Relationship between biotic and abiotic damage and the defoliation of conifers -the Finnish case

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”Differential diagnosis” needed

- **little scientific evidence to the theory that trees are predisposed to biotic or abiotic damage by air pollution alone**
- **the deterioration in the vitality of forests has sometimes been attributed to abiotic or biotic damage**
- **the monitoring results indicate no clear correlation between air pollution and crown condition e.g. in Finland**

Different levels of surveys

National Forest Inventory (NFI)

- **damage recording since the 7th NFI 1977,**
- **9th NFI started 1996**
- **more than 70 000 plots, 150 variables**

- **Permanent plots**
  - **in the 8th NFI, 3009 plots, measured 1985/86, 1990,1995**
  - **new permanent plots in the 9th NFI**

•National crown condition monitoring (ICP forests level I)

-450 plots since 1986

Intensive monitoring of forest ecosystems (ICP forests level II)

-30 plots

Damage recording system

•stand and sample trees

•one injury /subject

•symptom

•cause

•degree (apparent severity)

•similar system at all levels, but more detailed in level II

•in ICP-plots detailed description of e.g. discoloration also available

Symptoms

0) no damage

1) dead standing tree(s)

2) fallen tree or standing stem(s) broken below the crown

3) decayed standing trees

4) stem or root damage within 1 m from the stem

5) resin flow (above 1,5 m in stem)

6) broken or dry top (in the upper half of the crown)

7) other crown malformations

8) technical defects on stem

9) dead or broken large branches

A) unnaturally pruned branches (from below)

B) defoliation

C) discolouration

D) multiple symptoms (in a stand) due to ageing

Causes of damage

0) Unknown

A. Abiotic/ anthropogenic

A1) wind   A2) snow A3) frost

A4) other climatic factors

A5) fire A6) soil factors

A7) harvesting A8) air pollution (identified source)

A9) other human activity

B. Animals

B1) voles B2) elk, deer or reindeer

B3) other vertebrates

B4) *Tomicus* sp. B5) *Hylobius abietis* B6) Diprionidae

B7) other defoliators B8) *Ips* sp.

