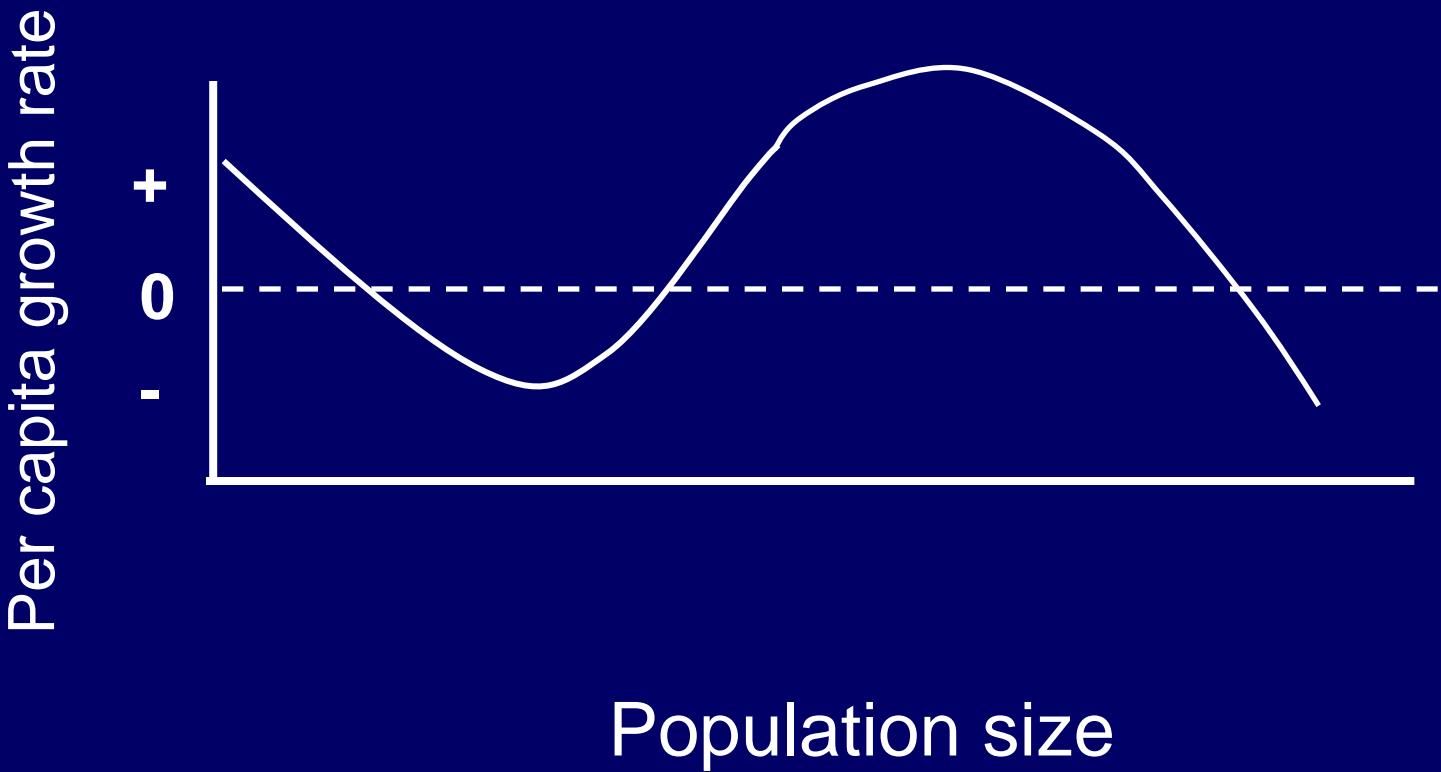


$$R_t = f(N_t) + \varepsilon_t$$

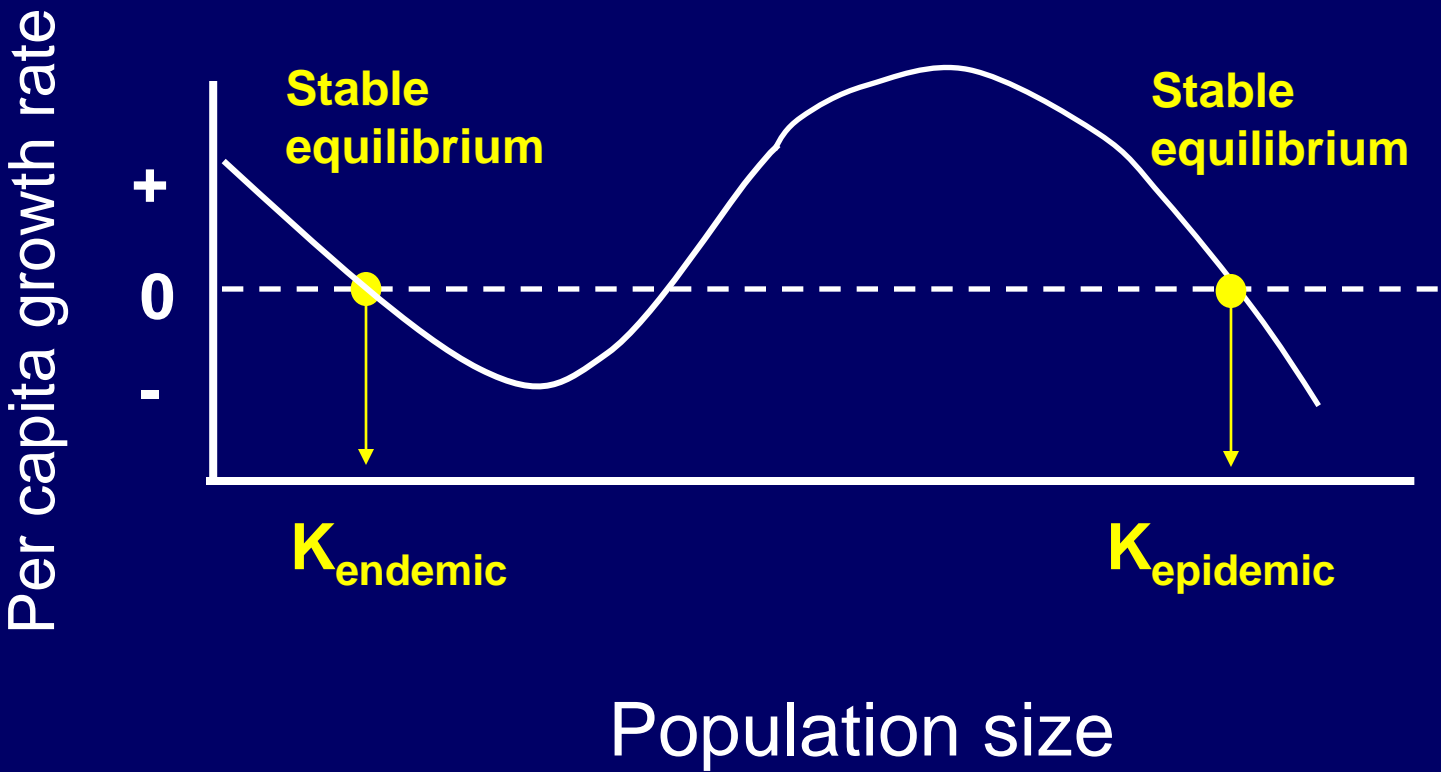
