

URBAN TREE DISEASES AND THE NEED FOR ARBORICULTURAL MEDICINE¹

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The development of the applied science and profession of forest pathology has until recently been parallel to that of general plant pathology. Early in the century the main emphasis was on the diagnosis and distribution of tree diseases with the employment of mycological and microbiological knowledge and techniques in the forefront.

Later, studies of the effects of the pathogen's physiology, genetics and ecology on disease development were introduced, and these findings became additional required knowledge of the pathologist.

More recently, studies on the effects of host physiology, genetics and ecology on plant disease development has been added to the plant pathologist's research and knowledge area. While such studies are of basic value to all branches of plant pathology, they appear to offer specific opportunities to the pathologist working on urban tree problems.

The high value of urban trees on an individual tree basis, justifies in my view, a new approach to diagnoses and treatment of tree disease problems, which would bring tree pathology in line with human and veterinary medicine, and which I shall refer to as "Arboricultural Medicine."

In the following I shall attempt to outline briefly what in my personal experience as a pathologist, is required for such a professional development, but first some observations on the urban tree disease syndromes.

Tree Disease Problems

Pathogenic diseases. The forest pathologist working under urban forestry conditions soon finds himself making a re-evaluation of his ideas regarding the separation between "serious" and "insignificant" disease problems. The need for a

change in concept arises as a result of a combination of factors. Firstly, the changes in goals for the growing of trees away from wood production; secondly, the changes in environmental conditions; and thirdly, the exposure to diseases caused by familiar pathogens, but here found on "new" host species. The latter may be genuinely exotic, introduced species or they can be selected cultivars of native species.

Foliage diseases, which under general forest conditions cause little damage and therefore require minimal attention beyond a diagnosis, under urban forestry conditions become "serious diseases" requiring disease control application. Defoliation and die-back, which from a wood production point-of-view often is quite insignificant, can totally destroy the landscape value of a boulevard planting (e.g. *Gnomonia platani* Kleb., anthracnose of sycamore and plane trees).

Stem decays and cankers, which under normal forest conditions contribute to natural succession, and which in many cases can be eliminated through regular silvicultural thinnings, become, under urban and amenity forestry conditions, diseases worthy of treatment and of grave concern (e.g. *Fomes ignarius* (L.) Gill.; *Ganoderma applanatum* (Pers. ex. Wallr.) Patl.; *Polyporus sulphureus* Bull & Fr.; *Valsa sordida* Nit.; *Mycosphaerella populorum* Thompson; and *Nectria* spp.).

Wilt and die-back diseases are, under urban forestry conditions, major problems of concern. Particularly prominent are *Verticillium* wilt as well as die-back associated with *Nectria cinnabarina* (Tode) Fr. or other commonly occurring facultative parasites. These diseases appear readily to adapt to introduced hosts or to the altered environmental conditions of the urban area.

While an introduced fatal disease, such as Dutch elm disease, causes equal destruction to

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the rural and the urban landscape, its impact on the latter is greater, both immediately and in the long term. Under urban conditions, trees are a scarce commodity and succession of the elms by other tree species must, in most cases, be brought about by planting at a high cost. In contrast, under woodlot conditions, the elimination of the elms merely constitutes a speed-up of the natural succession. Further, the woodlot conditions permit inexpensive removal of diseased trees and replanting with other species, using forest nursery stock.

Also, root disease problems are different under urban forestry conditions where soil disturbances through earth excavation work are commonplace. Diseases like shoe string root rot (*Armillaria mellea* (Vahl ex Fr.) Dummer) which under forestry conditions causes killing of young as well as over-mature trees and at times are of practical concern in young coniferous plantations, under urban conditions are often found associated with sudden death of pole-sized hardwoods. Granted, changes in drainage or in depth of soil over the root system of the trees affected are invariably contributing factors, but one is left with the impression that many trees would have survived the site changes had it not been for the pathogen.

With regard to the impact of mycoplasma or viral diseases under urban forestry conditions, the present author has little personal experience to offer beyond the observation that a disturbing number of urban deciduous trees exhibit leaf symptoms which might be indicators of viral or mycoplasma diseases, particularly during the late part of the growing season. The pathogenic causes of many tree diseases are unknown.

