Fig. 1. Tree dying of oak wilt caused by the fungus *Ceratocytis fagacearum*. The oak wilt fungus may spread locally from tree to tree through natural root grafts, which are common among oaks growing close together. Premature leaf shedding during the growing season is one of the best diagnostic symptoms in red or black oaks.

How To Diagnose

Tree Diseases

By

DR. P. P. PIRONE
Senior Plant Pathologist
New York Botanical Garden
Bronx, New York

DR. ROBERT S. HALLIWELL
Department of Plant Sciences
Texas A & M University
College Station

PLAIN ordinary common sense is the most important qualification of a good plant disease diagnostician. Some refer to this as a knack, or intuition, or good judgment. Diagnosticians must also have a thorough understanding of a so-called "normal" tree, including the tree species being examined. Not only must he know the name of the tree, but it is also necessary to know about the species' resistance to environmental factors such as dry and wet soils or adverse winter weather.

The good diagnostician will not be afraid to ask questions. Some tree owners and park officials, for some mysterious reason, withhold information essential for proper diagnosis. The history of the tree, such as when and how it was planted, and some information on the past climatic history must be known. This can be acquired from original records or by asking the owner or person in charge of the tree. Information about drought periods, severity of previous winters, and prevalence of hurricanes or other unusual weather must also be considered.

The relation between the soil and the tree must be thoroughly understood by the diagnostician. Is the soil properly drained; is it well aerated; does it hold enough moisture; is it fertile? All of these should be considered. Soil fertility can be determined only by a complete soil test. The expert must also have a working

knowledge of entomology and plant pathology.

A reliable arborist will not hesitate to admit his inability to diagnose some abnormalities, nor will he hesitate to recruit the aid of a specialist to help in the diagnosis.

Following are the standard procedures used by specialists in diagnosing tree troubles. They will vary somewhat with the individual and with the plant species. Some diagnosticians consider symptoms above ground more than those below ground. Others feel that the most serious tree troubles and those most difficult to diagnose are frequently associated with below-ground symptoms and factors.

General Exam Comes First

Before examining any one part of an ailing tree, one should study the general surroundings. Are other nearby trees healthy? Have any special treatments been given prior to the discovery of abnormal conditions? Is the tree so situated that a leaf bonfire beneath it, for example, or another diseased tree may have played a part in its decline? After these, and perhaps many other related questions have been answered, one should proceed then with the direct examination of the tree (Fig. 1).

Leaves Show Symptoms First

Leaves constitute the best starting point for examination, because they are the most accessible and are first to show outwardly the effects of any abnormal condition. Here also, a complete understanding of a normal leaf is essential. Size and color of normal leaves vary greatly among different tree species and even among trees of the same species.

Insect injury to leaves is rather easily diagnosed by the specialist, either by the presence of the pest or by the damage caused when it feeds or lays eggs. Leaves may be partly or completely eaten (Fig. 2), or they may be yellowed as a result of insects sucking sap, blotched from feeding between the leaf surfaces, or deformed from feeding and irritation.

Leaf injuries caused by parasitic fungi are not diagnosed so

Fig 2. Black walnut stripped of foliage by tent caterpillars supports only the silken tents left by the ravaging insects which are sure signs of their damage. *(Photo by H. P. Bryan).*

Fig. 3. Norway maple with a wilt disease, caused by the fungus *Verticillium alboatrum,* microscopic in size, has lost more than half its leaves.

Fig. 4. Leaves scorched on a sugar maple (center) are caused in this case by lack of water. Extremely hot weather may also give maples a similar appearance.

readily (Fig. 3), because the organisms that cause the disease are usually visible only with the aid of a microscopic lens. In some instances, tiny, black pinpoint fungus bodies in disease areas, visible without a hand lens, give a clue to the type of disease-causing organism. Lesions from fungus attack have a more or less regular outline with varying shades of color along the outer edges. They may range from tiny dots to spots more than ½ inch in diameter. When several spots spread and fuse together, coalesce, the leaves may wilt and die.

Atmospheric conditions preceding the appearance of spots on leaves often can be used to advantage in determining the cause of the injury. For example, when leaf spots appear after a week or 10 days of continuous rainy and cloudy weather, it is safe to assume that some parasitic organism is responsible, because such conditions are favorable for leaf spot development. Following a week or more of extremely dry, hot weather, lack of water (Fig. 4) may be responsible for spotted or scorched leaves. Low temperatures in late spring may also result in much injury to tender, newly sprouted leaves.

