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THE DIAGNOSIS OF URBAN TREE DISORDERS

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Many times the municipal arborist has just as baffling a mystery to solve as the municipal detective. "What killed my maple tree?" may pose an even greater problem than "Who killed Mrs. Jones?" It is interesting that both professions require similar approaches in problem solving. Both the arborist and detective gather all the clues at their disposal. The proper solution to their problems depends on the nature of the clues and their ability to interpret them. It should be remembered that some murderers get away and that some urban tree disorders go unsolved.

The municipal arborist also has a great deal in common with the physician in that he is often called on to be a diagnostician. The arborist is greatly handicapped, however, in that his patients can't talk to him. He must rely heavily on symptoms in his diagnoses.

What are symptoms? For our purposes we can say a symptom is a signal of a disorder. To recognize the signal we first have to be familiar with the normal appearance of the tree. Many times a plant pathologist will not be a good diagnostician because of his narrow interests and his limited familiarity with different trees. On the other hand, a municipal arborist may make an excellent diagnostician because he is constantly observing many trees under varying conditions. The municipal arborist must, however, fortify himself with an understanding of the nature of tree diseases, injuries, and insect damage.

Sifting the symptoms. The top branches are dying back, the leaves are yellow and dwarfed, signs of borer attack are around, fruiting of a fungus is apparent — which of these symptoms is important and which is insignificant?

The most important symptoms are those most directly related to the cause of the disorder. It must be recognized also that there may be more than one disorder of the tree — each with it's own set of symptoms. To further complicate the picture, one disorder may be the cause of another and the symptoms that you are observing may be masking the symptoms of the primary cause of the trouble.

Therefore, the sequence in which symptoms develop is important. This requires that trees be under constant surveillance for the first signs of any change. These first signs will be more likely related to the primary cause of the tree disorder.

The time of year in which symptoms first appear may be a clue as to the cause of a disorder. Browning of conifer needles in late winter or early spring may indicate winter injury from low temperatures or strong drying winds. Another possibility is salt injury, either by direct contact with the foliage or by uptake through the roots. We have observed the death of two 30 feet tall Norway spruce in March as a result of salt run-off into the root zone. The needles browned in a period of 2 weeks over the entire tree as temperatures warmed and water uptake became more rapid. Soil from around the base of these trees had very high soluble salt levels.

Need for case histories. In order to place symptoms in a proper perspective, a case history of the affected tree should be assembled. A case history should include such information as when and how the tree was planted, any foreign chemicals that were used in the area, any abnormal treatment of the tree (injuries, earth fills, paving, etc.) any control practices that were executed, and any abnormal defoliation. Many times it is impossible to solve the mystery without such information.

If a case history is not available, questioning of

residents in the area may provide you with needed information. In some instances this is the only way that a relationship between the symptoms and the cause of a disorder can be determined. We are reminded of the mysterious dying of a maple in a lady's yard that was finally solved when she admitted using an oil based aerosol insecticide spray on a wound to keep insects out.

Your historical account may require knowledge of changes or happenings in the vicinity of the tree several years earlier. A major modification of drainage patterns some distances from the tree may be important. Also, severe weather (e.g., hail) several years earlier may have weakened a tree sufficiently to cause decline and dieback symptoms years later.

The tree and its total environment. It is common to become so intently involved in certain symptoms of a disorder that you lose sight of the possible cause. There should be a rule in tree diagnosis that says you should "approach" all problem trees by taking ten steps backwards.

With a good overall view of the tree, ask yourself the following questions: Is this tree the only one affected? Are the other affected trees all the same species? Are there plants other than trees affected? What part of the tree is affected?

Such questions will allow you to determine whether a general environmental factor is involved or something that is specific to the affected tree. For example, if plants other than trees are affected you would immediately suspect some general factor such as chemical change. If only one species of tree is affected you might then suspect a disease or insect problem. By determining the pattern of the affected area you can many times narrow down the cause. For example, if the most severely affected foliage is on shaded lower branches you might suspect a leaf disease since moisture is retained longer in these areas. Or if the tree is dead from the middle upwards, you might suspect a canker on the main stem.

After having made a thorough assessment of the tree from a distance you are then ready to look at it close up. If you have eliminated general environmental factors, you are probably then dealing with an insect or disease caused disorder.

Symptoms of insect disorders. We intend to treat symptoms of insect attack very superficially. However, to become an accurate diagnostician you need to keep in mind the types of symptoms insects can cause.

Many times, you are fortunate enough to catch the insect in the act and the case is closed. In other cases you have to rely on signs of the insect such as excrement.

With aphid attacks sometimes the cast skins of the culprits are all that you have left on which to lay the blame. The presence of a sooty mold fungus that grows on aphid excrement is added evidence.