Bacterial diseases on the other hand, while of little consequence outside the urban forestry area, have been experienced on a number of occasions. Fire blight (*Erwinia amylovora* (Burr.) Winsl. et al.) in some particular years, has been found to destroy entire street plantings of Whitebeam mountain ash (*Sorbus aria* Crantz) while wetwood and slime flux are common occurrences on a number of hardwood species along streets and in parks, yet relatively inconspicuous under forest condition.

Physiogenic or environmental diseases.

Under general forest conditions, diagnosis of physiogenic diseases such as nutrient deficiencies, frost damage, air pollution and mechanical injury (i.e. ice, snow, lightning, etc.), has been part of the forest pathologist's work area since forest pathology was founded more than 100 years ago. The difficulties experienced in such work will be well known to all plant pathologists. However, the difficulties facing the forest pathologist who ventures into the urban forestry area are increased manifold. The increase stems from the vastly increased number of possible causal agents to be considered in each individual case. Among the most prominent additional causal agents are: manufactured or natural gas; road salt; excessive soil compaction; changes in drainage and in soil grade as a result of construction; air pollutants, from chlorine to reaction-induced complex organic compounds; dog urine; and a variety of agents causing mechanical damage to tree stems or crowns.

A scientific well-based diagnosis is presently far from possible in all cases, and a good diagnosis requires a great deal of practical experience combined with the attributes of a Sherlock Holmes. Was there a short-timed and minor release of chlorine gas from a nearby meatpacking plant? Or did the gas company fix a leak in a pipe some time during the last four weeks? Were the tree roots killed during the winter period and the crown leafed-out in the spring, only to wilt in the early summer? Is there a pathogen or insect pest involved? If so, how primary is the pathogen or insect pest (in the present case)? Such are some of the questions. A few can be answered in the laboratory; others cannot with our present means. The later the tree problem is reported after the damage has been done, the more difficult is the correct diagnosis.

Coping with Urban Disease Complexes

For clarity, and in the traditional fashion of the forest pathologist, I have in the above separated my discussion of urban tree diseases into one section on pathogenic diseases and another on environmental diseases. This separation is justifiable in a few cases, such as in the case of Dutch elm disease or sun scald. However, a

closer examination will show that these cases are the exception rather than the rule. In most urban tree disease problems the disease can indeed not be tied to one single causal agent whether pathogenic or nonpathogenic. We are dealing with complex syndromes rather than simple diseases, and we must recognize that the occurrence of a pathogen in many cases is a symptom of the presence of physiogenic causal agents, which by themselves can cause severe restrictions on tree growth and even death. Verticillium wilt and *Nectria cinnabarina* are good examples of pathogens that occur in the presence of adverse environmental conditions. The outbreak of the former invariably related to root death (salt, construction, soil fill, etc.) and the latter indicating lack of frost hardiness of the host plant under its particular growing condition.

Recognizing these and other situations, it becomes clear that diagnosis and treatment of urban tree diseases require an understanding of individual host or tree "health" which hitherto has not been possible and will require a concentrated research effort in a number of areas relating to the physiological expressions of healthy and diseased trees.

Animal and human diseases are similar in their occurrence to those outlined above for urban trees and it may be worth noting, that both human and veterinary medicine is based, to a high degree, on a knowledge of the normal functions and physiological expressions of the patient's body. Functions and expressions which can be measured and analyzed as part of both the process of disease diagnosis and of disease treatment, and which in turn has led to the development of a long series of specialists in organ functions, varying from the brain, heart and lungs to the eyes, ears and throat, all basing their specialty on the availability of specific laboratory technologies.

For tree pathology the area of specialization has not so far followed this pattern. The specialization which has taken place has, to a high degree, been centered around groups of pathogens rather than around functional tissues of the host, and this may indeed explain the almost total lack of instrumentation for measuring the physiological activity of a

tree or its individual organs.

Trees, like other plants, have tissues performing specialized functions, which have been and are being studied by plant physiologists. These fall into four main groups, namely: (a) the water and nutrition uptake tissues; (b) the transportation tissues; (c) the food production tissues; and (d) the strength building tissues. All of these must function in harmony to produce a tree with a balanced (normal) physiological expression. Should one tissue malfunction a disease condition will result, which in severe cases will cause symptom development, in general a form of necrosis, presently referred to as "physiological stress."

