EXTENSION BULLETIN 308

Control of DUTCH ELM DISEASE

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The photographs in Figures 1 and 2 are used through the courtesy of the Bureau of Entomology and Plant Quarantine, U.S.D.A.

Control of Dutch Elm Disease

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Dutch elm disease is so named because the fungus that causes it was originally isolated and described by workers in the Netherlands. It was introduced from Europe about 1930 at several points along the Atlantic coast of North America, and was carried west of the Appalachians on elm burl logs consigned to a veneer plant in the Midwest.

Following the discovery of the disease in this country, a vigorous control campaign resulted in the elimination of the disease from a few localities such as Cleveland, Ohio and Norfolk, Virginia. In most areas, however, the disease has persisted and spread slowly to adjacent communities. Since early in World War II, very little direct control has been attempted—such as intensive scouting to locate diseased material, and general sanitation for beetle control. Consequently, the disease is now known in 17 northeastern states in which our native elms are grown.

The first elms known to die of Dutch elm disease in Michigan were found in Detroit during the summer of 1950. An intensive scouting program is now in progress to find infected elms as soon as possible. The diseased trees are being removed and destroyed. These efforts will not only protect the elms in the vicinity of Detroit, but will also do much to prevent the spread of the disease to other areas in Michigan.

If Dutch elm disease is to be controlled in this state, it is important for property owners and others interested in growing elm to know the cause of the disease, how to recognize it, and what to do about it. To prevent the establishment of the disease in a community, the first infections must be detected soon after they occur, and control measures promptly applied.

THE FUNGUS AND HOW IT KILLS ELM TREES

The botanical name of the fungus that causes Dutch elm disease is *Ceratostomella ulmi.* Once established in an elm, the minute spores of the fungus pass readily up and down through the water-conducting

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tissues of the living tree. The spores reproduce themselves in these tissues by budding in a yeast-like manner to spread the disease throughout the tree.

The growing spores release toxic substances into the sap of the tree, substances which cause wilting of the leaves and death of the sapwood. The presence of the fungus also stimulates the production of gums by the tree. In time those gums accumulate sufficiently to plug the water-conducting tissues. Both the toxic substances and the mechanical plugging are responsible for the characteristic wilting and final death of the tree. The rapid reproduction and spread of the fungus within the tree accounts for the sudden death of large trees once they become infected. (Fig. 1.)

Many trees die in the same season that infection occurs, some are killed within a few weeks, and only a few live longer than the second or third season. All native American ornamental elms are susceptible. But some Oriental species, like Chinese elm and Siberian elm, show varying degrees of resistance.

Once the fungus becomes well established within a tree, death results. Only rarely have known diseased trees appeared to recover, or to have been saved by pruning. If the bark of a diseased elm is not properly treated or disposed of, the fungus continues to grow in the dying tissues and can be spread by the elm bark beetles to healthy elms in the vicinity.

INFECTION OF HEALTHY ELM

The fungus grows—similarly to bread mold—in the egg galleries, larvae tunnels and pupal chambers constructed in the bark by the beetles. (Fig. 2.)

When adult beetles emerge from the bark of a tree containing the Dutch elm disease fungus, their bodies are covered by thousands of spores. These spores lodge in the feeding wounds made by the beetles on 2 and 3-year-old twigs of nearby healthy elms. This is the most important method of transmission of the fungus. Control of Dutch elm disease, therefore, depends primarily on control of elm bark beetles.

ROOT GRAFT TRANSMISSION

The fungus is also able to pass from a diseased to a healthy elm by way of the conducting tissues of grafted roots. This is especially apt to occur along street parkways with continuous rows of elm. It then becomes necessary to remove and destroy one or two trees adjacent to

Fig. 1. Elm trees dying of the Dutch elm disease. The tree in the upper photograph is in the early stages of the disease; that in the lower photograph, in an advanced stage. As the foliage on the nearby trees indicate, both of these photographs were taken in the summer.