A powdery dust at the base of the tree may help you detect borers or ambrosia beetles in the main stem. Most borer attacks are not the primary cause of tree disorders, but indicate that some other agent has weakened the tree.

A common pest on spruce and some other conifers would be spider mite injury which causes a bronzing of the needles. Even though active mites may not be present, webbing, eggs, etc. can be found as evidence.

As an example, some damage can be misdiagnosed as insect damage. In the late spring, as leaves of maple and oak expand, holes in the interveinal areas may suggest chewing insects. However, the cause may be due to low temperature injury of small areas of leaf tissue as the buds were swelling.

It is good to be able to recognize the various galls that insects can cause on the leaves and stems. These may be confused with diseases. Insects can damage foliage in various ways by skeletonizing it, mining through it, piercing it and sucking out its juices, etc. It should be kept in mind that defoliation of trees may lead to other tree disorders such as winter kill.

Insects and diseases are closely related in some cases. Insects may carry the agents that cause disease. Diseases may predispose trees to insect attack and *vice versa*. In some areas the decline disease of maple (maple dieback) has been shown to be related to defoliation of maple by insects.

Tree diseases. When we say disease we mean a malfunctioning of the tree which is caused by repeated agitations. This is opposed to an injury

which is a single agitation. If you were to cut your finger off this would be a injury (a single agitation). If you were to get blood poisoning following the cut (a multiple agitation caused by bacteria) this would be a disease. There is in trees, as with fingers, a relationship between injury and disease. But it is important that we separate the two. Our only defense against injuries is to prevent them whereas we can perhaps cure a disease (or stop the agitators).

This paper deals with symptoms of some common tree diseases and injuries. A distinction has been made between injury and disease and now we need to consider the different types of diseases. It is important that you recognize the different types of diseases because they require different approaches to control them.

Diseases can be caused by living and non-living agitators. Living agitators or parasites include fungi, bacteria, viruses, nematodes, and mycoplasmas; and among the non-living agitators are nutrient deficiencies, flooding, air pollutants, herbicides, adverse environmental conditions.

Diseases caused by non-living agitators. Nutrient deficiencies. — Tree leaves are our best barometers for determining the vigor of the tree. This is particularly true of nutrient deficiencies where in some cases the behavior of the foliage indicates specific nutritional needs of the tree. Potash deficiency in some trees is expressed as a marginal killing of the leaf. A yellowing or chlorosis of the leaf may reflect a nitrogen deficiency or in some cases a deficiency for iron or magnesium. Shade tree specialists commonly run into a chlorosis of pin oak associated with iron deficiency. The pH of the soil determines the availability of the iron.

Diseases caused by poor water relations. Diseases of trees can be caused by excessive, deficient, or a rapidly fluctuating water supply. A symptom of the leaf commonly referred to as scorch is many times the result of a deficient water supply. The most generally accepted explanation for scorch is that it results from the depletion of water from the leaf faster than it can be supplied by the roots. It is also suspected that potash deficiency may be an associated cause.

Scorch results in browning and death of areas of the leaf. In severe cases the entire leaf will become brown and fall. Some other diseases, particularly anthracnose or leaf blight of maple, ash, and sycamore may be confused with this condition. The location of the more severely affected leaves can be used to distinguish scorch from leaf spots and blights caused by fungi. Leaves affected by scorch are generally on the side of the tree exposed to the prevailing winds or the most intense rays of the sun. Damage from leaf fungi generally is scattered throughout the tree and worse on the more shaded foliage. When in doubt microscopic examination usually will separate leaf scorch from the leaf diseases.

The tops of sweetgum commonly die back, and root mortality has been found associated with the top decline. There is also a relationship between water content of the soil and root mortality. One worker has found that constant excesses or deficiencies of water do not cause the disease, but rapid fluctuations in the water supply will. A fungus canker disease (*Botryosphaeria*) may sometimes cause dieback in sweet gum and in redbud. Here again, it may be that the fungus establishes only in trees first weakened by the unfavorable soil environment or by other causes.

Drought is a common killer of trees. Killing of roots through water deficiency allows root-rot and butt-rot organisms to become established and their progression causes a slow decline of the tree. Excessive water can kill roots by excluding oxygen, and rotting organisms can become established under these circumstances.

From the difficulties that can result from excessiveness, deficiencies, and rapid fluctuations in the water of trees it is evident that attempts should be made to see that the tree's water supply is constant. In picking sites to plant trees, the drainage and water holding capacity of the site should be a major consideration and such things as a hard pan avoided. The expanding demands of a growing tree for water should also be taken into account.