$$N_{t+1} = N_t \cdot \exp(R_t)$$



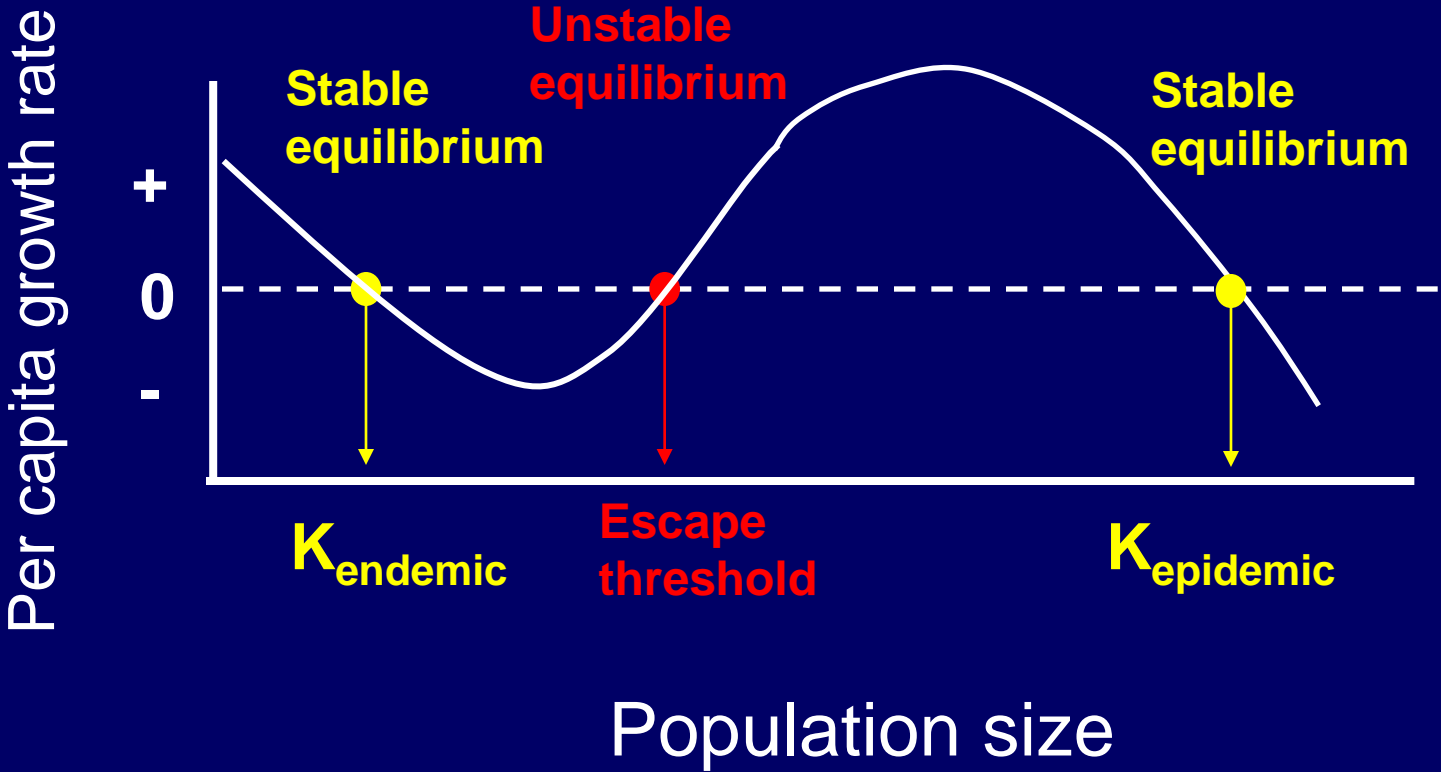
Multiple equilibria model