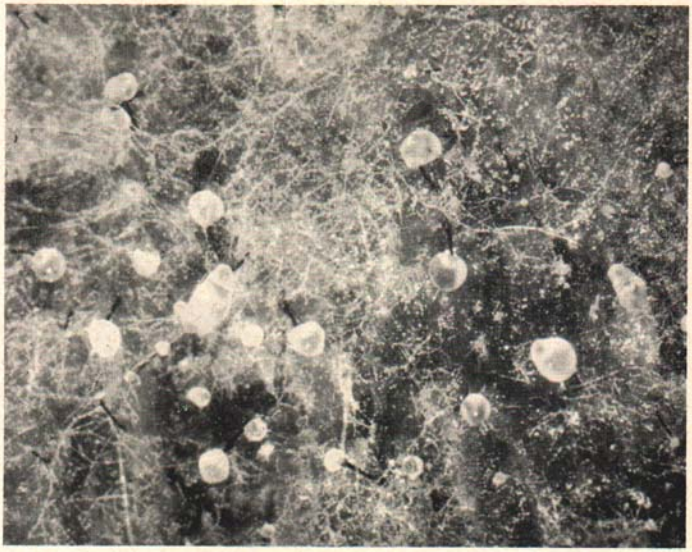

Fig. 2. Greatly enlarged micro-photograph of the Dutch elm disease fungus growing on elm wood.

each diseased tree, unless the disease is found before it spreads to the base of the tree.

Investigators have attempted to find other methods of control ever since the disease became important. Research workers in both Europe and the United States hope to find or breed trees that are resistant to the fungus. To date, they have been unable to obtain a variety of an acceptable type which is also sufficiently resistant to the disease.

Other workers, especially in the United States, have attempted to develop chemicals that could be injected into elm trees—either to cure them of Dutch elm disease or prevent infection. Although encouraging progress has been made, these lines of investigation are still in the research stage.

HOW TO RECOGNIZE DUTCH ELM DISEASE

Sudden wilting of one or more branches is the first indication that a tree is infected. The wilted leaves may recover temporarily. But eventually they become yellow, and later turn brown when dead. The

dead leaves sometimes hang among the green foliage of the unwilted branches to mark a tree a likely suspect. If the tree is infected by the Dutch elm disease fungus, the outer sapwood will be discolored (Fig. 3). The discoloration consists at first of light brown streaks. Later those streaks become darker brown and involve the entire outer surface of the wood.

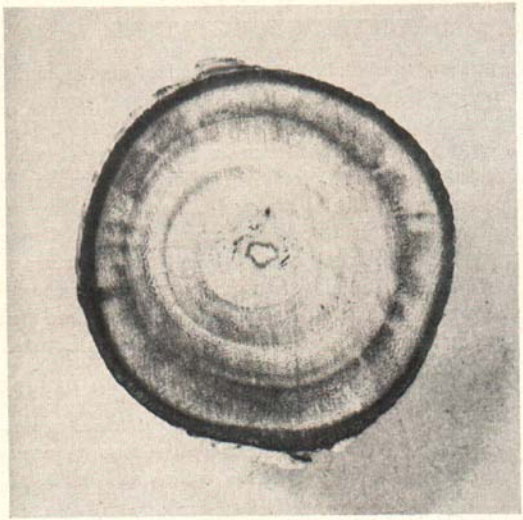

Fig. 3. Cross-section of an elm branch, showing how Dutch elm disease causes marked discoloration of the sapwood.

At least two other fungi cause a wilting and sapwood discoloration of elm trees so similar they cannot be distinguished from the Dutch elm disease symptoms in the field. For this reason, a positive diagnosis requires that the affected elm bark and wood be studied in the laboratory—permitting microscopic identification of the fungus involved.

Phloem necrosis of elm, a virus disease, also causes sudden wilting and death of the tree. It is characterized, however, by a yellow to butterscotch discoloration of the inner bark instead of the brown discoloration of the sapwood.

