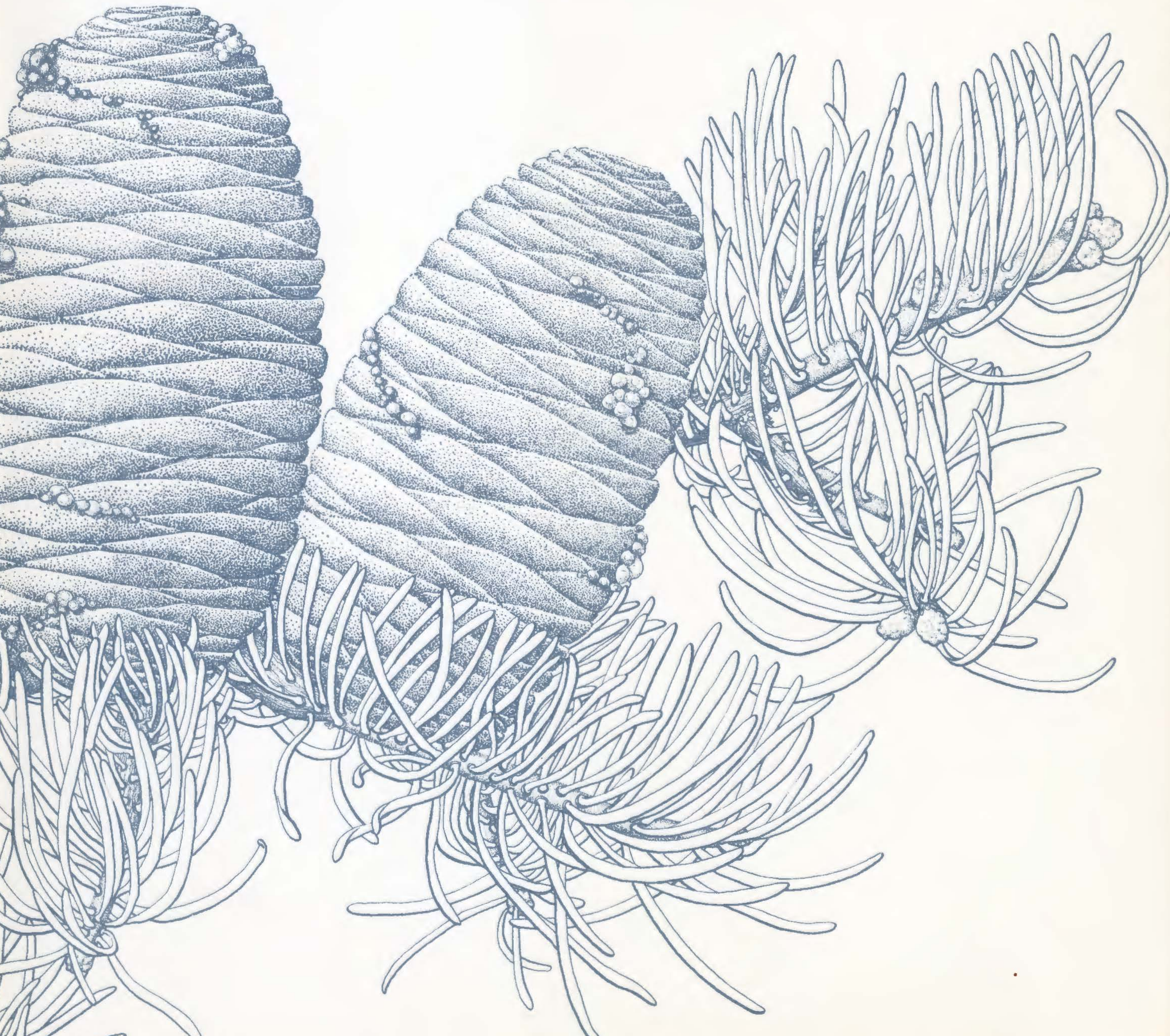
The Morton Arboretum Quarterly

VOLUME 10, NUMBER 4 *Winter 1974*



COVER: Colorado fir, white fir, *Abies concolor*
Original drawing by Nancy S. Hart

To people of the Chicago region, Colorado fir is by far the most familiar of the true firs, and one of the more frequently seen evergreens. Readily available in the nursery trade, it is a favorite conifer for landscape planting throughout the Midwest. It is tolerant of the widest range of climatic and soil conditions of any of the firs. Its grey-blue color and symmetrical shape, with branches all the way to the ground, attract our attention, and the large, soft, round-tipped needles easily differentiate it from any other commonly planted evergreen.

As is so often true, the geographical areas where this tree is horticulturally popular are far more extensive than its native distribution. White fir, in the-broadest sense, is native in the Rockies, from southern Idaho to Mexico, and also in the mountains of our Pacific coast states, again south beyond our border. The Pacific white fir is considered by some authors to be a distinct variety (*Abies concolor* var. *lowiana*); it is in this variety that the species, in central Californa, reaches its highest development as a forest tree.

Typical *Abies concolor* (Colorado fir) of the Rockies is considerably smaller and definitely hardier; it is from these interior populations that our landscape plants are derived. So far the chief value of this tree to man is esthetic; it is much loved both in the man-made landscape and in the scenery of its native habitats. Economically, its wood is too soft to be good structural lumber, though it is ideal for making crates and as paper pulp. *RSc*

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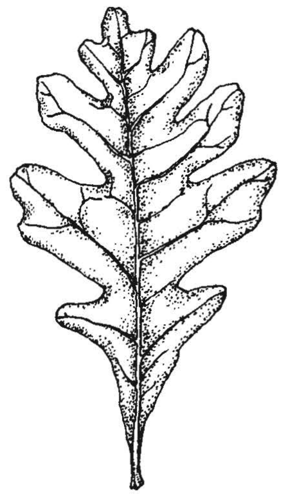
Published quarterly by the Morton Arboretum, Lisle, Illinois 60532. Annual subscription, four dollars; single copies, one dollar. Foreign countries, including Canada, add fifty cents postage.
US ISSN 0027-125x

Each year the Arboretum receives hundreds of inquiries about tree problems, especially those of oaks in the Chicago region. This issue of the Quarterly is devoted to a discussion of tree problems arising from adverse environmental factors.