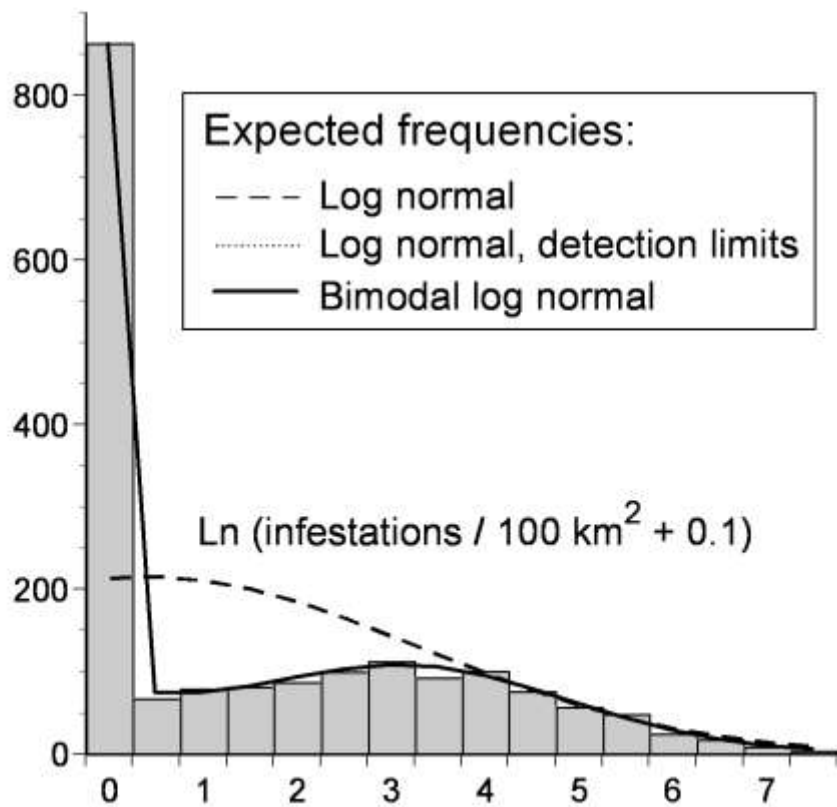
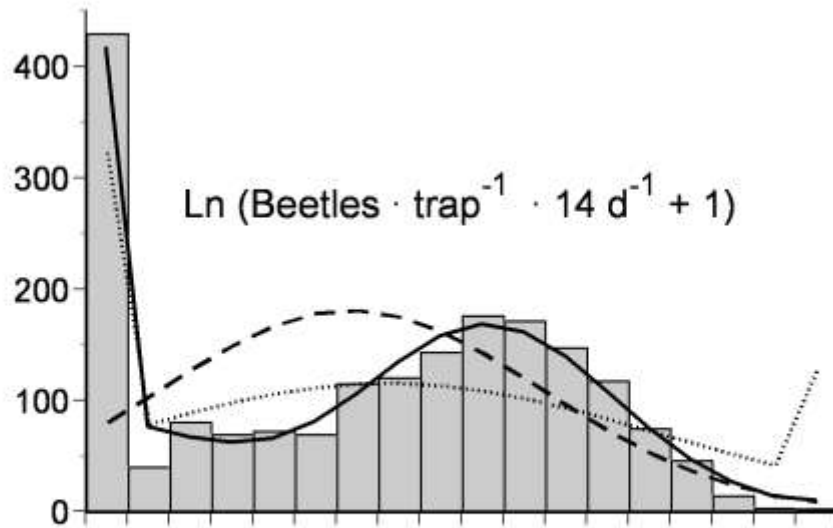
Multiple equilibria model