OBTAINING A POSITIVE DIAGNOSIS

A Dutch elm disease identification laboratory is maintained by the Federal Government at ~~Hoboken, New Jersey~~, for the service of all who wish a definite diagnosis of elm trees suspected of dying of the disease. If an elm tree is dying in such a manner as to indicate that Dutch elm disease may be involved, send the material to the ~~Hoboken~~ laboratory.

SPECIMENS FOR CULTURE[5]

The accuracy of the identification laboratory results, and the timeliness in reporting them, is dependent largely upon your sending in a sufficient quantity of good specimens.

Since the Dutch elm disease fungus may not be present in all parts of a diseased tree, your laboratory specimens must come from the infected part. The fungus dies out rapidly in dead and dry wood, or it may not survive in wood invaded by decay organism. Consequently, the specimens should be from living or recently dead parts in which the fungus is alive. The Dutch elm disease fungus may occur very sparsely in discolored wood, and in only a few of many hundred bark beetle galleries. This makes it desirable to collect specimens from *all parts* of symptomatic or bark-beetle-infested elm trees.

A report of the presence of the Dutch elm disease fungus in your specimens may be considered proof of the existence of the disease organism in the material cultured. A negative report, however, must not be considered proof of the absence of the organism in other parts of the tree.

SMALL BRANCH OR TRUNK SPECIMENS

To obtain proper laboratory specimens from *living trees* suspected of Dutch elm disease, follow this procedure:

Collect 6 discolored twig or branch specimens—each about 7 inches long and ½ to 1 inch in diameter—from one or more diseased branches of each tree suspected. The discoloration should show in the cut end, or under the bark of each piece. The wood should be green—or only recently dead—and not completely dried out.

When the diseased branches can't be reached, if possible cut 3 slabs of wood showing marked discoloration from the trunk. Each slab

[5]This section is adapted from the mimeographed instructions on "Specimens for Culture" distributed by the Dutch Elm Disease Identification Laboratory, Bureau of Entomology and Plant Quarantine, U.S.D.A.

should be 7 inches long, about 2 inches wide, and 1 inch thick. If the bark remains attached to the wood, trim off the outer loose bark.

BARK BEETLE GALLERIES

In the case of *dead or down trees* suspected of harboring the fungus, a far greater number of specimens is needed for laboratory analysis.

Collect 50 pieces of dead or dying bark and wood from each suspected tree (about 25 pieces of each). The pieces should contain *galleries of the elm bark beetles*. Each piece should be 3 inches square, or smaller. The clearer and fresher the dead bark or wood specimens is, the better it is for culture tests. However, slightly weathered wood and borer-riddled bark can be cultured. The bark need not be attached to the wood, but the dirty loose outer layer should be trimmed off the bark specimens. Neither wood which is extremely dry and punky, nor dry, crumbly bark is satisfactory.

UNSATISFACTORY SPECIMENS

It is not worthwhile to make cultures of elm material which cannot be expected to contain the Dutch elm disease fungus. For this reason, do *not* send leaves, small dead twigs, green wood without discoloration, or decayed wood and crumbly bark to the laboratory for culture tests.

TYING, MARKING AND MAILING SPECIMENS

Branch or trunk specimens from one tree should be fastened tightly into a bundle with rubber bands, or strong cord. Bark and wood squares from one tree should be placed in a strong paper bag and tied securely. Each set of specimens should be plainly marked with an attached paper tag bearing such identification as "Smith 1", "Smith 2", "Rogers 1". The specimens should be packaged securely for mailing. Any unused space in a box should be filled with crumpled paper.

A letter should accompany each package sent to the laboratory. The address, city, county, and state where each tree is located should be given. Your letter must contain the *name* and *mailing address* of the sender. All specimens and correspondence should be addressed to:

DUTCH ELM DISEASE IDENTIFICATION LABORATORY
~~Bureau of Entomology and Plant Quarantine~~
~~209 River Street~~
~~Hoboken, New Jersey~~
Botany and Plant Pathology
Michigan State College
East Lansing, Michigan

LABORATORY REPORTS

The Hoboken laboratory reports its findings directly to the person submitting the specimens. You should receive a report on branch and trunk specimens within 14 days after you mail them in. Identification tests on the wood and bark squares containing bark beetle galleries take more time; such reports may require four weeks.