Site Changes and Root Damage: Some Problems with Oaks

By Virgil K. Howe

Midwestern woodlots are sought increasingly as sites for the construction of urban dwellings. Where woodlots are located in areas adjacent to established centers of human population, their appeal for this purpose is even greater. Most of our upland Midwest forests, however, are dominated by oaks and do not tolerate the alterations that are brought about by man's intrusion. Among the oaks, white oak seems especially vulnerable to changes in its environment.

The typical pattern of destruction in an oak forest begins when construction activities are initiated. First, a number of trees are removed during site clearing and preparation. While construction is in progress, other trees sustain traumatic injuries, either from contact of equipment with the trunk or from root wounds inflicted by trenching or scraping and filling operations. Wounded trees often die during the first year following completion of construction activities, though some may linger on through a second year.

Other trees are not obviously damaged during construction, and trees in this category have been the subjects of our studies for the past four years. These trees exhibit decline symptoms beginning soon after habitation of the dwellings. Death may occur within months, though many trees survive for years. However, in most areas beset by decline problems, up to ninety percent of the oaks have died within fifteen years.

Decline symptoms often begin as a mild chlorosis (yellowing of the leaves) which may involve only one or two major branches, but usually the entire crown is affected. Signs of stress in the crown, with or without

Dr. Howe, a Research Associate at the Morton Arboretum, is Associate Professor of Biological Sciences at Western Illinois University, Macomb. *This article is adapted from one which appeared in the 1973 Proceedings of the International Shade Tree Conference 49:25-27, with permission.*

chlorosis, are characterized by thinning and reduction in size of the leaves. Following initial symptoms, there is twig dieback which progresses to the death of nearly all secondary branches and the terminal ten to fifteen feet of the primary branches. Foliage becomes confined to very short, newly formed secondary branches along the primary branches. During this phase, the primary branches look like leafy columns. In the final stages of decline, foliage is found only on the innermost portions of the lower primary branches. Death of the tree may occur during any season of the year, but appears to happen most frequently in early spring immediately after the leaves come out and during mid- to late summer.

In the Midwest, oak decline following disturbances does not appear to be caused by any biotic agent. The symptoms seem to reflect damage to the root systems, and our efforts have concentrated upon defining the nature and distribution of oak root systems and determining the physical factors which might affect the roots. The information from these and other studies is being used to postulate preventative and therapeutic measures to combat oak decline.

Changes in the Physical Environment

The age of our oak-dominated woods in the Midwest is from 100 to 125 years. During that time, a specific complex of physical conditions has evolved within the woodlots. These conditions are disrupted by the dramatic and rapid changes in the physical environment brought about by construction and urbanization, and these changes are thought to be primary factors in producing oak decline.

One of the detrimental changes is the opening up of the forest stand, which usually proceeds in a haphazard fashion. This permits increased amounts of solar radiation to reach the ground surface, resulting in elevated soil temperatures and increased water evaporation. The problem is increased by the destruction of understory shrubs and trees and herbaceous plants. In addition, forest soils lose the moderating effect of the litter cover which is removed and disturbed by the property owner in preparation for lawn establishment. Lawn grass soon becomes a serious competitor of the tree for water and nutrients and produces a suffocating blanket over the tree root system.

Other activities by the urban dweller further alter the natural environment to which the tree has been accustomed. Leaves are raked and removed in autumn, depriving the tree of a natural source of nutrients. When fertilizer is applied, it is usually lime-based, which alters the nature of the forest soil from one that is normally acid to one approaching or exceeding neutrality.

It is not surprising that as a result of marked changes in environmental conditions following dwelling construction, oaks do not continue to thrive and, in fact, usually die.

