The Bark Beetles (Coleoptera:Scolytidae)

What bark beetles can do!

We're going to move from insects feeding on foliage of essentially healthy trees to insects feeding in the inner bark or the phloem of trees – the barkbeetles.

In particular, we'll talk about three genera:

1. ***Ips***
2. ***Dendroctonus***
3. ***Scolytus***

Ips

Dendroctonus

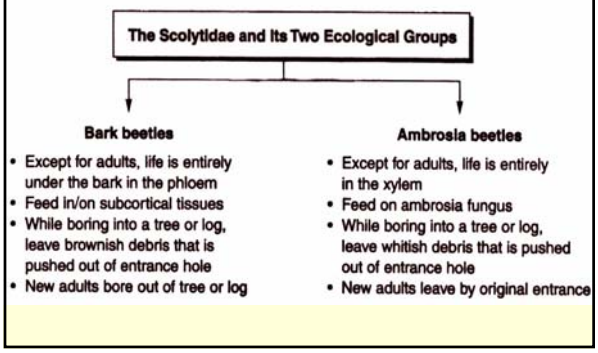
Scolytus

Barkbeetles are mostly secondary insects: they prefer to select, feed and breed in normally weakened hosts.

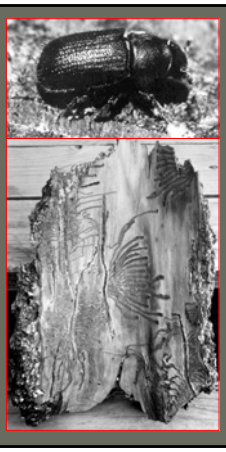
However, during outbreaks, barkbeetles can take on the role of primary insects: they can select, kill, feed and breed in healthy trees.

Beetles invading	Subcortical tissues	Attack behavior
Living, healthy trees	Defenses normal	Primary
Temporarily or permanently weakened trees	Limited defenses, phloem fresh and succulent	Secondary *Dendroctonus Ips, Hylastes, Etc.*
Fresh logs, windthrows, fire-killed trees, moribund trees etc.	Phloem moisture decreasing, fermenting, etc.	Secondary *D. pseudotsugae, Ips, D. rufipennis, etc.*

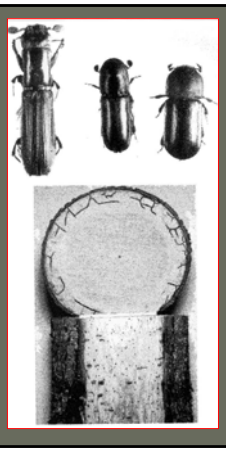
Barkbeetles belong to the family of beetles known as the Scolytidae.



Bark Beetles

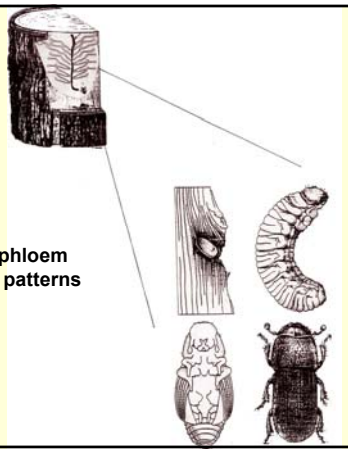


Ambrosia Beetles



All barkbeetles do the following:

- **Excavate egg galleries in fresh phloem**
- **Larvae feed away (right angles) from the egg gallery – devouring the succulent tissues of the phloem**
- **The patterns formed by both the original egg galleries and the larval mines is characteristic for each species – you can learn this!**



Egg gallery and larval mines in the phloem form characteristic patterns

The genus – *Dendroctonus*

Dendro = pertains to trees
Dendroctonus = tree killers

In Central America and North America there are about 16 species of *Dendroctonus;* only one species occurs in Europe, *D. micans.*

D. micans

THE MOST DEADLY *DENDROCTONUS*

Dendroctonus frontalis	Southern pine Beetle	Living trees, all ages between pole size to mature southern pines.
D. brevicomis	Western Pine Beetle	Mature senescent ponderosa pines.
D. ponderosa	Mountain Pine Beetle	Pole sized to young-mature western pines.
D. pseudotsugae	Douglas-fir Beetle	Down logs, but!
D. rufipennis	Spruce Beetle	Down spruces, but!

An example of *Dendroctonus*: The Douglas-fir beetle, *D. pseudotsugae.*

- As with all *Dendroctonus*, the Douglas-fir beetle attacks weakened host material – in particular down logs from windthrow or logging operations.
- First flight begin in April.

• Pioneering females find this scattered, degrading wind-throws or other downed material.