B9) other identified insect

B0) non-identified insect

C. Fungi

C1) ***Heterobasidion annosum***

C2) other decay fungi

C3) ***Gremmeniella*** **abietina**

C4) ***Melampsora pinitorqua***

C5) ***Peridermium pini*** **C6) other rust fungi**

C7) needle cast fungi

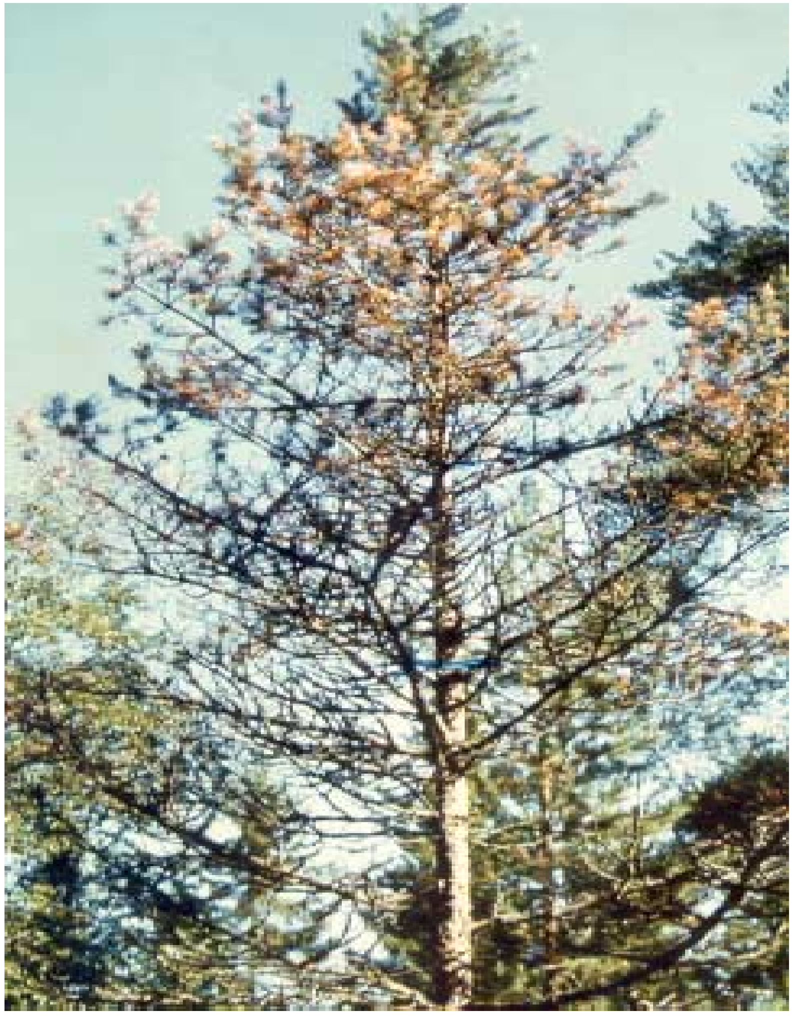
C8) other identified fungi

C0) non-identified fungi

D. other factors

D1) competition between plants

Some examples of the causal agents
Gremmeniella abietina



Chrysomyxa ledi

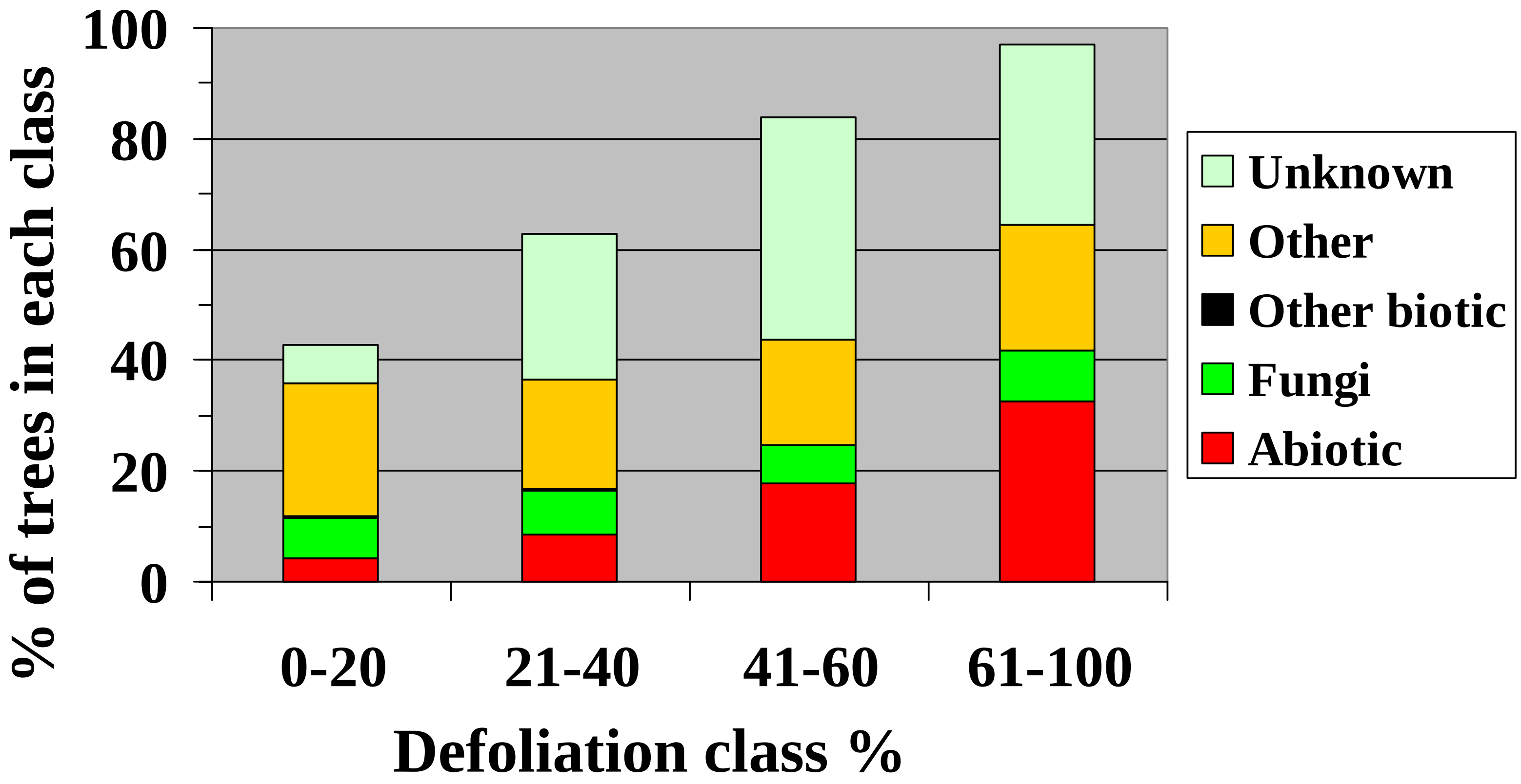
Neodiprion sertifer

Level I data not suitable for disease monitoring, but…

- **can be used to study co-occurrence**
- **spatial and temporal patterns of the most important abiotic or biotic epidemics were uncovered**
- **the (detailed) symptom codes helped to identify some of the causes of epidemics, e.g.**

  frost ,*Gremmeniella abietina*,*Lophodermella sulgicena* and *Chrysomyxa ledi*

The proportion of “damaged” trees increases with the increasing defoliation. Data: Forest condition monitoring, level I observation trees 1986-98, *Picea abies*.



Overall contribution of biotic and abiotic damage was calculated as follows:

$$\frac{(\bar{d}_d - \bar{d}_h) \cdot n_d}{n_{tot}}$$

The formula was derived by writing the mean defoliation of all the trees in the form

$$\bar{d}_{tot} = \bar{d}_h + \sum \frac{(\bar{d}_d - \bar{d}_h) * n_d}{n_{tot}}$$