Effects Upon Oak Root Systems

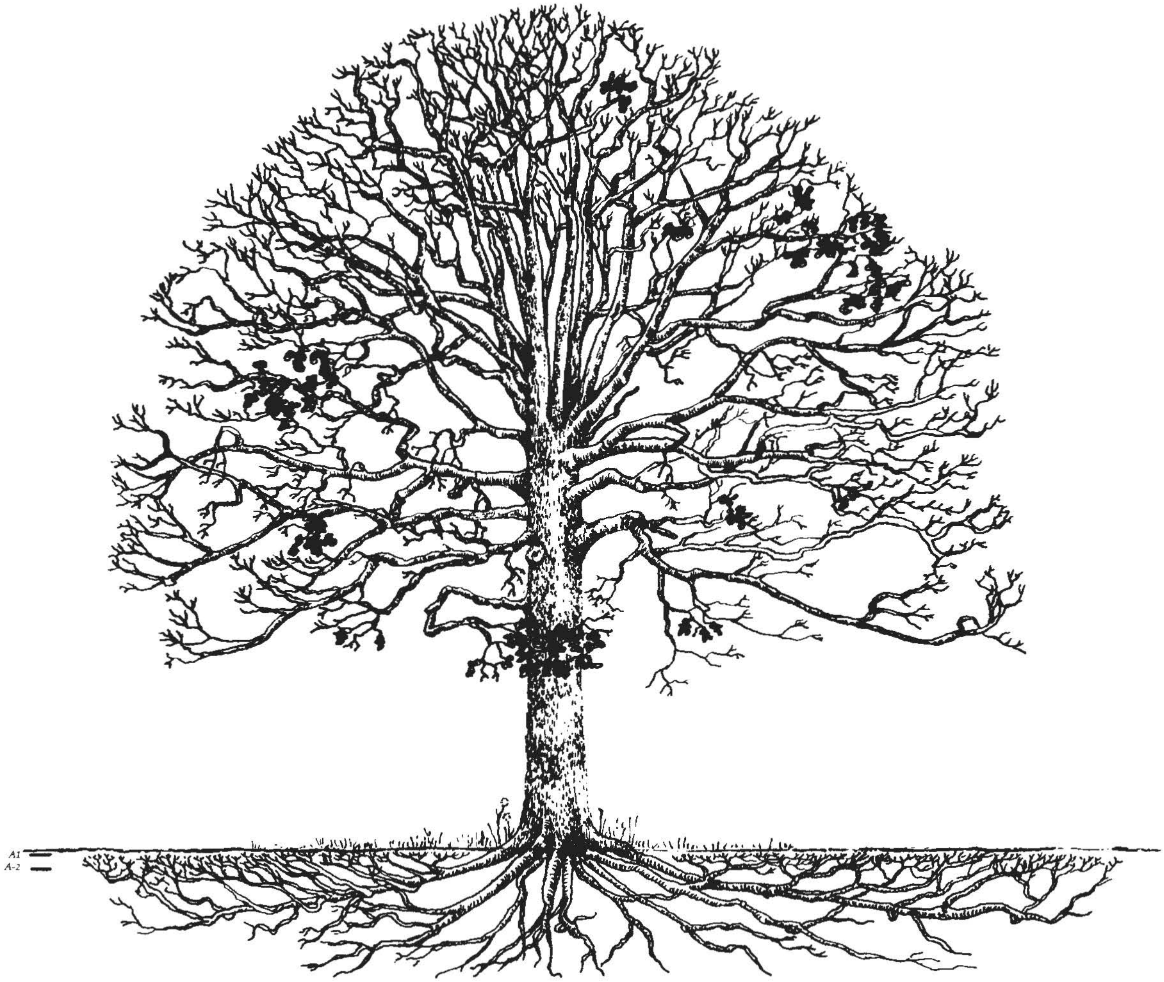
The indictment of the changes in the physical environment as being the primary cause of oak decline is feasible only if the oak root systems are shown to be adversely affected by these changes. Studies of oak root distribution help determine these effects.

Vertical Distribution of Oak Roots. Studies of the vertical distribution of oak roots have been conducted on both seedlings and mature trees. It has long been observed that variations in the root systems of the same kind of tree are often greater in different soils than those of different kinds of trees on the same type of soil. Consequently, it is difficult to gain a clear concept of how oak roots are distributed in a vertical plane.

Our observations tend to agree with the results of earlier studies, all of which were conducted in natural oak woods and all of which agree that the preponderance of roots, especially fine roots, are found in the A1 (topsoil) and A2 (subsoil) soil horizons (See illustration). The A1 horizon is particularly endowed with fine roots and is likely to be the site of greatest physiological activity in the root system. This thesis is supported by the observation that the greatest number of mycorrhizae (fungi/tree root associations which enhance mineral absorption) are found among the fine roots of the A1 horizon. This horizon provides the best conditions for fine root and mycorrhizal development and is high in nutrients. It is also most vulnerable to changes brought about by construction activities.

Long-term survival of oaks following construction seems to be determined by the depth of the A1 soil horizon and by the degree of alteration in the environment of the A1 soil horizon. Both factors affect the severity of damage to the fine root system. Since the tree is heavily dependent upon the fine root system for water and mineral nutrition, death comes in a relatively short time where there is a shallow A1 horizon to which the fine roots are confined and which undergoes alterations in the environment. Trees growing in soils with a deep A1 horizon have fine roots distributed more deeply and may survive for lengthy periods following severe changes in the environment. Where there is a deep A1 horizon, trees may tolerate the changes without visible signs of stress.

Lateral Distribution of Oak Roots. The extent of lateral root spread in oaks has been shown to far exceed that of the branches. This does not mean that there is complete utilization of soil nutrients and moisture to the



periphery of lateral root extension. The indications are that soils exploited at "root capacity" are found near the trunk of the tree or are within the area circumscribed by the outer branches. Remaining unanswered are questions relating to the degree of physiological activity of roots at varying distances from the tree and the minimum extent of lateral spread which would suffice to maintain an oak in good vigorous condition. The answer to the latter question would be dependent somewhat on tree size, soil conditions of the A1 horizon (depth, fertility, etc.), and the degree of competition between the trees and understory plants that are present, whether of the same or differing species.

Predictive Model. Our knowledge of the distribution pattern of oak roots is sufficient to postulate a model for predicting the responses of oaks which are subjected to disturbances. The oaks most likely to suffer when alterations occur in their environment would be those found in soils with a shallow A1 horizon and deeper horizons composed of impervious clay soils that resist penetration and development of deeper root systems. Tolerance to changing conditions would increase with a deeper A1 horizon and sandy subsoils which would allow for deeper penetration of roots and leaching of nutrients.

Preventative and Therapeutic Recommendations

The best recommendation is very simple: When a choice exists relative to building in an established oak woods, *don't build*. However, recognizing that woodlots are and will continue to be used as sites for housing developments, certain procedures may be tried which may help provide conditions in which established trees might survive and function for shade and esthetic purposes.