Leaf structure, appearance, or function may change because of widely different causes. Some are toxic vapor or fume injury, deficient or excessive moisture, lack of available food, poor soil aeration, root injuries, or diseases. All but the last two causes can be eliminated, if healthy trees of the same species as the one being diagnosed are healthy nearby. In other words, root injuries and diseases may affect leaves of an individual tree without affecting trees of the same species nearby.

Inspect Bark

A careful inspection of the branches and trunk should follow the leaf examination. Sunken areas in the bark indicate injury to tissues which lie beneath (Fig. 5). These injuries may have been produced by fungus or bacterial infection or by

Fig. 5. Cross section of a hackberry tree infected with the fungus, *Phymatotrichum omnivorum,* shows damaged tissue which lies beneath the bark. This fungus species flourishes on more than 2,000 wild and cultivated plants. When it attacks cotton, the disease is called cotton root rot *(Photo by H. P. Bryan).*

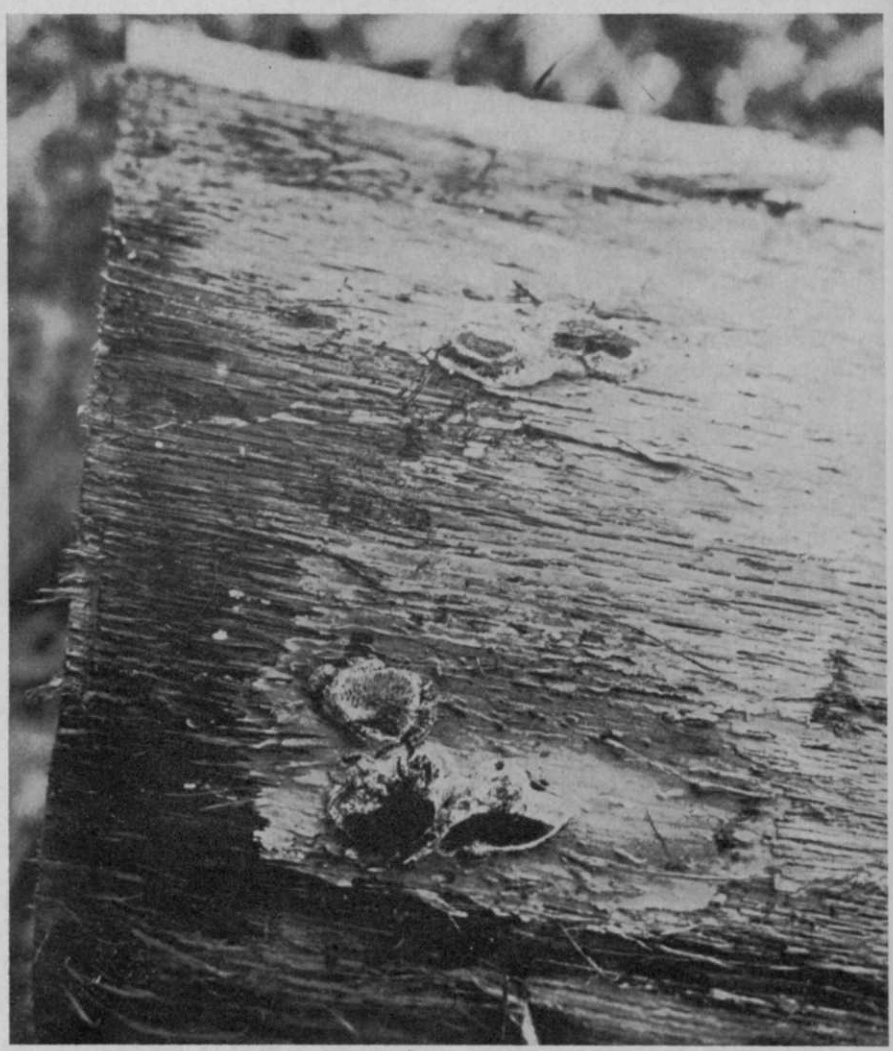

Fig. 6. Wood beneath the bark of a tree diseased by the oak wilt fungus, *Ceratocytis fagacearum,* is matted by a pathogenic growth. The bulbous growths are pressure pads that lift and crack the bark; the gray area around each pad is the fungus mat. Bark has been removed.