THE INSECT CARRIERS

Dutch elm disease is spread by elm bark beetles—particularly the small European bark beetle. The native elm bark beetle can also carry the fungus on its body, and may introduce it into the trunk and branches of elms it attacks. Furthermore, when bark beetles enter dead, dying, broken, or cut material they may introduce Dutch elm disease fungus into their egg galleries—thus making such material as hazardous as if it came from a diseased tree.

THE SMALLER EUROPEAN ELM BARK BEETLE

The smaller European elm bark beetle is the more important of the two beetles as a carrier. It was accidentally introduced into this country about 1909, and since that time has become more and more widespread. It is small, brownish to black in color, about 1/12 to 1/8 inch long (2.5 to 3.5 mm.) and breeds in elm bark. The adult female lays her eggs in niches in the sides of simple, unforked egg galleries under the bark. The galleries are constructed *with the grain* of the wood (Fig. 4).

In New Jersey the smaller European elm bark beetle has a life cycle ranging in length from 45 to 60 days. This makes possible two full generations, and a partial third generation, each year. In Boston, on the other hand, it is reported that there is only one complete generation. In Michigan the life history has not been studied completely. But from observations to date, Michigan probably has two generations each year (or one complete and a partial second).

Adult beetles emerge in May or early June, fly to healthy trees, and feed in the crotches of the twigs. It is during this time—if they have emerged from the bark of Dutch elm-diseased material—that they may introduce the fungus spores from their bodies into the healthy trees. This habit of feeding on healthy trees, after emerging from the bark of diseased or injured elm trees, makes these insects very important as carriers of Dutch elm disease.

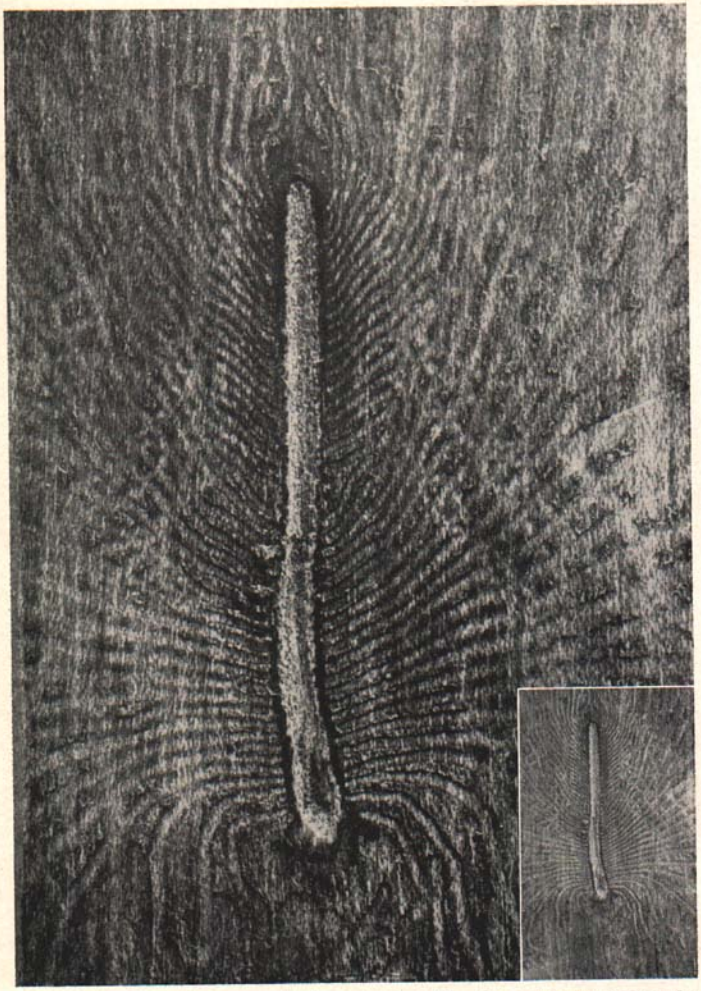

Fig. 4. Enlarged photograph of wood infested by the smaller European Elm Bark Beetle. Note that the egg galleries are constructed with the grain. This insect is the most important carrier of Dutch elm disease. Inset photograph (lower right) shows the same slab of wood, actual size.