Measuring visually the stress in terms of the percent impact of symptom development as we do today is far from being the final answer. The "stress" no doubt existed in advance of symptom development and would be measurable in one or more of the functional tissues if appropriate instrumentation and analytic procedures were available. Presumably, an early detection of stress would make treatment and cure possible, where this today follows after the fact of visual damage discovery.

One must therefore argue in favor of additional research on the development of methods and instrumentation, which can reduce the need for personal judgments in the assessment of stress values on the functional host tissues, and which are applicable both as tools to be used in diagnosing of diseases, and as tools for monitoring of treatment procedures and results. Biochemistry, plant physiology and electrical engineering may already be able to provide a number of the answers to the questions of the urban tree pathologist if only he was given the opportunity and support to search for it.

The needs are definitely present and the incentives ought to be made available for the development of a knowledge basis, which could put "tree health care" at par with that of humans and animals. A move which would lead to the development of a new profession of Arboricultural Medicine.

This desirable development will in my view eventually take place over a long period of time, but its progress is presently slowed by the tradi-

tional university education of plant pathologists. This is due to the strict separation between the biological sciences and the physical sciences and engineering areas which exist in most universities.

The development of arboricultural medicine could be furthered if an Interdisciplinary Research Institute for the training of graduate students was to be established at a major university campus.

Such an institute should have input from the biological area and the basic sciences as well as from engineering, and should concentrate its efforts on the development of instrumentation, which could be applied under field conditions for the monitoring of physiological expressions of tissues functioning in growing trees, as well as on the development of biochemical tests applicable for the rapid diagnosis of progress and development of pathogenic diseases.

Presently the majority of work in tree physiology is focused on seedlings and, as an example, thorough studies of water and nutrient translocation in mature trees is a neglected research area, which, however, beyond doubt, could yield important clues to curative and supportive treatments to trees under stress, as well as to the application of systemic pesticides (insecticides, fungicides, bactericides, etc.).

Very much speaks in favor of the future exclusive use of "systemics" in pest and disease control under urban conditions, where the environmental impact of spraying is even more pronounced, than under forest conditions, where direct human exposure can be more readily controlled.

Up to the present time the main functions of the urban tree disease specialist have been to advise on preventive treatments against maladies and to diagnose the causes of observed death and destruction. This has been done with an authority based on the individuals practical experience and his ability to make visual field observations and laboratory investigations, and often to the tree owners (municipal or private) complete satisfaction. However, rarely (as in the case of the root injection method for treatment of Dutch elm disease) has it been possible to apply symptom suppressing (curative) treatments, nor to aid the diagnosis in the field by examination of internal problems, without dissection, and thereby destruction, of the host.

Presently, portable x-ray machines, and the Shigometer which measures tissue resistance to a pulsed electrical current (Shigo, A.L. and A. Shigo. 1974. "Detection of discoloration and decay in living trees and utility poles." USDA Forest Service Research Paper NE-294, 11 p.) appear to be the only diagnostic tools under development for practical applications. Many more approaches are not only desirable but feasible. Technology transfer from human and veterinary medicine is a distinct possibility not to mention the possible invention of additional new methods specifically based on the nature of the "patients" who in all cases require house calls.

Summary and Conclusions

A review of urban tree disease as observed by the author in Ontario is presented and leads to the conclusion that most disease problems within the urban environment are of a complex nature, where environmentally adverse conditions take preference over pathogenic organisms as causal agents.

On this background it is proposed, that needs exist for research on the development of methods and instrumentation which will reduce the need for personal judgments in the assessment of stress values on the functional host tissues and which are applicable both as tools to be used in diagnosing of diseases and as tools for monitoring of treatment procedures and results. Successful research results in these areas would lead to the development of an "Arboricultural Medicine" profession on par with veterinary medicine and on an equally sound economic basis, facilitating treatment, cure and preventive treatments presently not possible under urban conditions.

It is further proposed, that the development of Arboricultural Medicine presently is slowed because of the inherited framework for the university education of urban tree disease specialists, and that the establishment of an Interdisciplinary Research Institute located on a major university campus, would be a desirable way of speeding up the necessary research work and technology transfers.

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