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Role of Insects and Diseases in Forest Decline

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ROLE OF INSECTS AND DISEASES IN FOREST DECLINE

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Introduction

Forest declines and diebacks are complex diseases. Usually many factors or causes are involved in the decline syndrome. These factors have recently been separated in three main categories (Manion, P.D., Tree Disease Concept, 1981). They are: 1) Predisposing or long-term factors; they can include climate, soil moisture, soil nutrients, air pollutants. 2) Inciting or short-term factors; they can include insect defoliation, frost, drought, mechanical injury; and 3) Contributing or relatively long-term factors like bark beetles, canker fungi, viruses, root-decay fungi. These categories are by no means exclusive. Under given circumstances a factor may be seen in one category rather than in the other. Generally, however, insects causing tree defoliations are inciting factors; they trigger the visible decline of trees where symptoms appear. Diseases, generally caused by fungi or viruses in trees, are usually categorized in the contributing factors because they will not be involved unless the trees are already weakened. They will however, accelerate and/or intensify the decline and can eventually prevent the recovery of affected trees and kill them.

This concept is now fairly well understood and accepted. I have been asked to underline the importance of insects and diseases in the decline syndrome, so that these two factors receive their fair share of consideration in the studies planned or already underway, in the forest declines we are experiencing today.

To that end, I have selected a variety of decline problems which have been fairly well documented and where insects and diseases were shown to be of major importance. I have relied when possible, on review or conclusive papers concerning individual problems to summarize the situation. For each case selected, I can provide you with the full reference of the papers cited, as well as parts of the text that seem pertinent. I have generally selected entire paragraphs rather than short excerpts, to prevent reporting statements completely out of context.

ASH DIEBACK

Hibben, C.R. and S.B. Silverborg. 1978. Severity and causes of ash dieback. J. Arboriculture 4:274-279.

"Ash dieback is a disease of white ash and less often of green ash (Fraxinus americana L., F. pennsylvanica Marsh.). Since the late 1950's it has been one of the more important tree problems in the Northeast."

"An unexplained branch dieback was first reported in white ash during 1925-1930 in southeastern Quebec and in several northeastern states of the United States. Ash again were reported dying back along roadside and in hedgerows in southeastern New York in the late 1930's and the 1940's. During the 1950's, white ash, and some green ash, were showing abnormal dieback in valuable forest stands. Since then, ash dieback has continued to be a problem in woodlands, hedgerows, home plantings and along road sides throughout New York, New Jersey, Pennsylvania, and parts of New England."

"Research in ash dieback in New York has shown that water stress in the trees followed by invasion of the bark by canker fungi are the primary factors of this disease."

The fungi referred to are: Cytophoma pruinosa (Fries) von Hoehnel and a Fusicoccum sp.

Effect of water stress questioned:

Castello, J.D., Silverborg, S.B., and Manion, P.D. 1985. Intensification of ash decline in New York State from 1962 through 1980. Plant Disease 69:243-246.

"Incidence and severity of decline of white ash (Fraxinus americana) were monitored periodicaly in New York State from 1962 through 1980. From 1962 through 1970 in one set of plots, mortality increased linearly at about 6.3% per year. From 1968 through 1980 in a second set of plots established in 1968, mortality increased linearly at about 3.3% per year. The relationship between the incidence, severity and rate of ash decline development and spring drought conditions as represented by the Palmer Drought Index was not distinct".

"On the basis of our results, however, the role of drought in ash decline in uncertain."

Causes (Cont). Hibben & Silverborg, 1978.

"Three observations raise the possibility that there are additional, as yet unknown, factors which should be included with the etiologic agents of ash dieback: a) From random observations of trees in the field, dieback and mortality can occur on ash with few or no branch and stem cankers, b) ash mortality continues in the Hudson Valley region of New York, where in recent years rainfall generally has been adequate for normal tree growth, and c) the pattern of diseased ash within a stand sometimes suggests an infectious agent because of the outward spreading of disease from individual infection centers."

"Two viruses are now known to infect white ash, but we know little about their capacity to incite or contribute to the dieback, or to predispose ash to other causal agents. We know nothing about how widespread these pathogens are over the natural range of ash."

Mycoplasma-like organisms have also been found in ash and this tree species in highly susceptible to injury from air pollution and several leaf fungi.