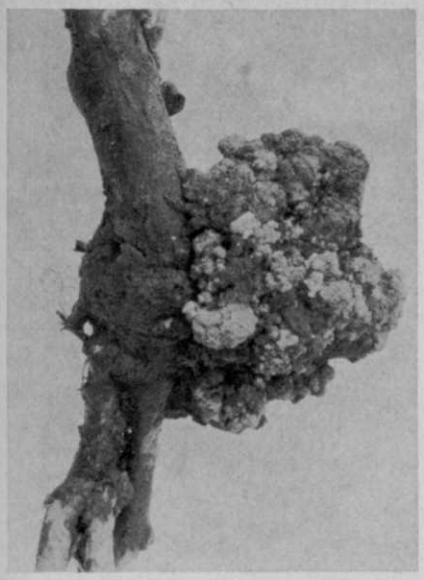

Fig. 7. Crown gall occurs at ground level on many kinds of trees, especially those belonging to the rose family. The malformations of crown gall are caused by bacteria, *Erwinia tumefaciens.*

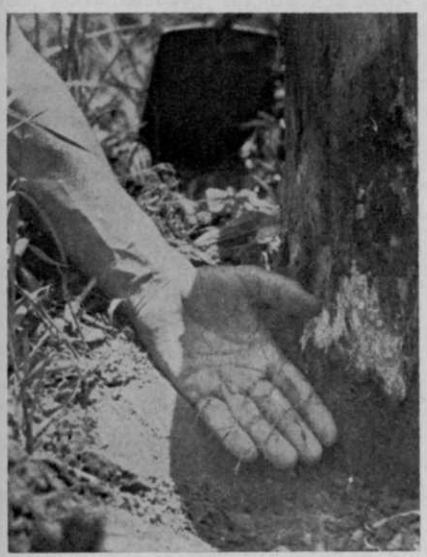

Fig. 8. Below ground, the fungus *Armillaria mellea,* produces black strands of tissue that resemble shoe strings. Careful manipulation of the soil is required to detect these below-the-ground fungal growths.

nonparasitic agents such as low or high temperatures. The presence of fungus bodies in such areas does not necessarily indicate that the fungus is the primary cause of injury. There are pathogenic species and nonparasitic species, and only a person with considerable mycological training can distinguish between the two.

As a direct result of fungus attack, diseased wood beneath the bark shows a gradual change in color from diseased to healthy tissue (Fig. 6). The injured area is usually dark brown in the earliest and most severely infected parts. In the more recently affected parts, the color is light green or brown with deeper hues toward the old injury section. On the other hand, injuries caused by low or high temperatures are usually well defined by an abrupt line of demarcation between affected and unaffected tissues.

The bark of the trunk and branches should be examined for small holes, sawdustlike frass, and scars or ridges. These are signs of borer infestations in the inner bark, sapwood, or heartwood. As a rule, most borers become established in trees of poor vigor. Because of this, it is necessary to investigate the cause of the weakened condition rather than to assume that borers are the primary cause. Branches and small twigs always should be examined for infestations of scale insects. Although most scales are readily visible, a few so nearly resemble the color of the bark that they are sometimes overlooked.

Branches and twigs with no leaves or with wilted ones should be examined for discoloration of the sapwood. This is the typical symptom caused by wilt-producing fungi. Because positive identification can be made only by laboratory isolations from the discolored tissue, a pathologist is needed to determine the species of fungus involved.

Suckers or watersprouts along the trunk and main branches may result from a sudden change in environmental conditions, structural injuries, disease, or excessive, incorrect, and ill-timed pruning.

Microbial parasites and unbalanced water relations between the soil and the tree may occasionally cause galls or overgrowth on the main trunk (Fig. 7). Many such malformations are produced by factors not yet clearly understood.

General vigor of a tree usually is revealed by the color in the bark fissures and the rapidity with which a wound callus forms. Fissures are much lighter than the bark surface in vigorously growing trees. A callus roll that develops rapidly over the wound also indicates good vigor.