Before beginning construction activities in an area where trees will be affected, protected zones should be marked off around each tree and no soil disturbances should be allowed within these zones before, during, or after construction. These zones should include the area within a twelve-foot radius of each tree trunk. Where it is not possible to create a "no violation zone" of this size, the tree should be removed prior to construction. It is better to create a void initially than to have dead or dying trees during the weeks, months, and years that follow.

Hope should not be abandoned for trees already in established lawns, even if they are exhibiting symptoms of decline. It is recommended that a three- to four-inch layer of mulch—leaf litter, bark chips, etc.—be applied in the area within a twelve-foot radius around the base of the tree. The mulch should kill the grass, and the litter zone should be maintained free of grass and other competitive plants. The tree should receive all other care needed to maintain it in vigorous condition. If destruction of the fine root system has not proceeded too far, the conditions produced by the mulch may promote the development of a vigorous new system of fine roots. It must be recognized, however, that if decline symptoms are present, the outlook for the tree is generally pessimistic.

The principal unknown quantity in the last two recommendations is whether or not there are sufficient fine roots in the twelve-foot radial zone to maintain a given tree. This would be especially critical in soils with a shallow A1 horizon. Evidence from past studies indicates that probably the twelve-foot radial zone is sufficient if the tree receives normal care and maintenance. If properly tended, the zones should not be esthetically unpleasant and would function usefully as repositories for fallen leaves and other compost. The ultimate worth of these established zones will be determined only through time and trial.

Diagnosing and Preventing Diebacks and Declines of Urban Trees:

LESSONS FROM SOME FOREST COUNTERPARTS

By David R. Houston

"...in wooded neighborhoods, oak trees in varying stages of decline are common, the evidence ranging from a few bare tips...to large dead limbs...dead trees or stumps are usually present...the basic cause of death is not a fungus, insect, virus, or any other identifiable agent...the oaks are being lost for ecological reasons—from changes brought about by urbanization."

These statements are excerpts from "The Destructible Oak," an article by George Ware which appeared in *The Morton Arboretum Quarterly* of Autumn 1970.

Concern over what is happening to our oaks, and to many other tree species, is no less today than in 1970. Indeed, the dieback and decline of urban trees has continued at an ever-increasing rate in the past several years. The reasons for this increase are multifold and complex—and primarily reflect a coincidence in time and place of the successional stage in development of our forests, the increasing use by man of these forests as home sites, and the increasing manipulation of our environment by man.

For the past six to eight years, our research effort in tree pathology at the Forest Insect and Disease Laboratory in Hamden, Connecticut, has focused primarily on the diebacks and declines of forest trees. We have come to understand a great deal about certain of the forest tree declines, and the purpose of this article is to place this understanding in the context of emerging urban situations.

Dr. Houston is Principal Plant Pathologist and Project Leader for the U.S. Forest Service at the Forest Insect and Disease Laboratory, Northeastern Forest Experimental Station, Hamden, Connecticut.

Several conceptual definitions concerning the nature of these diseases have developed in the course of our research, and these provide a framework for discussing these diseases.

The onset of diebacks and declines, in all cases, seems to be inseparably linked with environmental stress. Definitions of *stress* and *dieback/decline*, therefore, are necessarily circular. *Stress* refers to environmental pressure sufficient to bring about changes in the physiology, form, or structure of a tree that predispose it to attack by organisms that normally it could resist. Such pressure can be exerted by such abiotic factors as extremes of moisture or temperature, chemicals, and air pollution; or by such biotic factors as severe defoliation by insects or fungi, or attack by scale insects. *Dieback/decline* refers to a progressive disease condition that begins when trees are altered initially by the stress and continues as they become invaded by organisms of secondary action.

These definitions imply that changes induced by stress favor the organisms, and that abatement of the stress will result in a cessation of disease development in the absence of these organisms. Obviously, severe stress, if repeated or prolonged, can by itself result in a decline of tree vigor and even in tree death. There are many instances where this is so, especially when urban tree declines are initiated by certain abiotic factors. However, in the forest tree declines we have studied and for most of those reported in the literature, we have found that this stress/host-change/organism-attack relationship exists.

DIEBACK AND DECLINE OF ASH, BEECH, MAPLE, AND OAK IN THE NORTHEAST

From among the dieback and decline diseases that have been investigated in the Northeast, the ones to be discussed here were selected to illustrate (1) the syndrome common to most dieback/declines, and (2) the cause/effect relationships.

Ash Dieback. The symptoms of ash dieback are typical of the dieback/decline diseases. Affected trees undergo a progressive deterioration of the crown that begins with death of the branch tips and proceeds inward and downward. The production, often at the nodes, of small, chlorotic, sparse leaves results in a thin, "tufted" crown. Once begun, disease development usually continues until the tree dies.

The occurrence of this disease in the Northeast has been associated with periods of water shortage, beginning with the severe droughts of the 1930s. During these periods, bark tissues altered by drought apparently become susceptible to inroads by canker fungi that normally colonize only the bark of shade-weakened branches. The cankers that result often girdle twigs and even main stems, contributing to the dieback syndrome. Many questions about ash dieback still remain unanswered. We do not know why drought-altered tissues lose their normal resistance, nor do we know what possible roles may be played by air pollution and viruses. White ash has been shown to be very sensitive to ozone and to be a host for a strain of tobacco ringspot virus.

Beech Bark Disease. This destructive disease of American beech is characterized by a thinning crown bearing small, sparse, and chlorotic foliage. Absent, however, is the terminal dieback and development of sprout-origin foliage which is typical of the diebacks and declines. This may reflect the fact that the initiating stress factor, *Cryptococcus fagi* (a scale insect), and the organism of secondary agent, *Nectria coccinea* var. *faginata* (a canker fungus), primarily attack the bole rather than upper crown branches, with the consequence that the whole tree "dies back."