Diseases caused by living agitators. There is more variation in diseases caused by living organisms (fungi, bacteria, viruses, nematodes, and mycoplasmas) than those caused by non-living agents. This is because we are dealing with

two living systems (the host and parasite) both of which can vary and interact with each other in various ways. When the host and parasite confront one another a battle is waged: sometimes the host wins and sometimes the parasite. Generally a parasite attacks one part of the tree — the leaf, stem, or root. However, there are some parasites such as the Dutch elm disease fungus which can grow throughout the tree (become systemic). Let's now consider the various battlegrounds where diseases can occur and describe the symptoms that result.

Decline diseases. Trees can show reduced vigor, smaller leaves, dieback from the crown downward, and eventually die. The symptoms of such decline diseases are equivalent to the patient telling the doctor, "I don't feel well." There isn't much to go on. Because the symptoms are not very definitive, it is important to have a good case history of the tree. Also, knowledge on the susceptibility of the particular tree to various ills is helpful. Also, it is useful to have a knowledge of the environment (soil, moisture, temperature) that the tree requires for optimum growth.

Root rots. The most obvious place to look for the cause of a decline disease is at the root system of the tree. Examining the root systems of trees, particularly street trees, is a formidable task. On rare occasions the fruiting of the fungus causing the rot is apparent. In most cases we are left with only decline symptoms to go on. It is a good idea to pull back the bark at the base of the tree as it is possible sometimes to see shoestring-like growth of *Armillaria mellea* if it is involved. Culturing from the root system of affected trees is the only approach to a positive diagnosis in most cases.

Environmental changes are more critical for some tree roots than others. Some trees (e.g. beech and hemlock) have shallow root systems and sudden changes in the environment (e.g. change of drainage and water table, soil compactions, etc.) result in decline.

Tree injuries and rots. Man causes more tree injuries than any other agent. Most injuries to street trees are made during construction or pruning operations. Other agents such as lightning and freezing can also cause injuries. The only approach toward controlling injuries is to prevent them. Injuries many times strip the tree of its protective armor and allow organisms to gain entrance and cause disease. The most common offenders are the heart-rot fungi whose spores are always present in the air ready to alight on a wounded surface and grow into the heart of the tree. These fungi commonly enter through pruning wounds, particularly where stubs are left. The detection of rot in trees once it is established is sometimes difficult. Anytime there is a major wound on the tree a heart rot problem should be suspected. An enlargement of the base of the tree is a good indicator of heart rot. Death of larger branches may result from the spread of a heart rot fungus. Sometimes the appearance of fruiting bodies of rot fungi on the side of the tree will reveal the rot.

Leaf diseases. Leaves, besides showing symptoms of disorders in other parts of the tree, have maladies of their own. These diseases may be expressed as spots, blotches, or puckering of the leaf. Most of these diseases are caused by fungi which can be seen fruiting on the spots if magnified by a microscope.

Many times leaf diseases can be diagnosed by the specific shape and color of the diseased area. Positive identification in other cases requires an examination of the causal agent with a microscope.

Stem diseases. The trunks, limbs, and twigs of trees can be attacked by various canker organisms (fungi and bacteria) which by killing patches of bark and girdling the stem can cause considerable damage to trees. Most of these organisms need wounds or weakened trees to gain entrance although some can enter unwounded vigorous trees. Canker organisms are generally denied entrance to the tree by the bark. However, some organisms can apparently enter the lenticels or leaf scars of healthy trees and some gain access to the main stem through small branches or roots.

Stem diseases can be recognized by sunken, discolored, and sometimes bleeding areas of the stem. Failure of some trees to form callus around wounds is often due to the invasion of microorganisms.

Systemic diseases. In the diseases that we have talked about so far the tree has been able to confine the agitator to a particular organ of the tree or in some cases to a small area of that organ. Unfortunately there are organisms which certain trees cannot resist and they travel throughout the tree or "go systemic." Diseases caused by such organisms are usually very damaging, for example, oak wilt, Dutch elm disease, *Verticillium* wilt, and phloem necrosis of elm.

The vascular diseases. Although the vascular diseases are caused by a number of different fungi, there are similarities in their symptoms. The first signs are usually at the tips of branches in the top of the tree. Leaves may turn yellow to brown, droop, and in some cases fall.

The most universal symptom in vascular diseases is discoloration in the wood. The color of the discoloration will vary with different species and different diseases.

The agitator that causes elm phloem necrosis is a mycoplasma. The symptoms are quite characteristic in that the phloem turns a chocolate brown and emits a wintergreen odor when warmed in a container. The best place to detect these symptoms is in the buttress roots.

Chemical damage to trees. Air pollutants, herbicides, salt, and other foreign chemicals are taking a major toll of street trees in this country. Since we have not defined the nature of the damage caused by many of these agents, the total returns are not in yet. Symptoms from different pollutants are as varied as the different chemicals involved. Also, individual trees vary in their tolerance to chemical toxicants.

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