• These pioneering females and the rest of the flying population then use their exquisite "game plan" to find these scattered, degrading host material.

After execution of their host-finding & colonization plan:

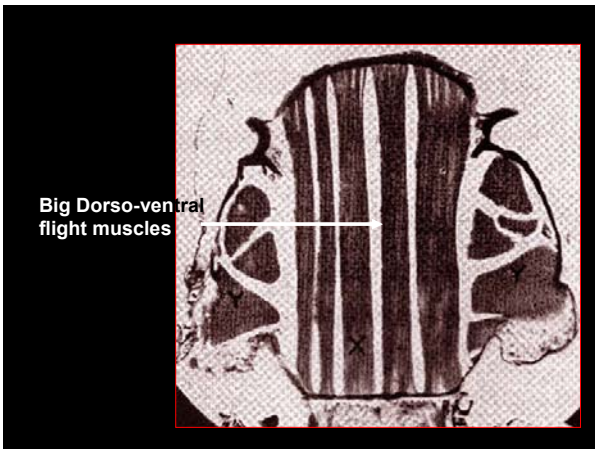
1. Gravid females cut egg galleries in the fresh phloem and lay eggs on alternate side of the inner bark (phloem region).
2. The larvae feed in the phloem to the last instar, then they cut pupal cells and pupate next spring around March.
3. The new generation of adults then cuts its way out of the bark and they fly once again in a dispersal flight.

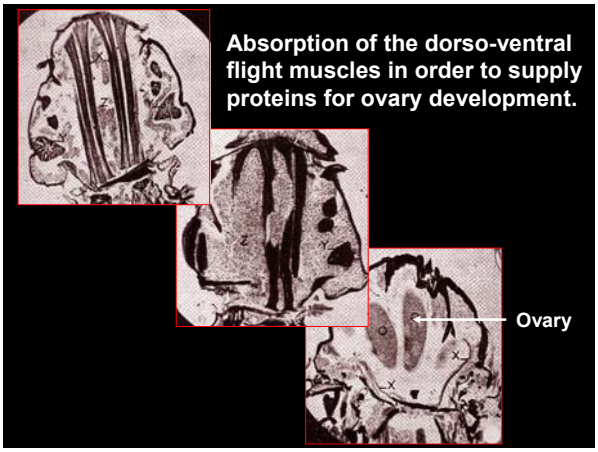
In spring the new adults chew out of the bark and fly off in search of new hosts.

Upon peeling away the bark we see the egg galleries and larval mines

Peel away the bark with an axe and we see the egg galleries and larval mines, and even larvae.

The Douglas-fir beetle also has what are called re-emergence flights in late summer: this is due to the fact that females absorbs their flight muscles then reconstitutes them.





Three Statements

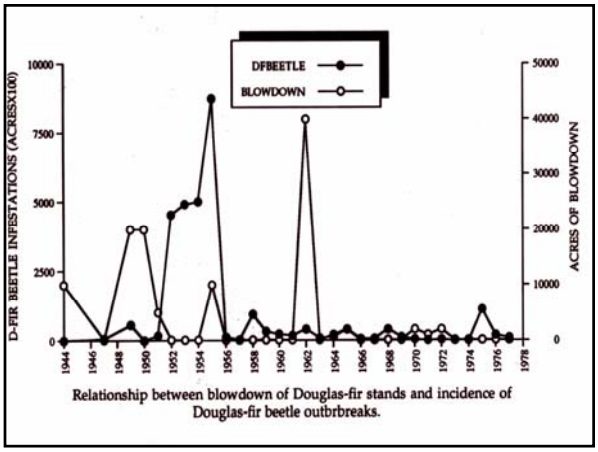
(1) It would seem that the Douglas-fir beetle is simply a benign member of the ecosystem: its main duty being one of the early steps in decomposition of large woody debris.

(2) But, what happens when there are HUGE blowdowns and the Douglas-fir trees have been weakened by a long standing drought?

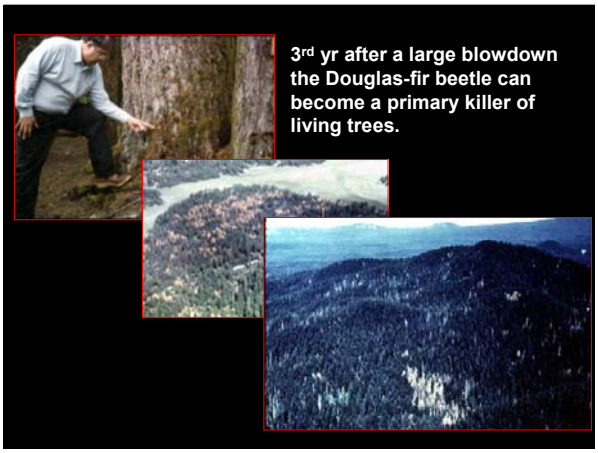
(3) THE DOUGLAS-FIR BEETLE CAN BECOME A PRIMARY PEST: ATTACKING AND KILLING LIVING TREES!