BEECH BARK DISEASE

Houston, D.R. and J.T. O'Brien. 1983. Beech Bark Disease. Forest Insect & Disease Leaflet #75. U.S.D.A. Forest Service 8 p.

"Beech bark disease causes significant mortality and defect in American beech, Fagus grandifolia (Ehrh.). The disease results when bark, attacked and altered by the beech scale, Cryptococcus fagisuga Lind., is invaded and killed by fungi, primarily Nectria coccinea var. faginata Lohman, Watson, and Ayers, and sometimes N. galligena Bres.

"Accounts from Europe indicate that the disease was killing beech (Fagus sylvatica) before 1849. The scale insect, readily visible on the trees, was considered the cause of death until 1914, when it was learned, that a fungus, then identified as Nectria ditissima Tul., infected trees infested by the scale.

Around 1890, the scale was accidentally brought to Nova Scotia. By 1932, the scale and an associated nectria fungus were killing trees throughout the mature areas of the Maritime Provinces and in localized areas of eastern and southcentral Maine. In addition, isolated infestations of scale were occurring in southwestern Maine and eastern Massachusetts. The scale insect has continued to spread to the north into Quebec and to the west and south throughout New England, New York, New Jersey, and northern and eastern Pennsylvania. In 1981, a 70,000-acre area was found infested in northeastern West Virgina."

OAK DECLINE

Houston, D.R., J. Parker, and P.M. Wargo. 1981. Effects of defoliation on trees and stands. Chapter 5 In: The gypsy moth: Research toward integrated pest management. U.S. Dept. Agr. Tech. Bull. 1584. pp. 217-297.

"The tree disease condition known as oak decline and mortality has occurred in many different places and at many different times in the oak forests of the Eastern United States and Western Europe. Many accounts of this disease ascribe as causal factors spring frosts, drought, and insect defoliation, sometimes operating singly but more often interrelated directly or indirectly (Houston, 1971). The relative importance of one or more of these climatic factors, along with outbreaks of host-specific insects, is a major reason why one oak species or one oak group is often more affected than another in a given episode."

"In Switzerland, oaks in the Save Valley declined when spring floods and silting were followed by gypsy moth infestation and attack by the fungus Oidium quercinum Thum (Barbey 1937). In Russia, a decline of oaks was correlated with droughts of 1921, 1948 and 1956, followed by defoliation in 1927 and by browntailed moths (Nygmia phaeorrhoea (Donov.)), gypsy moths, and leaf rollers (Minikevich 1962) in 1928, 1953 and 1959. The weakened trees were predisposed to vascular pathogenic fungi."

"A decline of red and scarlet oaks occurred from Pennsylvania to North Carolina. In intensive study of this problem by Staley (1965) revealed that decline resulted from leaf roller defoliation possibly aggravated by drought and late spring frost and by attacks of Agrilus and Armillaria. Essentially the same conclusions were reached by Nichols (1968). Periodic declines of white oak in the Northeast have also followed similar combinations of adverse factors."

Houston, D.R. 1981. Stress triggered tree diseases: The diebacks and declines. V.S. Dept. Agric. For. Serv. NE-INF-41-81. 36 p.

The Process of Oak Decline

"Diebacks and declines of oaks are not new to forests of the East. Numerous instances of severe problems have been associated with stress factors such as late spring frost, drought, and insect defoliation, singly and in concert. In recent years, severe defoliation by gypsy moths in New England, New York, New Jersey, and Pennsylvania has triggered the decline and death of millions of oaks. Regardless of the predisposing factors involved, the death of trees is primarily associated with the lethal attacks by Armillaria mellea, by Agrilus bilineatus, the twolined chestnut borer, or both.

Oak decline occurs when healthy oaks, predisposed by the effects of defoliation by insects such as the gypsy moth, frost, or drought are attacked and killed by the shoestring fungus, Armillaria mellea and the twolined chestnut borer, Agrilus bilineatus. Trees on ridge tops and in wet areas suffer most severely from drought, and frost pockets. Trees defoliated sufficiently to be refoliated the same season may show symptoms the next year. Repeated defoliations can result in tree death as weakened trees succumb, sometimes suddenly, to the girdling actions of the borer above ground, and of the fungus below."