Where

$\sum$ = sum over different damage types

d_{tot} = Mean defoliation of all the trees

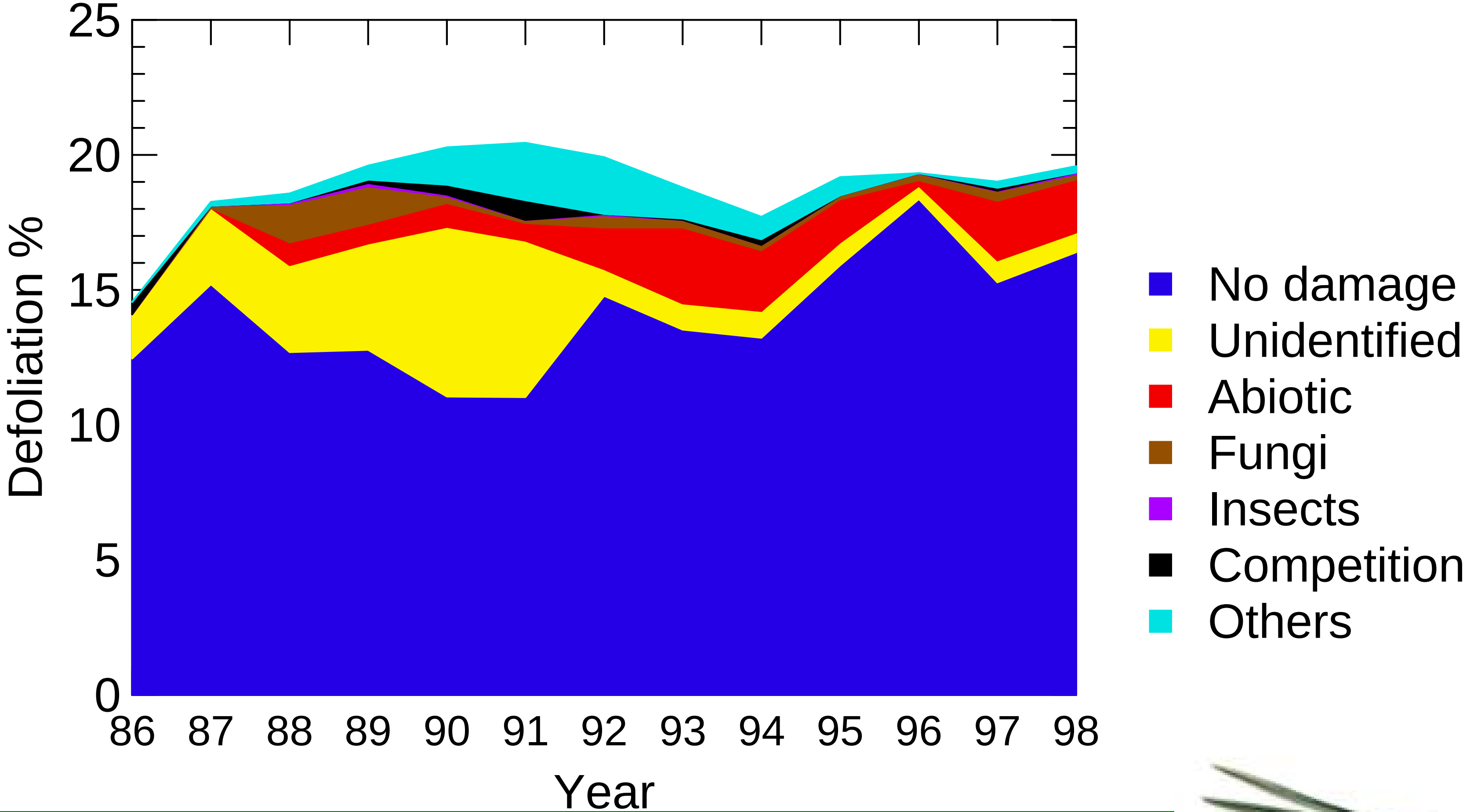
n_d = Number of damaged trees

n_{tot} = Total number of trees

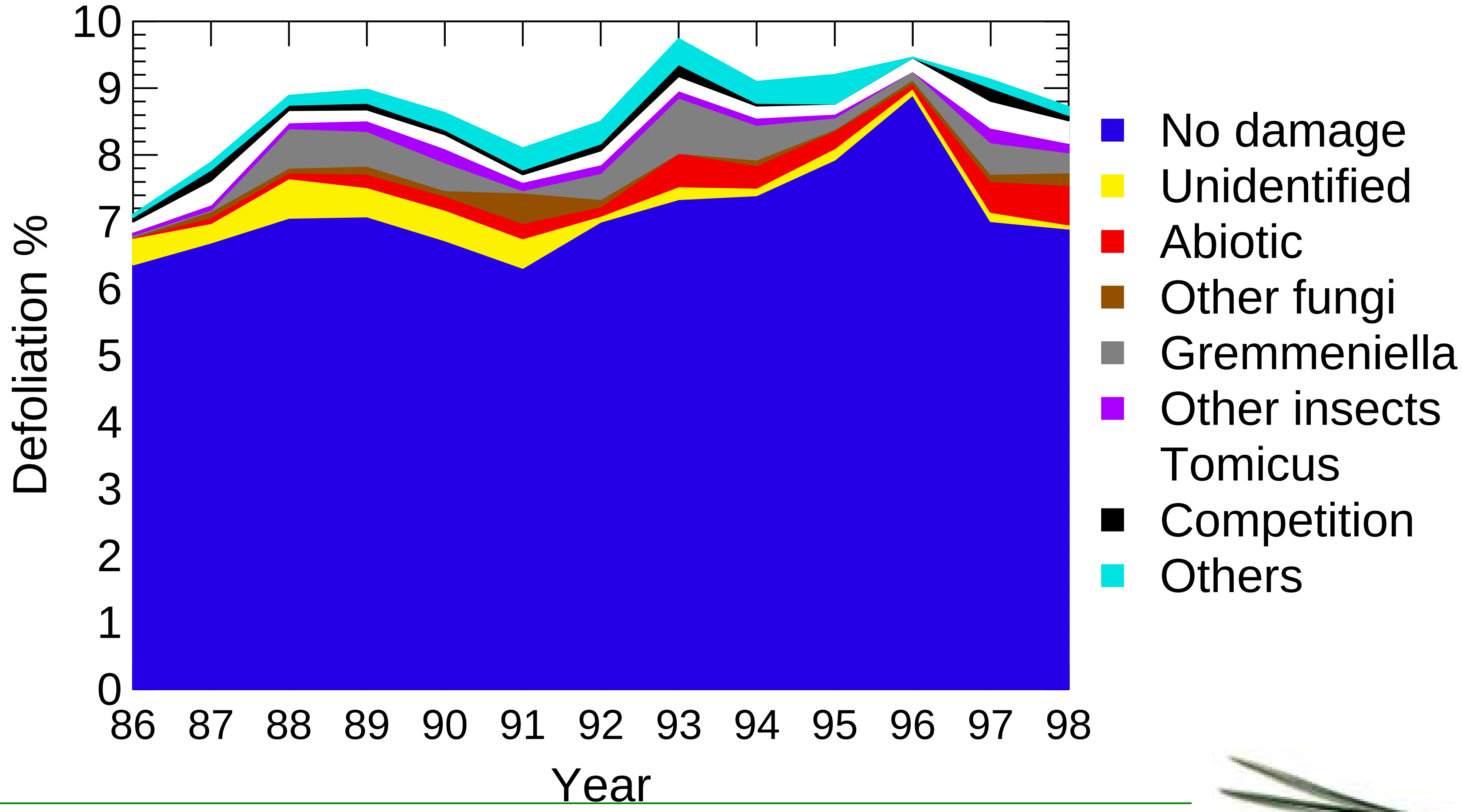
d_d = Mean defoliation of damaged trees

d_h = Mean defoliation of healthy trees

In *Picea abies* the contribution of all damage to defoliation was 4,6 %-units %). Mean defoliation was 21,3 %. Data: Level I observation trees



In *Pinus sylvestris*, the contribution of all damage was 1,6 %-units. Mean defoliation was 9,6 %. Data: Level I observation trees



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Conclusions/discussion

- **Detailed damage symptoms help the interpretation of national and regional patterns of forest condition**
- **Keep the symptoms and causes separately**
- **Abiotic and biotic damage can cause great variation in the annual defoliation pattern > difficult to see the trend?**
- **Proportion of unidentified damage high >training! Quality control?**

Conclusions/discussion contd.

Level II: Dynamics of defoliation/causes

- **Litterfall analysis?>insect faeces, needle cast fungi & other measures in epidemic years**

- **Needle trace method?**

The pathologist's dilemma

" The "mystery" of decline etiology is largerly attributable to its complexity. Declines are difficult to diagnose, especially after the fact. Triggering stress factors are often ephemeral and they frequently occur many months or even years prior to tree mortality.

The decline episode itself is often ephemeral and <u>trees are either dead or in an active stage of recovery when the pathologist appears on the scene."</u>

Houston, D.R. 1987. Forest tree declines of past and present: current understanding. Canadian Journal of Plant Pathology 9: 349-360

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