Sequence of events that convert the Douglas-fir bark beetle from an "opportunist" (living in the phloem of blowdowns) to a "prime mover" (killing and colonizing living trees).

Susceptible Host Material -- logs and blown down trees	Population phase (endemic, extensive, intensive)	Population activity
Yr. 1-- Extensive blow downs occur	Endemic	Normal host selection activity
Yr. 2-- More food material population can utilize	Beginning of extensive phase	Normal host selection activity
Yr. 3-- Just enough food to maintain the population	Extensive phase, huge pop. develop	Normal host selection activity (primary attack possible !!)
Yr. 4.-- Less food available to maintai ı huge population	Intensive phase and population collapses	Attack of living trees occurs



Relationship between blowdown of Douglas-fir stands and incidence of Douglas-fir beetle outbrbreaks.



Take home message: After large blowdowns of Douglas-fir, it is essential to salvage the downed material.

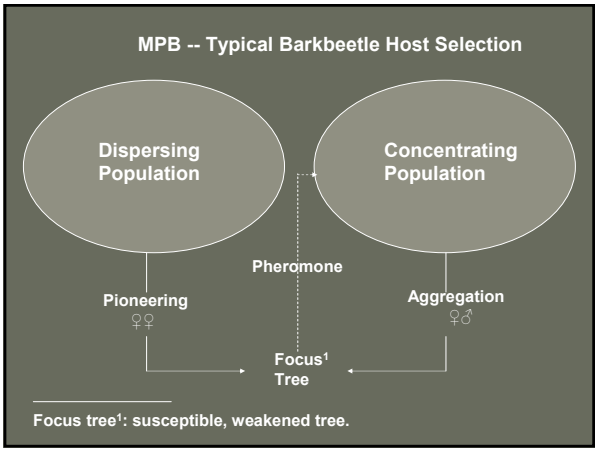
The mountain pine beetle *D. ponderosae.*

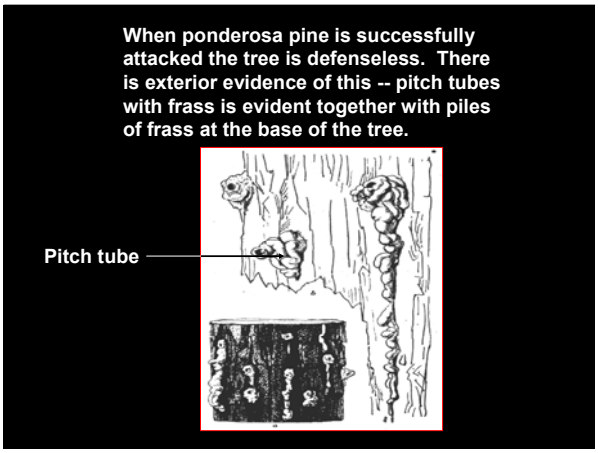
What the MPB does:

In spring as ambient temperatures get to 15.5°C, the MPB dig out of the bark of their host trees and --

Buzz off* in the dispersal flight*!

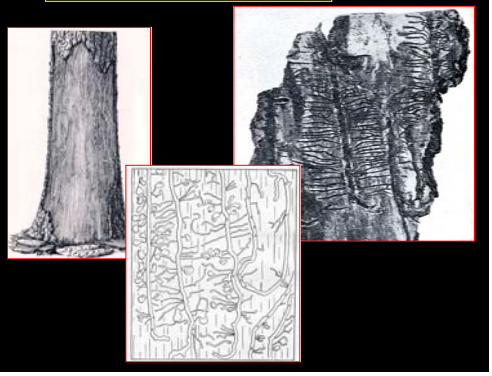

"Why yes, the MPB does have a typical host selection game plan. "

