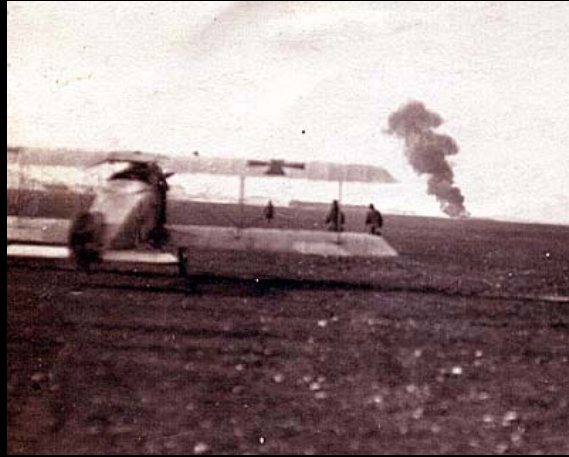


## Introduced and Invasive Pests



When we discuss invasive insect species, we must review a couple of ecological principles:

(1) Competitive exclusion

(2) The unoccupied niche



## 1. Competitive Exclusion

Two or more insect species that do the same thing cannot coexist, i.e. they can't occupy the same niche. One will always win out.

## 2. The Unoccupied Niche

Let's say an insect species is introduced to a new area and to our dismay:

- it's preadapted to this new habitat,
- it likes the new food source, &
- it rapidly adjusts to this new life;

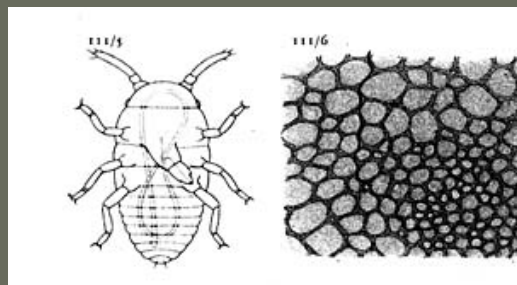
## Continued

Moreover, there are no native insect parasites or predators -- the newcomer left its natural enemies back from whence it came.

Populations of the new pest explode!

Let's look at a couple of examples 

### The balsam wooly adelgid, *Adelgis piceae*



BWA

Phloem Tissue

## The Balsam Woolly Adelgid<sup>1</sup>, *Adelges piceae*.



<sup>1</sup> Phylloxerid

As BWA feed they inject a toxin into actively growing tissues -- causes hyperactive growth & galls

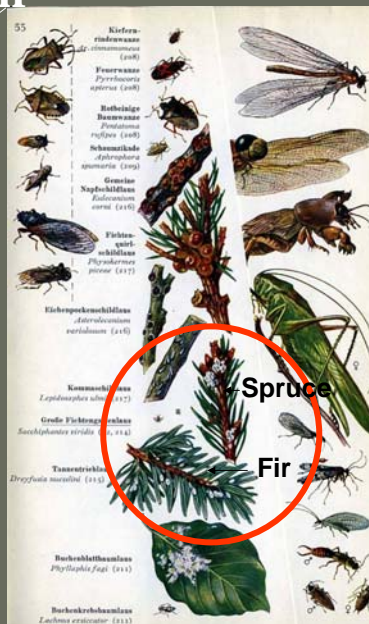
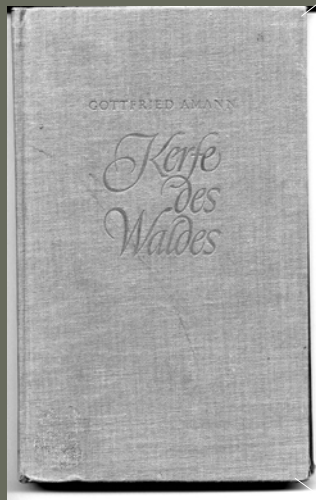


1905 in a small coastal town in  
Maine, a Quarantine Inspector.

“These European fir trees  
have only female *Adelges  
piceae* -- I'll let them pass.”



Well known pest in  
Europe: on spruce and fir



## The BWA in North America

- In North America the BWA “did away with males,” they’re parthenogenic.
- In North America they only attack fir trees



## More about the BWA

- Each female lays 50-100 eggs & there may be several generations per yr.
- As each new BWA sucks the sap, they inject that toxic substance I told you about; this causes the fir tree’s cells to divide out of control – galls!
- Tree death!



Some conclusions:

- BWA preadapted to fir trees;
- BWA genetic makeup was flexible enough to favor parthenogenesis – “we don’t need males.”



The BWA populations exploded across northeastern North America – killed fir trees across huge landscapes.