THE NATIVE ELM BARK BEETLES

Because of its feeding habits, the native elm bark beetle is not as important a carrier of Dutch elm disease as the European beetle. According to the U.S.D.A. Forest Insect Laboratory at Morristown, New Jersey, young adults emerging from bark infected with Dutch elm disease carry the fungus with them on their bodies—the same as the European beetle. When confined in cages, the native beetle also feeds in crotches of young twigs, but it is not known that it does this in nature. Therefore, it is not believed to be as important.

The native elm bark beetle is widely distributed, small—only 1/16 to 1/12 inch long (2.25 to 2.75 mm.)—brownish, moderately stout, and the wing covers are coarsely punctured. The egg galleries are constructed *across the grain* (Fig. 5), distinguishing them from those of the European beetle which run with the grain. The native beetles have only one generation a year as far as is now known.

AIDS TO CARRIER CONTROL

SANITATION

Sanitation in areas where Dutch elm disease is present is most important. All brush from trimmings more than one inch in diameter should be destroyed. Destroy or treat all other material such as dead, dying, or newly cut elms.

According to Dr. R. R. Whitten, Bureau of Entomology and Plant Quarantine, U.S.D.A., burning or thoroughly spraying all bark surfaces with a solution of DDT in No. 2 fuel oil (8 pounds of DDT in each 100 gallons of oil) may be used. However, this will burn grass and shrubbery. Other sanitary methods are advisable such as peeling and burning, and mechanical "chippers". Furthermore, any other means that reduce beetle populations and spread should be used. (Fig. 6.)

SPRAYING

The bark beetle carrier of the Dutch elm disease infects healthy elm trees when it feeds in the twig crotches and in the leaf axils. To prevent this feeding it is essential to spray thoroughly all bark surfaces, especially in the tree tops.

FIRST TREATMENT—Apply the spray before the elm flowers or leaves appear; complete bark coverage is very difficult after leaves or flowers are out. This period is usually during March in the South and during April in the North.

Fig. 5. Enlarged photograph of the egg galleries of the native Elm Bark Beetle. Note that the native beetle constructs its galleries across the grain, distinguishing it from the European. Inset photograph (upper right) shows the same galleries, acual size.

In hydraulic sprayers use Formula A or B (given below) diluted with water to make 100 gallons.

In mist blowers use Formula C (given below) diluted with water to make 20 gallons.

The average 50-foot elm tree will require from 25 to 30 gallons of spray with hydraulic equipment, or from 2 to 3 gallons with mist-blower equipment. These volumes may need to be increased for the second treatment when trees are in full foliage.

SECOND TREATMENT—Apply 2½ to 3 months after first treatment.

In hydraulic equipment use formula A or B diluted with water to make 200 gallons.

In mist blowers use formula C diluted with water to make 40 gallons.

Recommended Formulas[6]

The following formulations, when diluted with water, have been found to be non-injurious to elm trees and, when properly applied, produce residues which remain effective for long periods of time. These formulations were prepared in the laboratory.

Several of the commercially prepared DDT concentrates were found to be too injurious to elm trees, when used at the required concentrations. Undoubtedly, many insecticide manufacturers will produce DDT-emulsion concentrates safe for use on elm at high concentrations, when the demand for them is made known.

Formula A

16 pounds of technical DDT dissolved in a mixture of 2¼ gallons of benzene and 1 gallon of Velsicol AR-50 (chiefly mono- and di-methyl-napthalenes). To this solution add 1 pint of Triton X-100 (an aralkyl polyether alcohol).