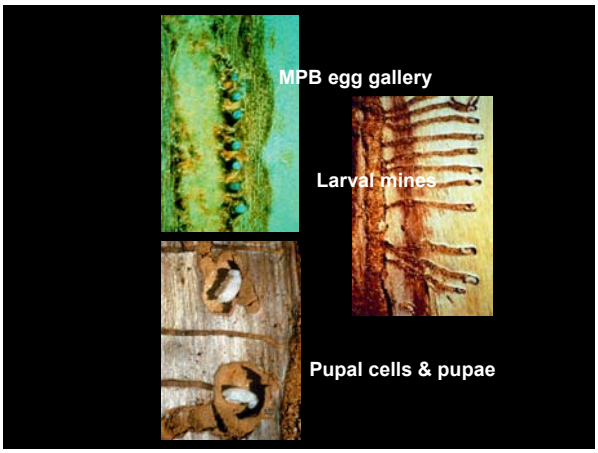

MPB -- Typical Barkbeetle Host Selection
Dispersing Population
Concentrating Population
Pheromone
Pioneering
♀♀
Aggregation
♀♂
Focus[1] Tree
Focus tree[1]: susceptible, weakened tree.


When ponderosa pine is successfully attacked the tree is defenseless. There is exterior evidence of this -- pitch tubes with frass is evident together with piles of frass at the base of the tree.
Pitch tube

Sometimes MPB females make mistakes: The tree wins!

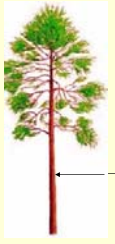
Drawings and photos of MPB activity by A.D. Hopkins 1910



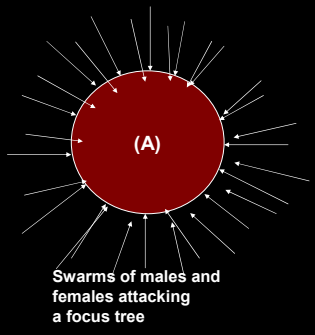


"There is a wrinkle, however, -- has to do with the males."

Just at the point of mating the MALES send out an antiaggregant (blocks the female pheromone!)



Let's backtrack a moment. To the time the males are emitting an anti-aggregant; what happens?



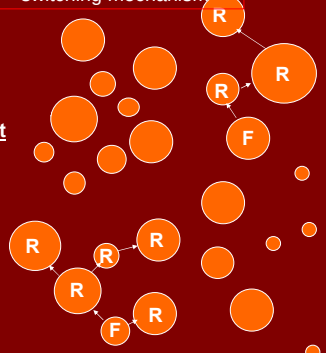
Comments on the typical 70 - 80 yr-old ponderosa pine stands of eastern OR & WA.

- Historically, there has been a 10 - 15 yr fire return cycle in these stands: no longer!
- These stands have not been thinned.
- These stands have crown closure, and a high basal area -- THESE FORESTS ARE STAGNANT.

- Along comes a 2 - 4 yr drought.
- Many focus trees are created (susceptible trees, these are trees out of water balance).
- Conditions are set up for a MPB outbreak.

Along comes a series of dry yrs.: A DROUGHT!

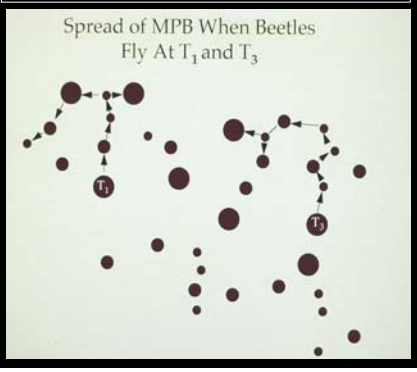
Spread of an MPB Spot: the switching mechanism



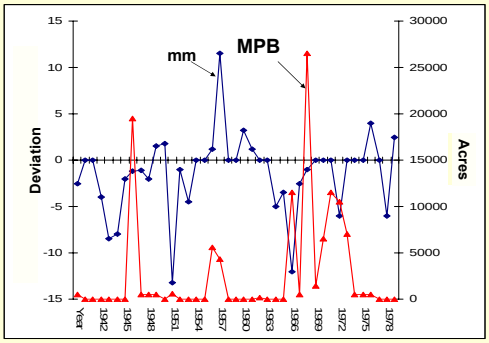
Effect of the drought

The MPB population is high because there have been many focus trees created -- MPB spots grow dramatically.