OAK DECLINE - FRANCE

Guillaumin, J.J., C. Bernard, C. Delatour et M. Belgrand. 1985. Contribution à l'étude du dépérissement du chêne: pathologie racinaire en forêt du Tronçais. Ann. Sci. For. 42(1):1-22.

"Root pathology of Quercus robur L. dieback in the Tronçais forest (of Central France).

Since 1978, dieback of 20 to 120 years old oaks has been observed mainly in two regions of France: the plains of Central France and the "Pays Basques". The etiology of the phenomenon is complex: pendulate oak (Quercus robur L.) is the only species affected, and the other oaks (Q. petraea Sm. and Q. borealis Michx.) growing in the same stands are not affected.

The onset of the dieback is related to climatic and edaphic variables. It was induced by the 1976 drought."

"It appeared that root rot fungi play an important role in the dieback phenomenon. They may not interfere during the initial stages of decline. However, their presence can explain the death of some of the trees since 1978 while non-infected, neighbouring trees recovered during this period."

Three species of basidiomycetes were involved in the decline of Q. robur:——". They were Armillaria mellea, A. bullosa, and Collybia fusipes.

PINUS PINASTER DECLINE IN FRANCE
(Cluster pine)

Carle, P. et D. Schvester. 1975. Perspectives d'avenir du pin maritime en Provence (Pinus pinaster Ait. var mesogeensis Fieschi et Gaussen). Rev. For. Fr. 27(5): 339-349.

"Quelque 120,000 ha de pineraies pratiquement détruits dans le Var et les Alpes-Maritimes, tel est l'actuel bilan du "dépérissement du Pin maritime" en région méditerranéenne française. Les dégâts, en peu d'années, n'ont cessé de s'étendre et, même s'ils revêtent peut-être maintenant un peu moins d'acuité qu'au début, leur extension aux peuplements encore indemnes reste à prévoir jusqu'en Italie, la Corse étant, quant à elle, à la merci d'une introduction malheureuse.

En 1956,les premières manifestations importantes de ce "dépérissement" sont observées conjointement dans les régions de Saint-Tropez, Gassin et de Bormes-Le Lavandon. On croit d'abord à un phénomène relativement banal d'attaques par insectes xylophages...".

"Les causes du dépérissement

La cochenille Matsucoccus feytaudi est bien le facteur initiateur du "dépérissement": les expériences d'infestation forcée (Carle, 1968, 1973) et les résultats des traitements chimiques (Blanck et Gayrand, 1969; Carle, Riom, Schvester, 1920) concourent à en établir la certitude."

MAPLE BLIGHT

Lake States Forest Experiment Station. 1964. The causes of maple blight in the Lake States. Lake States Forest Exp. Sta. St. Paul. Mim. 15 pp. U.S. Forest Serv. Res. Paper LS-10.

"In 1957 severe damage and mortality of sugar maple in Florence County, Wis., resulted in a strong cooperative research effort among Federal and State agencies and industry to determine its cause. Detection and appraisal surveys and insect, disease, and ecological studies were made. The following conclusions were drawn:"

"All studies of the problem support the view that insect defoliation is the primary cause of maple blight. This conclusion indicates that sugar maple is much more susceptible to serious injury from a relatively limited period of defoliation than was previously considered to be true for hardwood species. This, the major finding of the maple blight studies, calls for a considerable reorientation in attitude toward defoliation of sugar maple. The studies also indicated that timing of defoliation is very important if serious damage is to occur. The defoliation must be early enough in the season so trees reflush, and it must be late enough so the reflush growth does not harden off at the end of the growing season. July to early August, therefore, is the critical period for maple defoliation."

"The research studies also showed that other factors contribute to the severity of maple blight damage. Armillaria root rot appears to increase the amount of postdefoliation mortality - mostly the mortality that occurs the second and third years after defoliation. Previously killed trees and stumps apparently provide the food base that seems to be necessary in order for Armillaria to aggressively attack living trees. Below-normal soil moisture levels increase the severity of maple blight symptoms. Hence, defoliation coincidental with a period of drought would result in somewhat greater damage than would occur under other conditions."

SUGAR MAPLE DECLINE

Parry Sound and Bracebridge districts, Ontario.