Multiple equilibria model



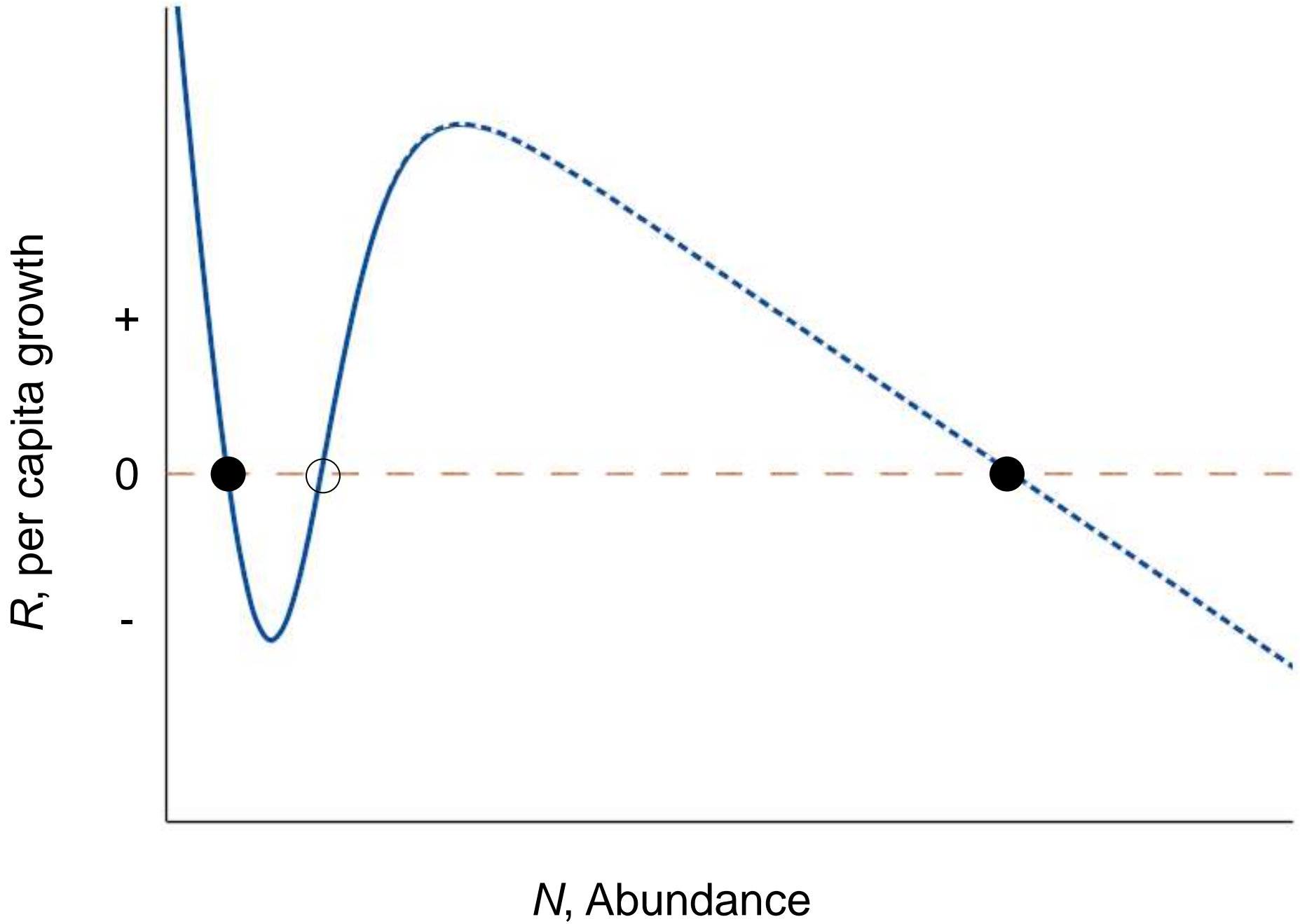
Number of forest-years



Sharon
Martinson



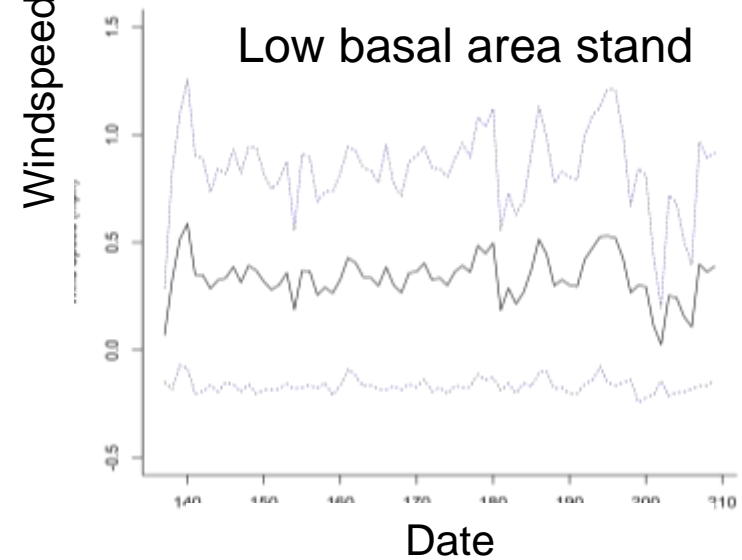
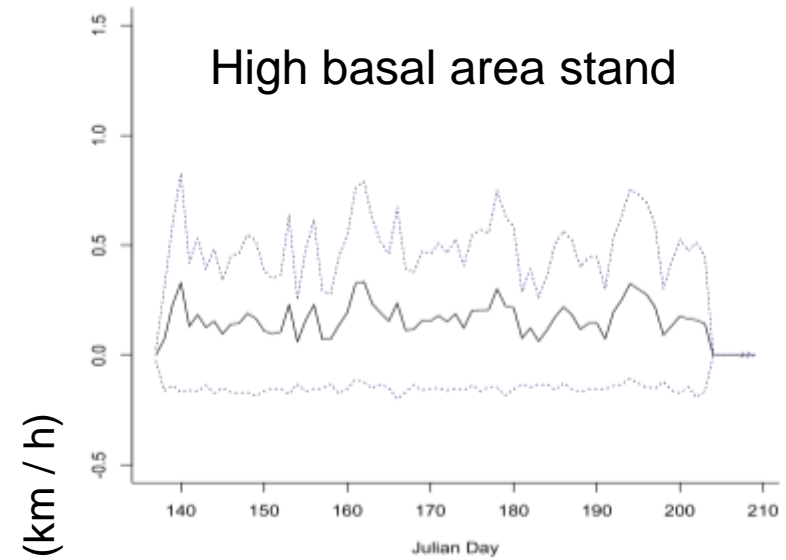
And Ron Billings, Tiina Ylioja, Brian Sullivan



Carissa Aoki



Jeff Lombardo



Becky Niemiec: ecological economics of SPB in The Pinelands



Advised by Professor Richard Howarth,
Environmental Studies, Dartmouth. [Rich's homepage](#)