Beech bark disease has not been studied intensively in recent years, and there are many major gaps in our understanding of this complex. We do not know just how the scale insect paves the way for *Nectria*, nor do we know the needs and modes of attack of the fungus.

Maple Declines. There are several kinds of "dieback and decline" that affect maple. The two that have received the most attention are the defoliation-initiated forest tree decline and the decline of roadside trees resulting from winter road salting. Because we have worked rather intensively with the forest situation, most of my comments will relate to that disease.

In the late 1950s a decline of sugar maple, termed maple blight, occurred over several thousand acres of forest in northern Wisconsin. Affected trees showed terminal dieback, progressive crown deterioration, and the production of small, sparse, and often chlorotic foliage on sprout-origin tissue. This condition was initiated by severe insect defoliation that appeared to pave the way for attack by the root fungus, *Armillaria mellea*. In recent years in the Northeast, defoliation by the saddled prominent, *Heterocampa guttivitta*, triggered a similar decline where defoliation recurred for several years.

We have looked critically at this disease in order to explain the cause/effect relationships.* Defoliation severe enough to elicit refoliation results in the death of buds and twigs—the dieback symptom. But death—rapid death—is associated with invasion by *A. mellea*. When we examined this system critically we found that, along with refoliation, marked biochemical changes occur in the root tissues invaded later by *A. mellea*. Starch levels decline sharply, and certain sugars, especially glucose and fructose, increase significantly. These stress-induced changes favor the growth of *A. mellea* and encourage its invasion of the root tissues. For example, the starch-sugar shift satisfies the energy requirements of the fungus—for it utilizes glucose and fructose readily but can metabolize sucrose, the sugar normally present in greatest quantity, only poorly. The role of some of the other biochemical responses to defoliation—namely, changes in numbers and concentrations of certain amino acids and phenolic compounds—in the increased susceptibility to organisms is being studied now. Also under investigation is the possible role played by certain tree-produced enzymes in the resistance of healthy trees to facultative organisms.

"We" includes my colleagues, Dr. Johnson Parker and Dr. Philip Wargo, who have studied the biochemical effects of stress on trees and the relationship of these changes to attack by Armillaria mellea.

Oak Decline. Oak decline parallels maple decline closely in disease expression and causal factors. Several defoliating insects, including leaf rollers and leaf tiers, the elm spanworm *(Ennomos subsignarius)*, and the gypsy moth *(Porthetria dispar)*, initiated the decline over large areas in the Southeast, Mid-Atlantic, and Northeast regions. This disease is compounded by drought and by the attacks of *A. mellea* and the two-lined chestnut borer, *Agrilus bilineatus*. Our recent studies with oak decline following gypsy moth defoliation, aside from confirming and expanding the stress-induced biochemical relationships, have been probing the ecological relationships between the insect, the forest it defoliates, and the site. We have verified that certain sites are more likely to be defoliated than others, and we are attempting to determine the factors responsible.

Our preliminary results suggest that sites subjected continuously to severe environmental perturbations are most likely to be defoliated, but that trees growing on these sites may not succumb as readily to a given level of defoliation as trees growing on sites disturbed only infrequently.

In the order presented above, the forest diseases represent a series whose primary initiating factors are abiotic, biotic, and abiotic/biotic respectively, and whose relationship with mortality-causing organisms of secondary action is increasingly complex.

OAK DECLINE—MIDWEST VS. NORTHEAST

In "Site Changes and Root Damage," Howe has stated that oak decline in the Midwest following disturbances does not appear to be caused by any biotic agent. This appears to be contrary to the concept, presented here, of stress-initiated predisposition to organisms of secondary action. The differences may be those of the relative degree to which secondary action organisms are involved—and may reflect basic differences between the oak forests of the Northeast and those of some Midwestern areas, including northeastern Illinois. A brief comparison between these two regions may be of value in understanding these relationships.

Ecologists consider the juncture of two biotic communities—the ecotone—as a unique place. It is, on the one hand, an area of increased diversity of species, especially of birds, animals, insects, and herbaceous plants. On the other hand, it is a zone of tension. Among other places, ecotones occur between sea and shore, between timbered and nontimbered zones on mountains, and between prairie and forest.

Unique to much of the Midwest's oak forest is its relatively recent evolution from the prairie/forest ecotone. The control of prairie fires by the white man signaled the demise of prairie grasses and the emergence (release) of the trees in this tension zone. But underlying the soils of these young forests is a dense, often impervious layer of calcium-rich clay—a legacy of centuries of interaction between prairie vegetation and climate. Oaks growing in these soils develop most of their feeder-root system in the aerated upper zones of soil and thus are especially vulnerable to disturbance.

Encroachment of man into the tension-zone forests creates conditions that often result in the onset of dieback and decline. Howe summarized the changes in the soil environment wrought by urbanization of Midwestern woodlots and the effects on tree root systems. In general, he concluded that practically everything that man normally does around his home—thinning, elimination of natural ground cover vegetation, raking of leaf litter, planting of grass, applying lime-based inorganic fertilizers—tends to alter the natural environment unfavorably. In ecological terms, these actions appear to tip the balance once more in favor of the prairie component of this ecotone.

By contrast, much of the oak forest of the Northeast is growing on acidic, well-drained soils of glacial origin. Some forests have probably always been forests; many others are a relatively young stage in succession as old fields and pastures revert to forests. In the oak region of the Northeast, unlike Illinois, impervious calcareous clays are relatively uncommon, and oaks are usually deep-rooted. In these forests, other species—especially the shallow-rooted birches, maples, beech, tulip tree, and ash—usually succumb to stress first. Decline of oaks follows, but is primarily associated with severe stresses such as repeated insect defoliation or prolonged drought.