Injured or Diseased Roots Cause Major Loss

Because of their inaccessibility, roots are rarely inspected by many arborists. To diagnose general disorders, however, the possibility of root injury or disease must be carefully considered (Fig. 8). More than one-half of the abnormalities in the hundreds of street and shade

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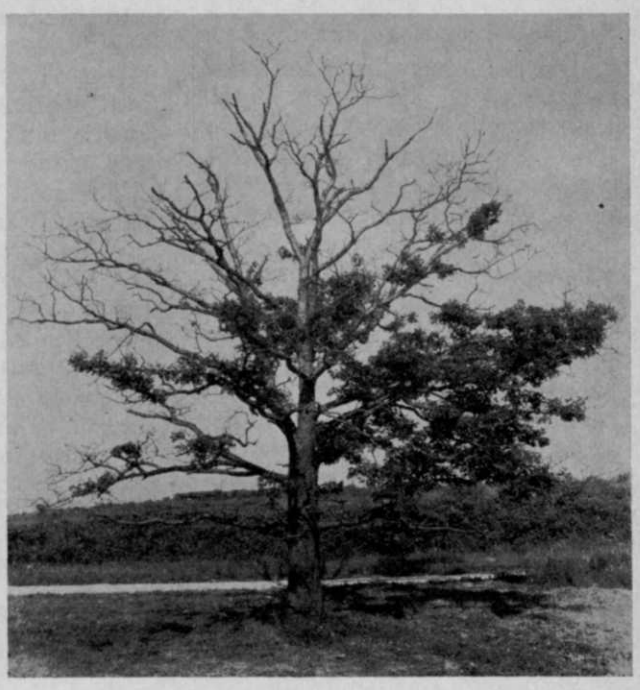

Fig. 9. White oak trees become defoliated and die from the top first, then towards the ground. This die-back is a result of an invasion below the ground of the shoe-string root rot fungus, *Armillaria mellea (Photo by J. C. Carter).*

sites as golf course tees can be attributed to the use of tall-growing varieties rather than the modern, dwarf types currently available.

Data reported for Cougar and "Nebraska blend" in Table 1 are from plots seeded in the fall of 1963. These plots were cut to ½- and 1-inch heights in the spring of 1964 and during 1965. Note particularly the root production of these two varieties; they were not allowed to become well established before cut to the ½-inch height. Bluegrass must be well established before clipping back to ½-inch. At the 1-inch height, Cougar root production was comparable to that of the varieties in the older trial.

Research Seeks Growth Habit Difference

Seedling characteristics of 4 bluegrass varieties are shown in Table 3. In the laboratory we attempted to identify some structural characteristic that could be measured to define the difference in their growth habits. Number of tillers and leaf sheath length have been proposed as possible distinguishing factors. We have not yet arrived at a satisfactory standard in our trials for measuring leaf sheaths (Table 3). Cougar and 0217 in seed production plots have the shortest mature plant stature. Thus, they are considered the most nearly true dwarfs of the varieties in this study. Yet, Delta and Nebraska dwarf have the shortest leaf sheaths. On the other hand, Cougar and 0217 show the greatest number of tillers which is one measure of grass ability to heal after mechanical injury. More refined tests are to be conducted in 1966 greenhouse trials to search for a characteristic that will distinguish bluegrass variety growth habits.

Table 3. Seedling characteristics of four bluegrass varieties in 1965.

	Average Number[1] Tillers	Average Leaf[1] Sheath Length (mm)
Cougar	2.0	7.1
0217	2.3	8.0
Delta	0.9	7.0
Nebr. Dwarf	1.7	6.5

1. 9 weeks after planting.

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trees examined by the authors have been caused by injuries to roots or diseases of root systems.

The sudden death of a tree usually results from the destruction of nearly all the roots or from the death of the tissues at the trunk base near the soil line. Factors most commonly involved are infection by disease organisms (Fig. 9), winter injury, rodent damage, heavy concentrations of natural gas, lightning, and various types of toxic chemicals. Trees that progressively weaken over a period of years may be affected by girdled roots, decay following nearby pavement work, poor soil or drainage, lack of food, grade changes, natural gas leaks, and excessive planting depths. Any of these factors and several more may contribute to the ultimate death of the tree. Diagnosticians must be ever alert for the symptoms above ground as well as for those not so obvious below the soil.

Apply Fungicide Now To Check Snow Mold

Lawn care specialists who applied fungicide to customers' lawns last November or December for snow mold control should plan to make another application this spring.

But even if lawns were not treated last fall, applying a fungicide now will help control the disease.

This advice comes from Dr. R. E. Partyka, Ohio State University Extension plant pathologist, who says fungicides containing mercury provide satisfactory chemical control of snow mold. He suggests fungicides with organic mercury such as phenyl mercury acetate, or inorganic mercury as mixtures of mercurous chloride and mercuric chloride. Also effective are Tersan OM, Thimer, Dyrene, and Ortho Lawn plus Turf Fungicide, Partyka says.

Mercury compounds can cause plant damage if applied in heavy doses, the specialist warned. He advises that special attention be given to manufacturer's recommendations for chemical use.