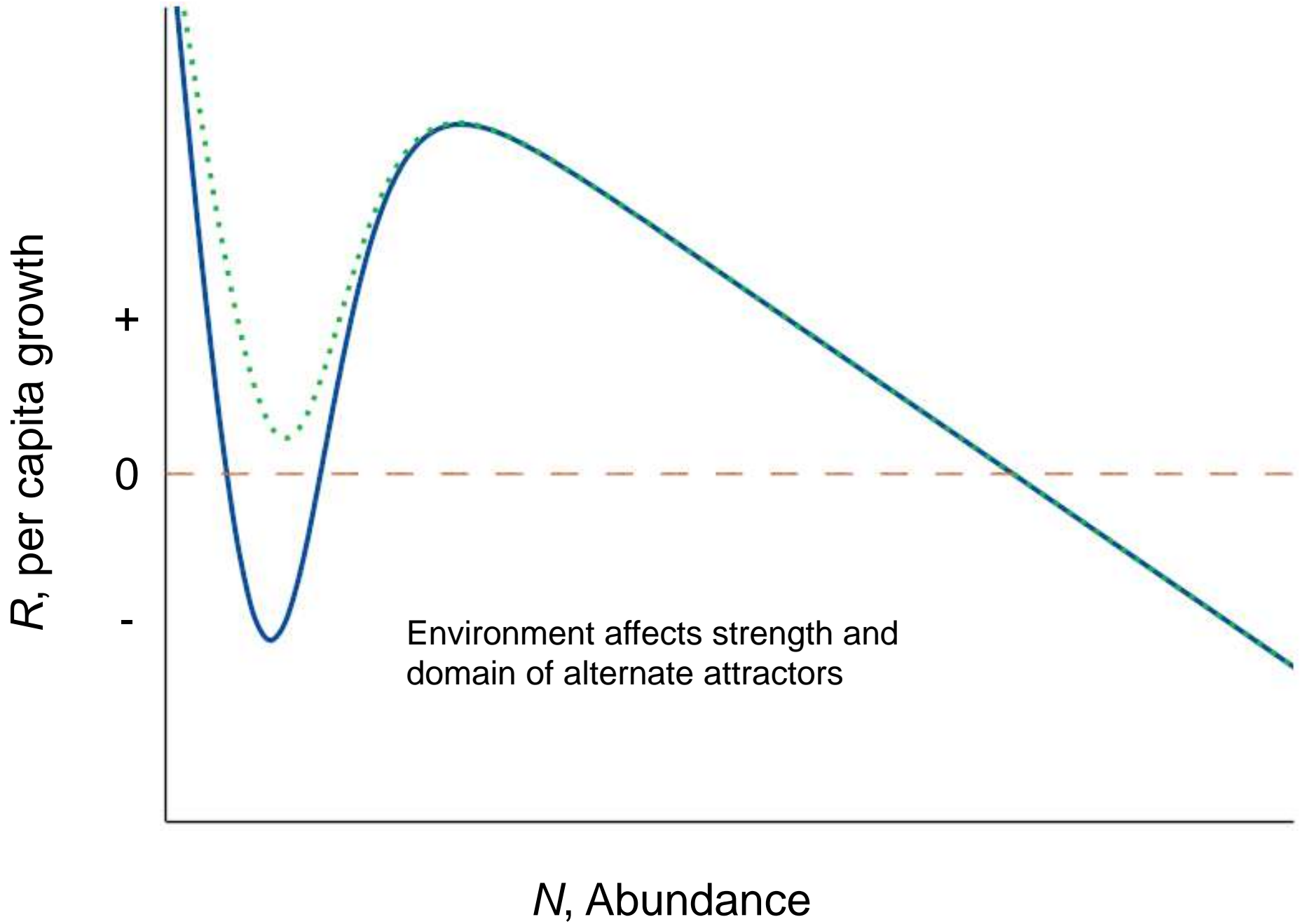
Milo Johnson

[Link to Milo's blog from The Pinelands](#)