Spread of MPB spot when emergence and flight occur at T_1 and T_2



Rainfall-deviation from average as related to MPB outbreaks in eastern Washington

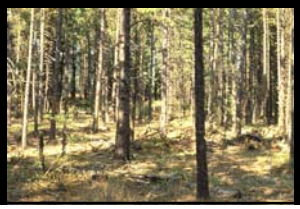


1º yr, there are MPB-spots scattered across the landscape

2°- 3° yr spots start to coalesce

Unthinned stand

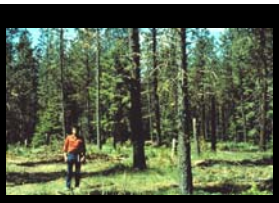
Thinned 6m between trees



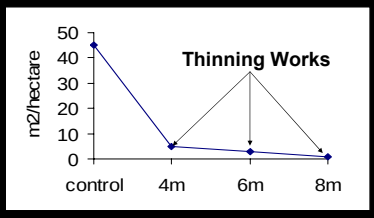
Heavier Thinning

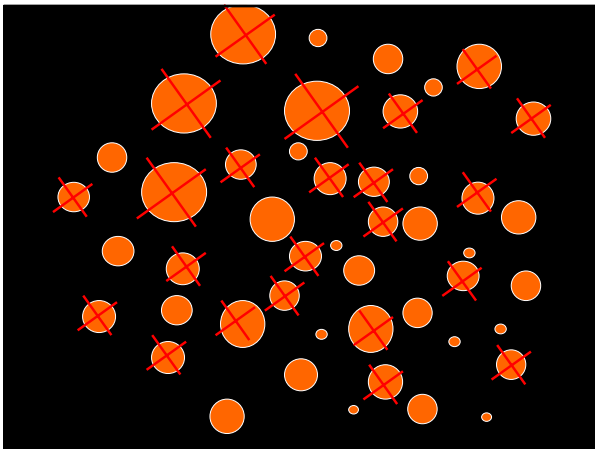
Eight meters between trees

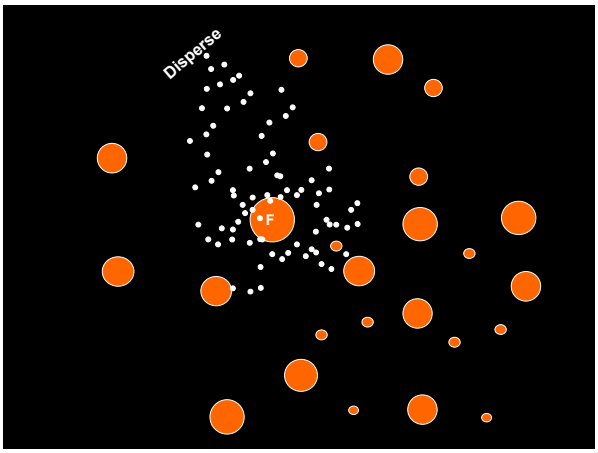
Bringing in the synthetic pheromone -- Pondelure™



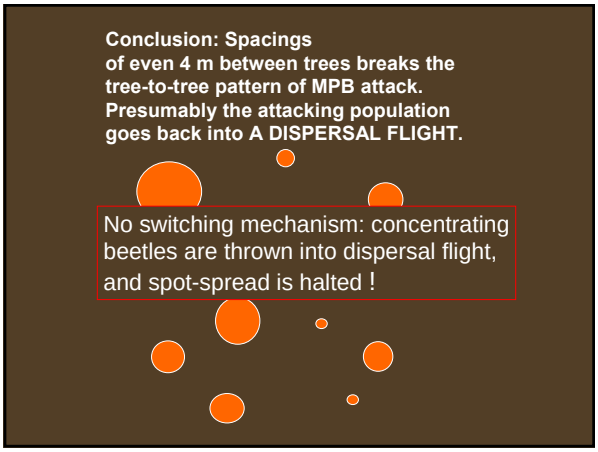
MPB-caused Basal Area Reduction in Control (Unthinned) Plots and Plots With 4m, 6m, and 8m Spacings Between Trees.







Conclusion: Spacings of even 4 m between trees breaks the tree-to-tree pattern of MPB attack. Presumably the attacking population goes back into A DISPERSAL FLIGHT.



No switching mechanism: concentrating beetles are thrown into dispersal flight, and spot-spread is halted !

Thinning stagnant ponderosa pine stands prevents MPB infestations -- even in the long run.

Thinned stands of ponderosa pine lowers incidence of MPB attack (USFS Research by Sartwell and others).

Stem Basal area m^2/ha^{-1}				
Spacing	Stand Density		Net Growth	Mortality
	Yr 1	Yr 2		
Unthinned	39.2	34.6	-4.6	2.7
3.7X3.7	26.6	25.9	-0.7	0.7
4.6x4.6	19.5	20.2	0.7	0.1
5.5X5.5	13.9	14.6	0.7	0.0
6.4X6.4	8.0	8.6	0.6	0.0

Conclusion: Don't let MPB thin your stands -- you do it!

Where feasible bring fire back into the ponderosa pine landscape -- use prescribed fires.

Thinning & prescribed fires will prevent MPB outbreaks -- even during drought years.

Barkbeetles: To be continued