CONIFER DEFENSES AND XYLOPHAGOUS INSECTS

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INTRODUCTION

The resistance of woody plants to phytophage damage consists of a universal system of mechanisms: 1) repellent chemicals, 2) defensive reactions both mechanical and chemical, 3) retention of viability under disturbed metabolism and low biomass accumulation, and 4) recuperative capacity.

Siberian coniferous tree species, with the exception of *Larix*, are less resistant to phytophage damage than deciduous ones. Evergreen conifers evolved toward constitutive antibiosis by improving their chemical mechanisms of defense, i.e. terpenoid repellents and toxins. In deciduous species, there was evolution of defenses in the direction of an increase in tolerance and recovery (especially after damage or loss of assimilation organs). The universality of the protective mechanisms of woody plants is manifested in the nonspecificity and the relative uniformity of their responses to the different agents of injury (biotic, chemical, or mechanical).

We have tried to correlate the main stages of tree decline with tree metabolic and resistance changes (Fig. 1). The number of eliciting damage sources could be extended to include drought or disturbances in soil conditions, but the five categories of tree conditions shown in Fig. 1 were determined to be adequately representative of the processes involved.

STAGES OF TREE DECLINE

Each successive stage of decline in tree resistance is characterized by certain biochemical transformations. During the first stages of injury, under excited but not reduced metabolism, the levels of resins, a number of mono- and sesquiterpene hydrocarbons, quinic and shikimic acids, polyphenols, tannins, some amino acids (e.g. proline), increase in the inner bark. For a while, the increase in these substances stimulates the protective system to a level exceeding its initial level. Even the most aggressive xylophages fail to colonize such trees.

The prolonged defensive responses result in a decrease in biomass synthesis and hence in insufficient repair of the photosynthesizing, conducting, and storage systems. In such a weakened tree with reduced metabolism, the synthesis of protective toxins begins to decrease. In the majority of cases, a decrease of delta-3-carene and an increase of α-pinene takes place. The diminution of the resin "barrier" in conifers colonized by xylophages can be accounted for mainly by the overall content of resinous substances in the inner bark and the involvement of their neutral fraction. The concentrations of specific toxic components of the essential oils are also significant.

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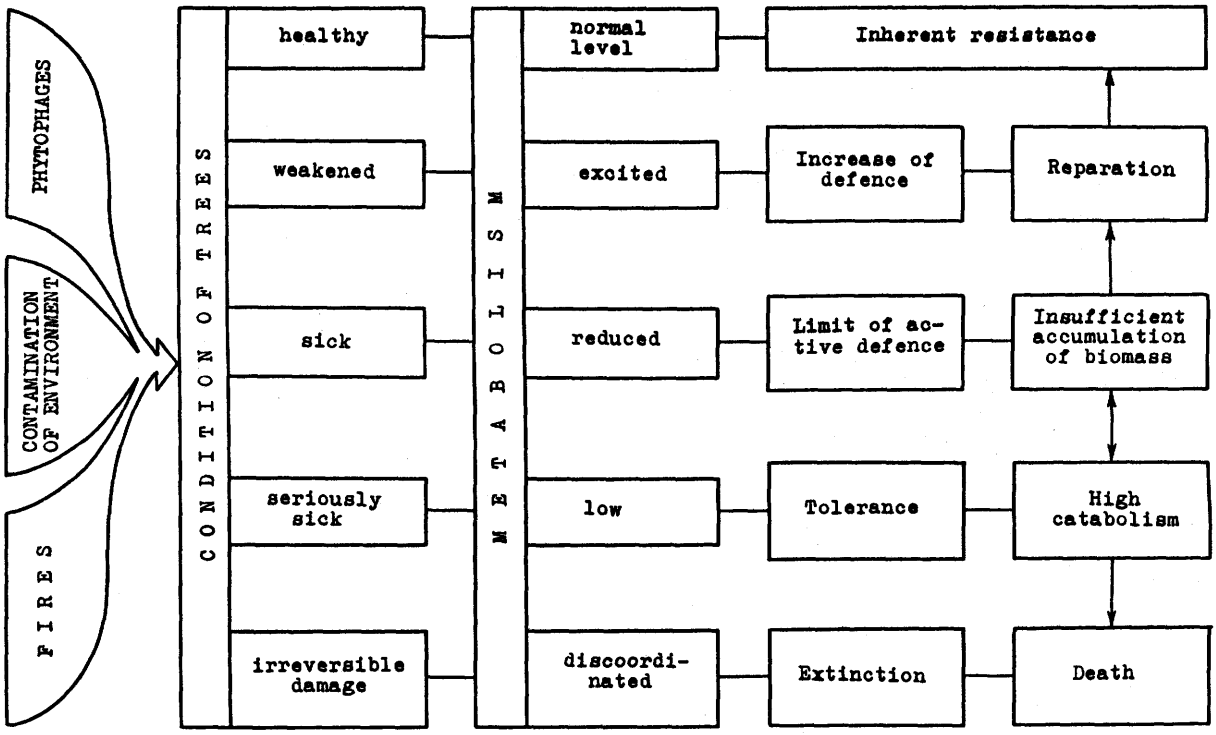

Figure 1. Correlation of tree decline stages with changes in tree metabolism and resistance.

The severely weakened tree is accessible to attack both by aggressive xylophage species and by species otherwise susceptible to its defenses (mainly conifer oligophages). In many cases, this stage of tree damage culminates in irreversible disturbance of the tree's metabolic processes without any additional damage by insects to the trunk tissue. This state of irreversible damage is characterized by a very low level of resins and resin activity. Larch, pine, and fir trees become nonviable when their resin level has fallen to 1 to 2 percent, 3 to 4 percent, and 4 to 5 percent, respectively.