Can. For. Serv. 1982. Annual Report of the Forest Insect and Disease Survey, 1978. Ontario Region (p. 49). Ottawa.

"Hardwood Declines - Several species of broad-leaved trees are showing crown deterioration. The conditions are called declines or diebacks. In Ontario, the species most affected are ash, beech, birch, sugar maple, and red oak. All have been affected for at least 10 years. This year, possibly aggravated by previous insect defoliation, the effects of decline are especially severe.

Decline of sugar maple is currently the most serious of these problems. The disease usually occurs in stands that have recently experienced forest tent caterpillar defoliation. However, there likely are other influences as indicated by the reactions on plots where defoliation histories are known. Branch dieback and tree mortality are most severe in patches but frequently the condition affects single trees throughout a stand. This patchy nature and the presence of range-wide deterioration of maple make estimation of total impact difficult. The patches total more than 15 000 ha, including one large patch of about 8 000 ha in the Parry Sound District. Mortality within these patches frequently exceeds 80%, and for the total maple population, mortality in affected areas is about 5%."

Can. For. Serv. 1982. Annual Report of the Forest Insect and Disease Survey, 1979. Ontario Region (p. 53). Ottawa.

"The maple decline that occurred in areas defoliated by the forest tent caterpillar in the mid-1970s seems to have stabilized.

No new affected areas were detected in 1979. Trees affected in the Parry Sound and Bracebridge districts of the Algonquin Region appeared to improve, providing less than 40% of the crown had been killed previously. In the Owen Sound District of the Southwestern Region, dieback seemed to stabilize and, while some trees improved, others declined. This district experienced a fairly serious drought through most of the 1978 growing season, whereas the Parry Sound and Bracebridge districts had fairly normal seasons."

SUGAR MAPLE DECLINE IN ONTARIO

McLaughlin, D.L., Linzon, D.E. Dimma and W.D. McIlveen. 1985. Sugar maple decline in Ontario. Rept. No. ARB-144-85. Phyto Ont. Min. of the Envrionnement. Sept 1985. 17 p.

Summary

"The current outbreak of sugar maple decline in Muskoka first became evident about 1978. Based on a study conducted by the Ontario Ministry of the Environment in 1984, decline symptoms were observed on trees throughout the Muskoka region, with no consistent pattern as to topography, aspect or site. Although some degree of tree decline was observed on maples in all age classes it was most pronounced on older trees and trees which had been tapped for maple syrup production or otherwise wounded. Site nutrient deficiencies were not implicated in the decline of sugar maple.

The soil at the Muskoka sites was acidic and contained high amounts of soluble aluminum. Declining trees in Muskoka suffered extensive root death and the fine roots had significantly higher Al concentrations than fine roots of healthy trees. Conversely, higher Al concentrations were not found in the fine roots of declining trees at the Thunder Bay site, where low amounts of soluble aluminum occurred in the soil. A foliar chemical gradient was detected with reduced elemental concentrations in the tops of the tree crowns at Muskoka. Annual growth rings for both healthy and declining trees were very narrow during two years of forest tent caterpillar defoliation. Subsequent to the collapse of the insect epidemic, growth recovered in the healthy trees but not in the declining trees. Incremental growth in the declining tree population appeared to be falling relative to the healthy trees for 20 years prior to the caterpillar infestation suggesting this group of trees may have been predisposed to decline perhaps by physiologic, genetic or environmental factors. Early season droughts during the two years of the defoliation by insects (1976 and 1977) and again in 1983 and root infections by Armillaria mellea were some of the contributing factors to tree decline.

It is apparent that the role of acidic precipitations as a contributing factor to sugar maple decline is part of a complex system."

MAPLE DECLINE AND NEMATODES

Di Sanzo, C.P., and R.A. Rohde. 1969. Xiphinema americanum associated with maple decline in Massachusetts. Phytopathology 59:279-284.

Abstract

Xiphinema americanum was associated with the roots of sugar maple trees with symptoms of decline in each of 17 plots studied. Higher numbers were found around the roots of moderately declining sugar maple trees than around the roots of either healthy or severely declining trees. Symptoms on root and on foliage of declining sugar maple trees were reproduced by inoculation with X. americanum. Nematodes of this species were observed feeding on the roots of sugar maple seedlings, and they reproduced in one test in the greenhouse.