## **The Balsam Woolly Adelgid**

**Comes West in  
1950**



**The BWA infest and kill:  
No. 1 subalpine fir, No. 2 grand fir,  
No.3 silver fir & noble fir, and No. 4  
Shasta-red fir is barely attacked. In  
the Northeast, they kill Fraser fir  
and Balsam fir.**





(1) The BWA overwinter as a diapausing 1<sup>st</sup> instar, the winter form.

(2) In early spring, the 1<sup>st</sup> instar swells and begins to produce honey dew as the tree sap starts flowing.

(3) The immature female molts several times and becomes an adult in  $\pm$  3 weeks.

(4) Each female then lays  $\pm$  100 eggs.



(5) Eggs hatch in about a week and each motile nymph crawl rapidly around the new foliage, twigs and branches.

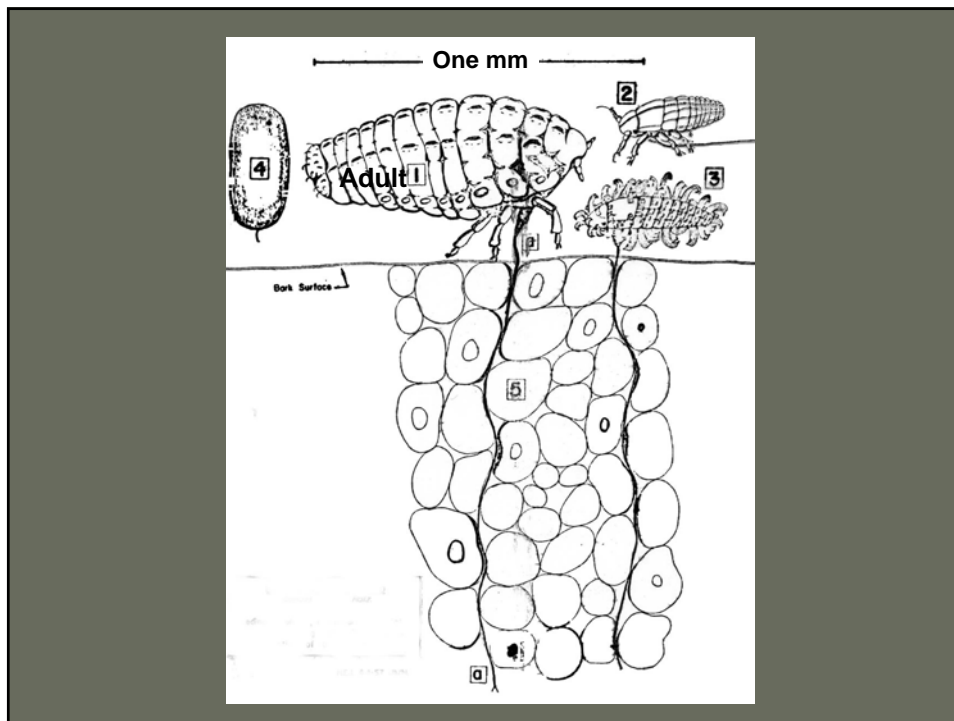


(6) These motile nymphs then thread their stylets through the bark and tap a vascular bundle -- they are stuck for life, a life of sucking sap, the summer form.

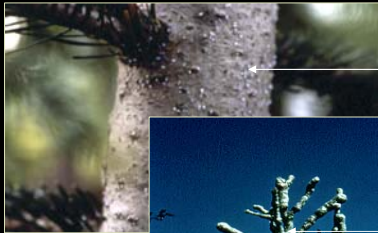
(7) This summer generation, then aestivates for 1 - 2 months.

(8) In July they "wake up" and quickly molt to adults. These summer-generation adults lay  $\pm$  50 eggs apiece.

(9) Depending on the climate, elevation, site, aspect etc., there maybe 2 - 3 generations/yr.



As BWA feed they inject a toxin into the actively growing tissues, which causes hyperactive growth & galls



A few  
BWA



Millions  
BWA



The BWA Disaster



Subalpine  
fir near  
the town of  
Concrete



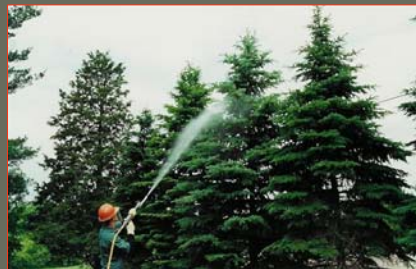
$$Mq = \frac{(100)(1) - 1}{(100)(1)} = 0.99/\text{generation}$$

i.e., 100 eggs - 99 killed = 1 female!