Charlie Governali: predators of southern pine beetle





R , per capita growth

+

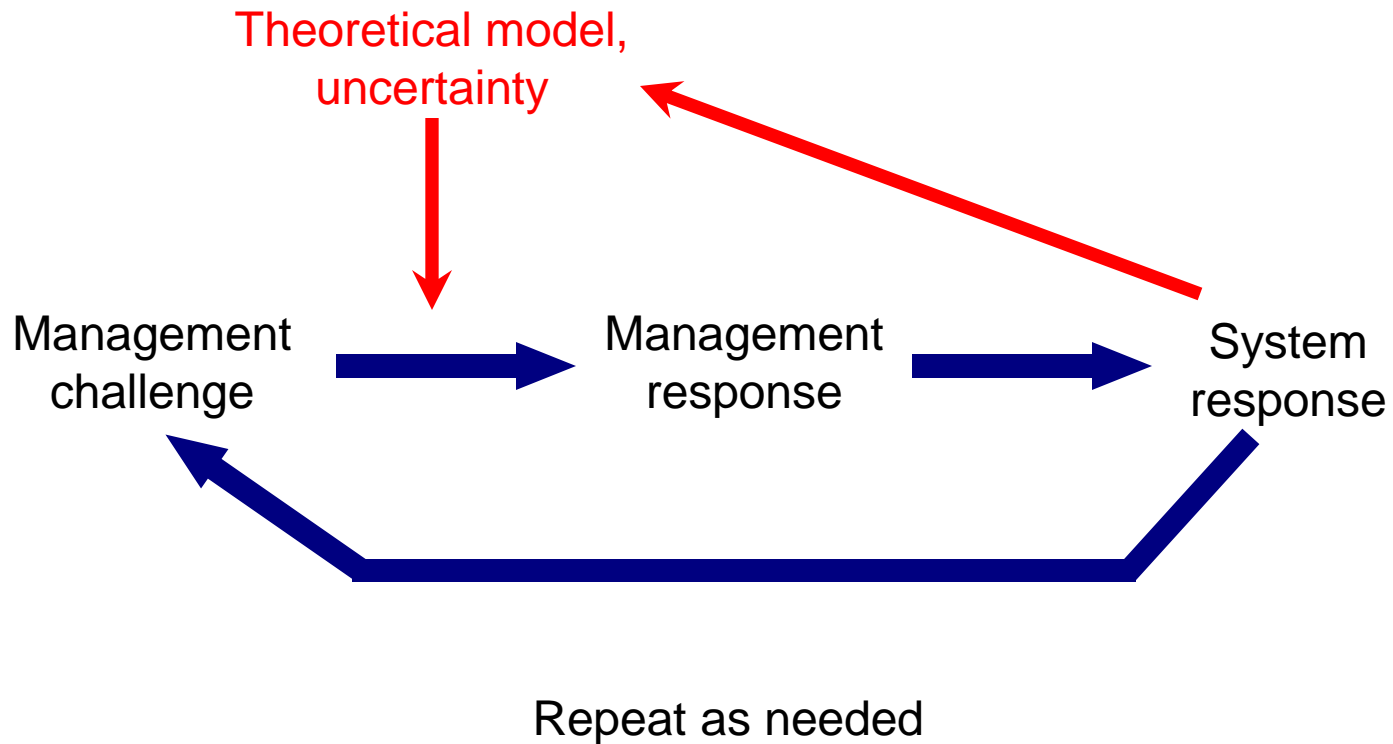
0

-

N , Abundance

Environment affects strength and domain of alternate attractors

Adaptive management





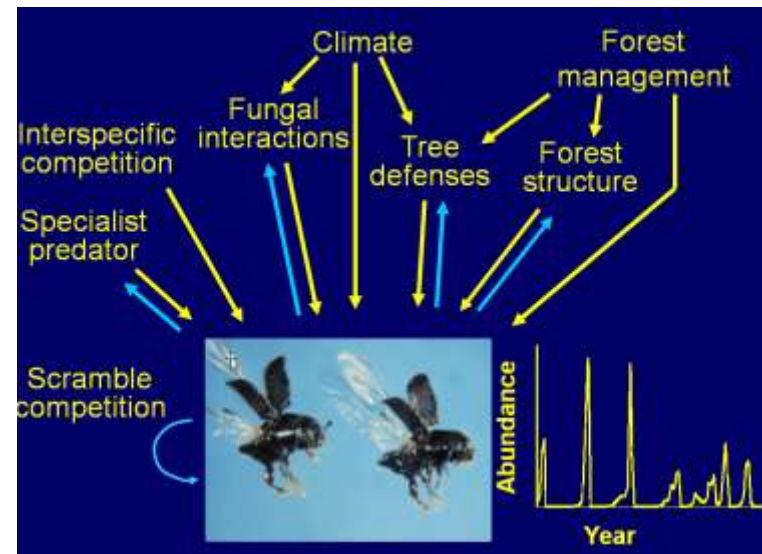
Beetle
abundance at