In the Northeast, where urbanization of the forest is extreme, man is establishing an ecotone between yard and forest. The conditions being created there, aside from the direct effects outlined by Howe, appear sometimes to lead to further stress. For example, as mentioned earlier, disturbance seems to be a characteristic of those forests where gypsy moth populations fluctuate most violently most often, and some of these forests are the yard/forest ecotone.

APPROACHES TO CONTROL OF TREE DECLINE

Oak decline in the Midwest and the Northeast illustrates the sort of problem encountered when remnants from an existing forest suffer from home-site alterations. Prevention of these problems lies in reducing as much as possible deleterious changes in the tree root environment. In the Midwest, recommendations center primarily on eliminating grass in a circular zone around the tree by the use of ground cover plants or heavy mulches of bark chips or leaves. This practice not only avoids the smothering competition of heavy sod, but protects the feeder roots from attendant insults of weed killers and lime-based fertilizers used on lawns.

Similar recommendations would appear sound for preventing oak declines in the Northeast, except that emphasis may differ slightly. The use of lime-based fertilizers, if not excessive, may be less detrimental on the Northeast's acidic and generally very infertile soils. Research with other plants indicates that resistance to drought is increased when soil nitrogen is not limiting. Practices that tend to increase drought resistance or maintain an adequate soil moisture balance are especially important in the Northeast because of the often marked disturbance of drainage patterns incurred in the grading of rocky, steep house lots. Similarly, compaction and impeded aeration caused by excessive fill grading is perhaps more important in the Northeast than on the gently undulating, rock-free soils of the Midwest. In both regions, control of biotic stress agents such as defoliating or sucking insects is of major importance.

When symptoms of decline do appear, their further development sometimes can be arrested by increasing actions to reduce the initiating stress, and sometimes by judicious pruning to reduce moisture and energy demands.

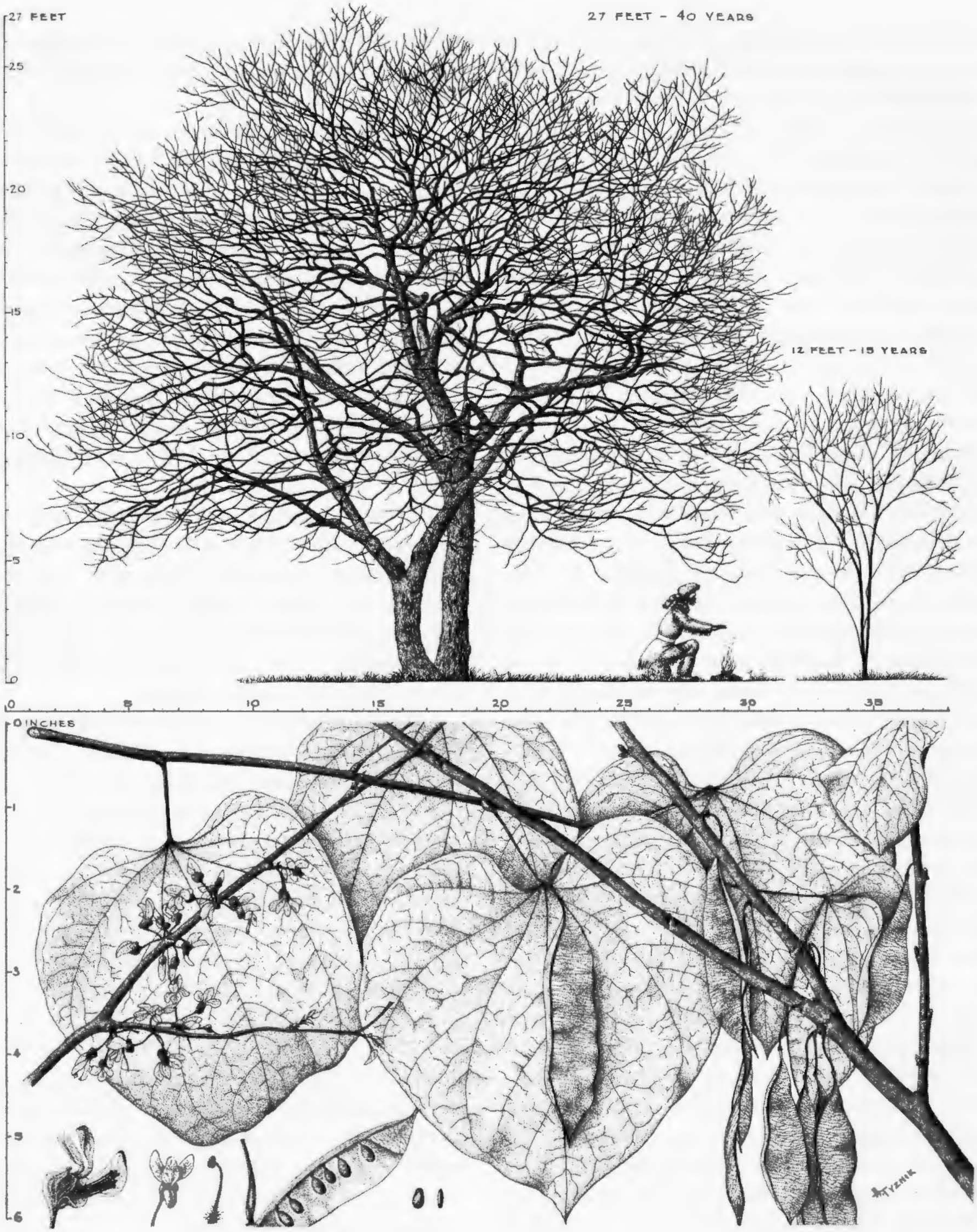
The above statements deal primarily with decline of trees established in the forest setting. Often, however, trees planted in the home area develop dieback and decline symptoms. In this case, trees usually are not suffering from effects of site alteration on an established root system, but rather from factors that could occur regardless of when the tree was established, namely frost, drought, defoliation, and toxic substances including air pollution.