**Management of BWA in urban forestry:**

- **Avoid planting subalpine fir;**
- **Maintain a high vigor in plantings of other *Abies* spp.;**
- **Consider applied control of BWA-infested firs if they have special intrinsic value, e.g. a historical fir planting on the Olympia Capitol Campus.**
- **Consider applied control when the aesthetic value of a commercial *Abies* spp. planting is threatened, e.g. the Christmas tree industry.**

**With valuable true firs, you  
may have to treat -- about bud-break  
time.**



Will introduction of invasive insects ever end? Are we now more vigilant?



No we aren't!



The Asian longhorned beetle arrived in wooden pallets and dunnage from China. We talked about this. Remember?



Asian longhorned beetles are  
destroying maples in the Chicago &  
NY regions: non-stop!



The Emerald Ash Borer, *Agrilus planipennis*.





Recent killer of ash trees – came in dunnage from Asia: the emerald ash borer, *A. planipennis* .

A huge problem in the Midwest.

#### Details of EAB:

- ...killed over 20million ash trees in Ohio and Indiana;
- ...all N. American *Fraxinus* are vulnerable;
- ...EAB has damaged nurseries, logging, tourism, and hardwood manufacturing industry;
- ...native to Russian Far East, China, Korea and Japan;
- ...life cycle;
  - summer, eggs are laid in bark fissures;
  - larvae bore in phloem until it ferments;
  - by then the trees are dead as the larvae excavate the sapwood;
  - overwinter as later instars in dead tree;
  - pupate in spring and emerge is early summer.
- ... now in Michigan and moving into other mid-western states.



## Emerald Ash Borer



Eggs under bark scale

Larvae



Larval tunnels



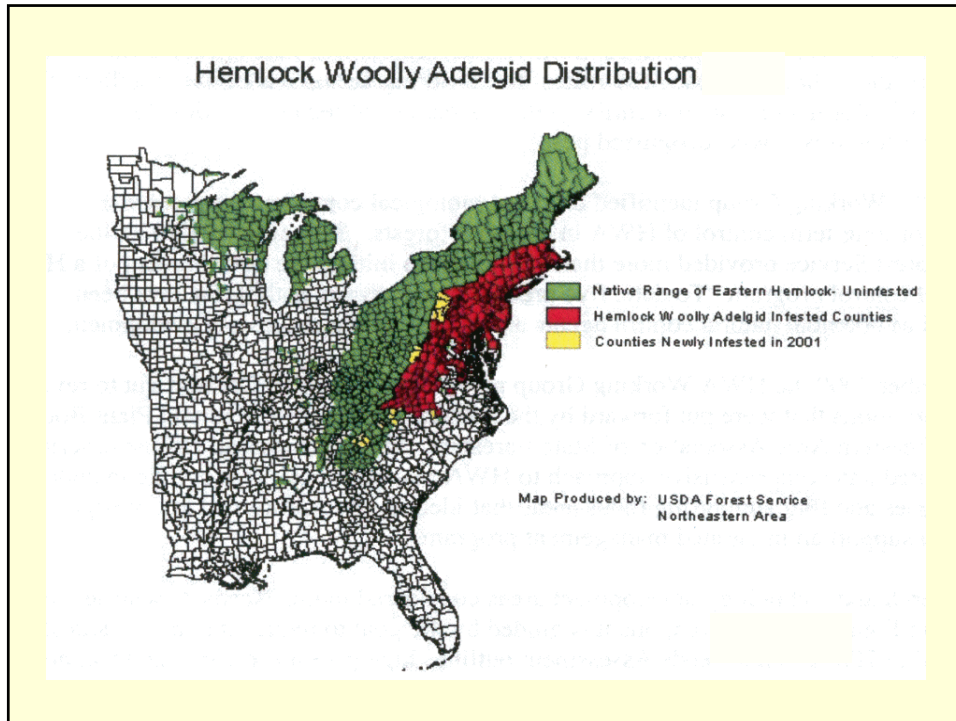
Em



## Quarantine systems are in place:

- No movement of fire wood between states
- Immediate cutting and removal of infested trees
- Continual monitoring via public education.
- Initially attacked trees can be injected with a systemic pesticide.





### Hemlock adelgid, *Adelges tsugae* (Annand)

- Annand reported it in the PNW 1924
- It moved to the Northeast soon thereafter
- Now killing whole watersheds of eastern hemlock

## **The invasion of exotic forest insects**

**goes on and on.**

**On and on**

**...and on**

### **Solutions:**

- **Know well the potential enemies – usually a track record.**
- **Refine inspection services at ports of entry.**
- **Have ready an eradication scheme.**
- **Have ready an IPM scheme if eradication fails.**
- **Continually work with and hold conferences with international trading partners and their pest quarantine services.**