time t

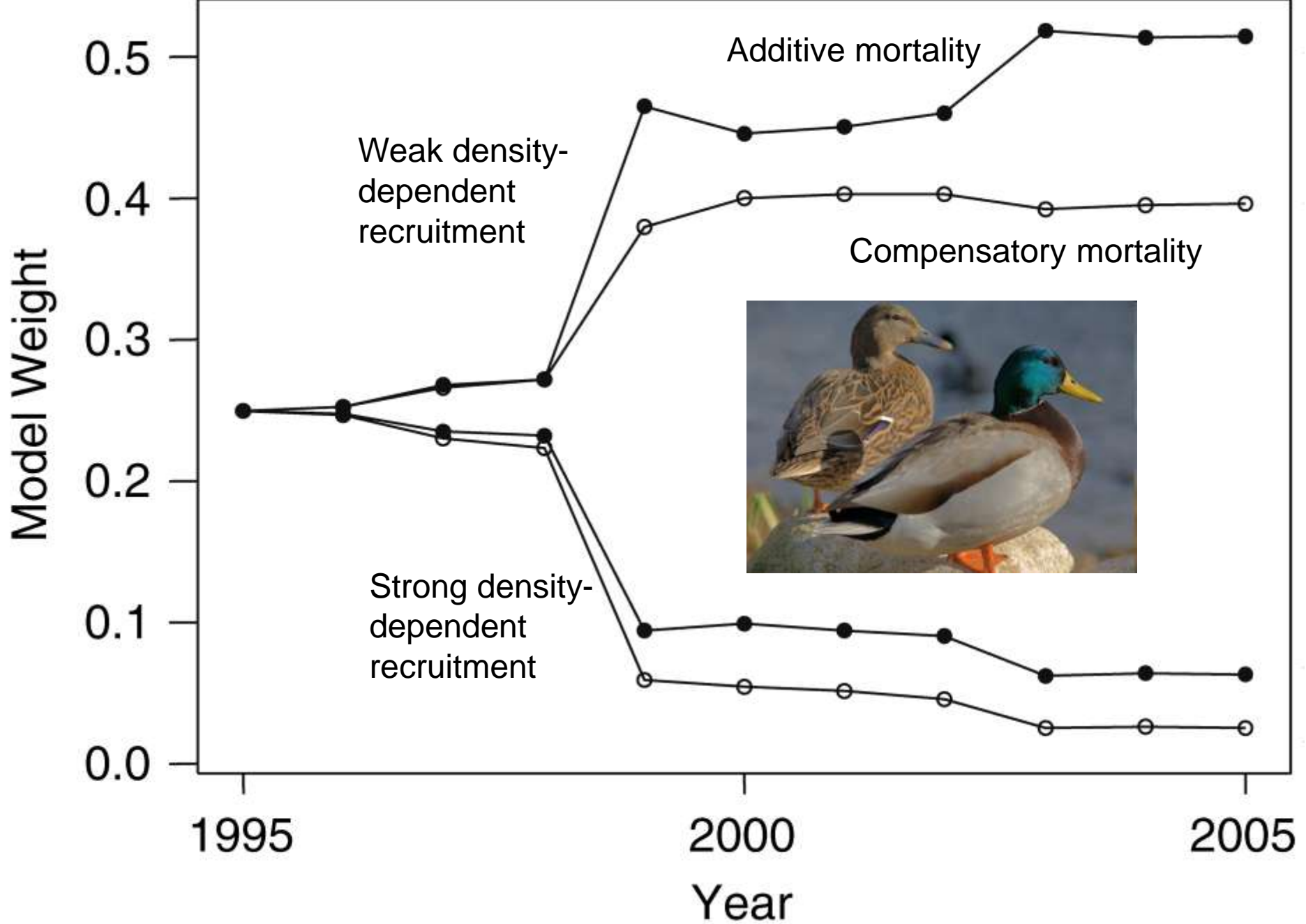
Climate
Bluestain fungus
Predators
Tree defenses
Forest structure

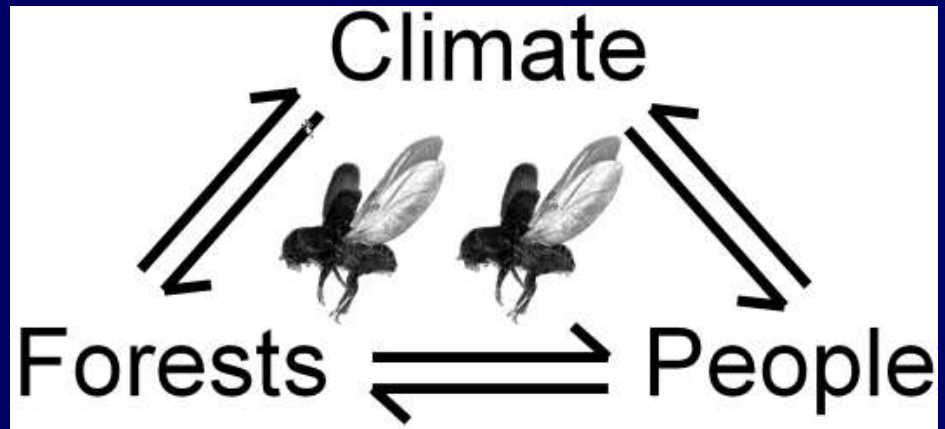


Beetle
abundance at
time $t+1$

Monitoring
Suppression
Prevention







Duhamel de Monceau

"Traité complet des bois et forests" 1755-1768.