Formula B

16 pounds of technical DDT dissolved in 4 gallons of xylene. To this solution add 1 pint of Triton X-100.

Formula C

20 pounds of technical DDT dissolved in a mixture of 5 gallons of xylene and 2½ gallons of Acme white oil (a horticultural white oil

[6]Reproduced by permission from an article by R. R. Whitten in TREES Magazine, Vol. 9, No. 3 (March-April) 1949. In addition to the formulations recommended by TREES, there are several commercial ready-mixed DDT formulas which may be purchased.

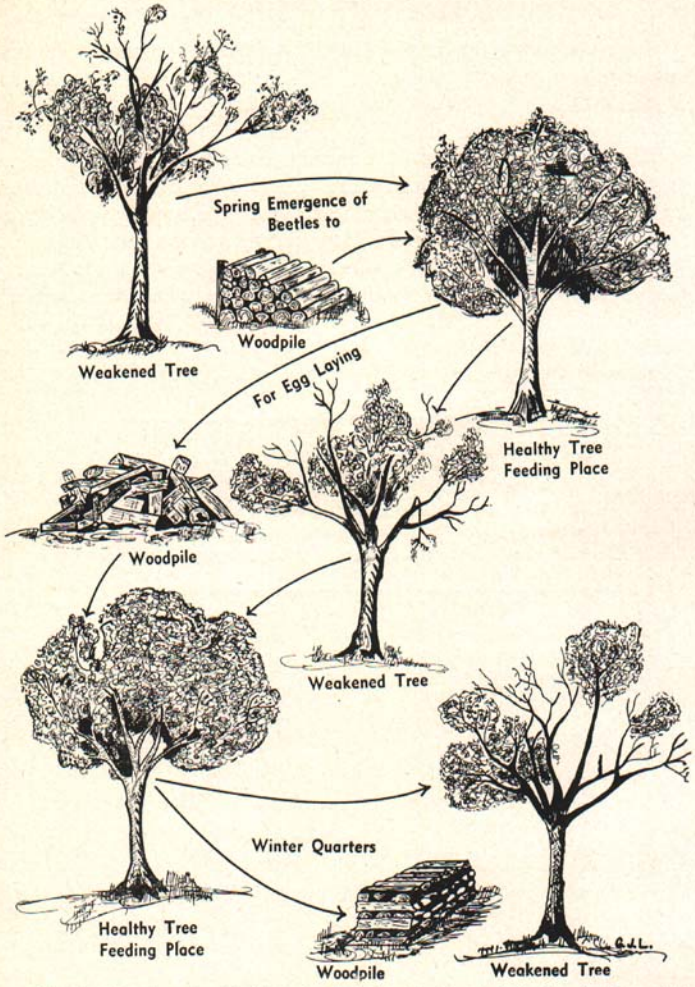

Fig. 6. Drawing showing how the bark beetles, by their feeding habits and in their normal cycle, spread Dutch elm disease. Spores of the fungus can be carried by the beetles as they move from infected wood into healthy trees. **DESTROYING BARK BEETLE BREEDING SITES IN ELM WOOD AND WEAKENED TREES HELPS TO CONTROL DUTCH ELM DISEASE.** *(Adapted from Circular 346, New Jersey Department of Agriculture.)*

having a viscosity—(Saybolt at 100° F.)—of 80-85 seconds and an unsulfonatable residue of 95 per cent). To this solution add 1¼ pints of Triton X-100.

WARNING: Caution should be exercised in handling the DDT solvents, as they are inflammable and concentrations of the fumes may be toxic. In handling the concentrated mixtures take care that they are not brought in contact with the skin for prolonged periods. Skin surface should be washed with soap and water soon after exposure.

These DDT-emulsion concentrates may be stored for indefinite periods of time, if kept in tightly sealed containers in a warm place.

CAUTION

When spraying for the control of Dutch elm disease, use hose and gaskets of neoprene (or comparable material) only. Formulations containing xylene and similar solvents will break down ordinary spray hose.

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