The preceding suggestions for preventing dieback and decline diseases are aimed either at preventing the initiating stress or at alleviating its effects. Our research to clarify the interactions of stress, trees, and organisms is suggesting some additional ways to help cope with these problems. For example, we now know that root starch content is a good indicator of past stress. Because of this, we think that it also may prove useful as an index to vigor of defoliated and/or droughted trees. If so, we will have another tool to help predict a tree's ability to tolerate additional adverse environmental factors.

We have learned that the massive starch-sugar conversions associated with defoliation (and perhaps with drought) take place only when these stresses are severe enough to elicit refoliation. Treating trees to prevent budbreak, or to hasten it, might reduce dieback and help maintain resistance to organisms of secondary action.

In the Northeast, the effects of drought and defoliation have often been confounded. Defoliator outbreaks are often associated with hot, sunny periods when soil moisture content is low. In dry periods, cellular constituents of leaves are more concentrated, and insects feeding on them develop faster. Fertilization has been shown to reduce the suitability of foliage to some defoliating insects, and, as mentioned previously, soil nutrition may affect the way trees respond to drought.

We can conclude that dieback and decline diseases will continue to increase as the number and diversity of stress factors increase with our expanding urbanization. Unravelling these important problems is a time-consuming and difficult task which requires a multidisciplinary approach, but efforts now under way promise to provide the tools necessary to cope with them.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Redbud, *Cercis canadensis*

Pea Family *(Leguminosae)*

General Description:
Redbud is a small, irregularly-shaped tree that is frequently flat-topped. Its stout, upright trunk divides into several heavy branches a few feet above the ground, giving the tree a low, wide appearance. At maturity the tree reaches twenty to twenty-five feet in northern Illinois, with a trunk diameter of ten to twelve inches. Each season's new growth has brown lustrous bark which becomes dull and darker the following year. In older trees, the trunks and larger limbs have reddish-brown bark, half an inch thick and separated into long narrow plates by deep longitudinal fissures. A surface layer of peeling scales reveals a bright reddish color beneath it.

The leaves of redbud are large (three to five inches across), roundish, and somewhat heart-shaped. They are dark green, with paler undersides, and appear in April, usually after the blossoms are out. In autumn they become clear yellow.

The tree is noted for its abundance of magenta flowers that emerge in April. The flowers, typical of the pea family, are about a half-inch in diameter and appear in clusters along the slender branchlets and often on the trunk. They are long-lasting and usually remain well into May after the leaves have come out.

The thin, flat fruit pods bear ten to twelve chestnut-brown seeds, a quarter-inch long, that mature in midsummer. The pods turn brown and remain on the tree until late fall or early winter.

Landscape Value:
Redbud in bloom presents a stunning display, whether planted alone, in combination with wild plum or shadblow, or against an evergreen background. Additional features of interest are the form created by the divided trunk and irregular branches, the interesting reddish bark, and the yellow autumn color. Redbud is used as a lawn specimen and in groups or border plantings where it may be combined with plants of contrasting color and form. It is well suited to naturalistic compositions in partly shaded locations.

Origin and Hardiness:
The natural range of redbud extends from southwestern Connecticut across Pennsylvania, parts of New York, lower Michigan to southeast Minnesota and Nebraska to northeast Texas and eastward to western Florida. It is hardy in Zone 5.*

Soil and Site:
Redbud thrives best in moist but well-drained soils and in part-shade. It is found along streams.

Planting and Care:
Redbud is available in most local nurseries. Plants grown in local nurseries from seed collected in the northern range are preferable for hardiness. Redbud is easily transplanted, and should be mulched. Sites protected from severe winds are best. Redbud occasionally is subject to verticillium wilt.

Locations in the Arboretum:
West of the Visitor Center parking lot; west of the Administration Building; around Meadow Lake and Lake Marmo; east of the Thornhill Conference Center; along the east branch of the Du Page River.

****Hardiness zone based on Plant Hardiness Zone Map prepared jointly by the U.S. National Arboretum and the American Horticultural Society. U.S.D.A. Miscellaneous Publication #814, 1960.***

People & Projects

Tundra Ecology

Patricia Armstrong, Assistant in Education, is teaching a ten-week course at the Arboretum this winter on "Tundras of the Western Hemisphere." Her studies of tundra vegetation and her enjoyment of mountain climbing have taken her to high altitudes in New England, Alaska, the Canadian Arctic, the Rockies, Mexico, Ecuador, Bolivia, and Peru. Mrs. Armstrong is especially interested in tundra ecology and floristics, recording her observations of the highest elevations and northernmost limits at which she finds various species growing. In classes she utilizes her collection of photographic slides and herbarium specimens to acquaint students with these areas and with the lichens, bryophytes, and vascular plants that are found there.

In August, Mrs. Armstrong collected tundra plants in Baffin Island National Park on a sixteen-day backpacking trip sponsored by the Sierra Club. The trip, for which she served as assistant leader, began in Montreal. From there the twenty participants flew to Pangnirtung—a settlement of about nine hundred people, mostly Eskimos—where they boarded the freight canoes that took them to the head of the fiord. The group backpacked for a distance of about sixty miles, with extra climbing excursions adding another fifteen miles to Mrs. Armstrong's total. She was particularly impressed, again, with the impact of people on the fragile tundra environment. For example, the footprints made by the group as they began their trip could be seen clearly when they returned ten days later.

Writing is another means by which Mrs. Armstrong shares her alpine experiences and botanical knowledge with people. Among her recent publications is "Lichens: A Singularly Alpine Life Form," which appeared in the April 1974 issue of *Off Belay*, a national mountaineering magazine. Illustrated with drawings and many close-up photographs, the article gives an overview and appreciation of the lichen world.

Jensen Collection

Additions to the Jens Jensen collection during the past year and a half include several albums of photographs, letters, and other memorabilia given by Mr. Jensen's grandson, H. L. Wheeler of Wilmette; a gift of historical materials from Ragna Eskil of Chicago; and photographs loaned for copying by Elizabeth Coonley Faulkner of Washington, D.C., Elizabeth Holmes of Geneva, Illinois, and Maurice Hull of La Grange, Illinois.

A number of original landscape plans and an extensive photographic collection were also given by the Wisconsin Farm Bureau, which manages The Clearing, the school Jensen established in Ellison Bay, Wisconsin. The immense job of identifying and organizing the photographs is being done by Steve Christy, a student in the Department of Landscape Architecture at the University of Wisconsin. Other descriptive and organizational work with the Jensen collection is being done by Sue Windesheim, a volunteer who has donated many hours of her time to this project. Mrs. Windesheim is a third-year graduate student in the Department of City and Regional Planning at the Illinois Institute of Technology in Chicago.

Information about possible sources of materials and inquiries about the use of the collection may be directed to Carol Doty.

Staff Attend Meetings

Walter Eickhorst, Curator of Collections, was among the approximately one hundred members who attended the third annual meeting of the International Lilac Society in Hamilton, Ontario, in late May. Mr. Eickhorst is Chairman for next year's meeting, which will be held May 16-17 at the Morton Arboretum.

The annual meeting of the American Association of Botanical Gardens and Arboreta was held in Boston, October 4-8. Morton Arboretum staff members who attended were Webster R. Crowley, Richard Wason, and Peter Bristol. Mr. Crowley serves as a member of the Board of Directors of the AABGA.

The American Horticultural Society held its annual congress in Washington, D.C., October 10-13. Attending as representatives of the Morton Arboretum were Anthony Tyznik and Charles A. Lewis.

Climatological Summary

	TEMPERATURE (F.)							PRECIPITATION			
					NUMBER OF DAYS						
MONTH	MAXIMUM	MINIMUM	AVERAGE	TEN-YEAR AVERAGE	MAXIMUM 90° or above	MAXIMUM 32° or below	MINIMUM 0° or below	SNOW	TEN-YEAR AVERAGE	TOTAL PRECIPITATION	TEN-YEAR AVERAGE
August	91°	47°	70.3°	70.6°	2	—	—	—	—	3.20″	4.09″
September	86°	27°	60.9°	63.7°	0	—	—	0	—	2.22″	4.18″
October	76°	22°	52.6°	53.2°	0	—	—	0	0.08″	1.58″	2.48″

Of the Infirmities of Trees, &c.

"So many are the infirmities and sicknesses of trees, and indeed of the whole family of vegetables, that it were almost impossible to enumerate and make a just catalogue of them; and as difficult to such infallible cures and remedies as could be desired; the effects arising from so many, and such different causes: Whenever therefore our trees and plants fail and come short of the fruit and productions we expect of them, (if the fault be not in our want of care) it is certainly to be attributed to those infirmities, to which all elementary things are obnoxious, either from the nature of the things themselves, and in themselves, or from some outward injury, not only through their being unskilfully [sic] cultivated by men, and expos'd to hurtful beasts, but subject to be prey'd upon and ruin'd by the most minute and despicable insect, besides other casualties and accidents innumerable, according to the rustick rhyme,

'The calf, the wind-shoc and the knot,
The canker, scab, scurf, sap and rot,'

affecting the several parts: These invade the roots; stony and rocky grounds, ivy, and all climbers, weeds, suckers, fern, wet, mice, moles, winds, &c. to these may be added siderations, pestiferous air, fogs, excessive heat, sulphurous and arsenic smoak, and vapours, and other plagues, tumours, distortions, lacrymations, tophi, gouts, carbuncles, ulcers, crudities, fungosities, gangreens, and an army more, whereof some are hardly discernable, yet enemies, which not foreseen, makes a bargain of standing-wood (though seemingly fair) very costly ware: In a word, whatsoever is exitial to men, is so to trees..."

JOHN EVELYN
Sylva: or a Discourse of Forest-Trees
London, 1664

The Morton Arboretum

ILLUSTRATION SOURCES

Pages 49 and 52: Pen and ink drawings by Nancy S. Hart
Page 38: Photograph by George Ware; special effects by William R. Stickney
Page 60: Pen and ink drawing by Anthony Tyznik
Page 64 and inside back cover: wood engraving from J. Mitchell, *Dendrologia...*, London, 1812. In the Sterling Morton Library.

THE MORTON ARBORETUM · PLANT TREES ·

The Morton Arboretum was founded by Joy Morton in 1922 as "A privately endowed educational foundation for practical, scientific research work in horticulture and agriculture, particularly in the growth and culture of trees, shrubs, and vines by means of a great outdoor museum arranged for convenient study of every species, variety, and hybrid of the woody plants of the world able to support the climate of Illinois . . . to increase the general knowledge and love of trees and shrubs, and to bring about an increase and improvement in their growth and culture."