FACTS ABOUT DUTCH ELM DISEASE TOLD IN NEW EXHIBIT

By JOHN W. THIERET
CURATOR OF ECONOMIC BOTANY

IN THE UNITED STATES ALONE, plant diseases cause an estimated loss of three billion dollars a year. In spite of the importance of phytopathology (the study of plant ills) and the logic of including this science under economic botany (a subject to which four halls of Chicago Natural History Museum are dedicated), the Museum, until now, has never devoted an exhibit to any phase of pathology. Appropriately enough, our initial venture in this field is concerned with the Dutch elm disease, a malady much in public notice and for which public education has been called "the key to adequate control."

The clouds of World War I had scarcely lifted from western Europe when, almost simultaneously in the Netherlands, Belgium, and France, a wilt disease began to ravage elms. Dr. Bea Schwarz, of the plant pathology laboratory at Baarn, Netherlands, studied the disease and concluded that a fungus was the cause of the trouble. This newly recognized organism she named *Graphium ulmi*. Soon thereafter, a German investigator of the disease claimed that a certain bacterium was to blame. The pros and cons of the two viewpoints occupied pathologists for some time, but eventually Dr. Schwarz and *Graphium ulmi* won out. Now that the complete life-history of the causative fungus is understood, this organism is referred to the Ascomycete genus *Ceratocystis* as *C. ulmi*. The threadlike filaments of this pathogen grow in the conducting cells of the young sapwood of the elm and damage the functional wood of the current season, interfering with the movement of water.

The Dutch elm disease was so named, to the chagrin of Dutchmen, by a British pathologist because Dutch scientists were the first to study it and also because the assumption was that it started in the Netherlands (some think, though, that it was noticed first in France). Whatever the country of its origin, it eventually spread elsewhere in Europe and is now known over almost all the continent and in Great Britain. Some twenty years ago certain European scientists were asserting that the disease spelled the doom of the elms of western and central Europe. While their pessimistic prophecies have not been literally fulfilled, myriads of trees have succumbed, and many areas, both urban and rural, have lost all or nearly all their elms.

DISEASE ENTERS UNITED STATES

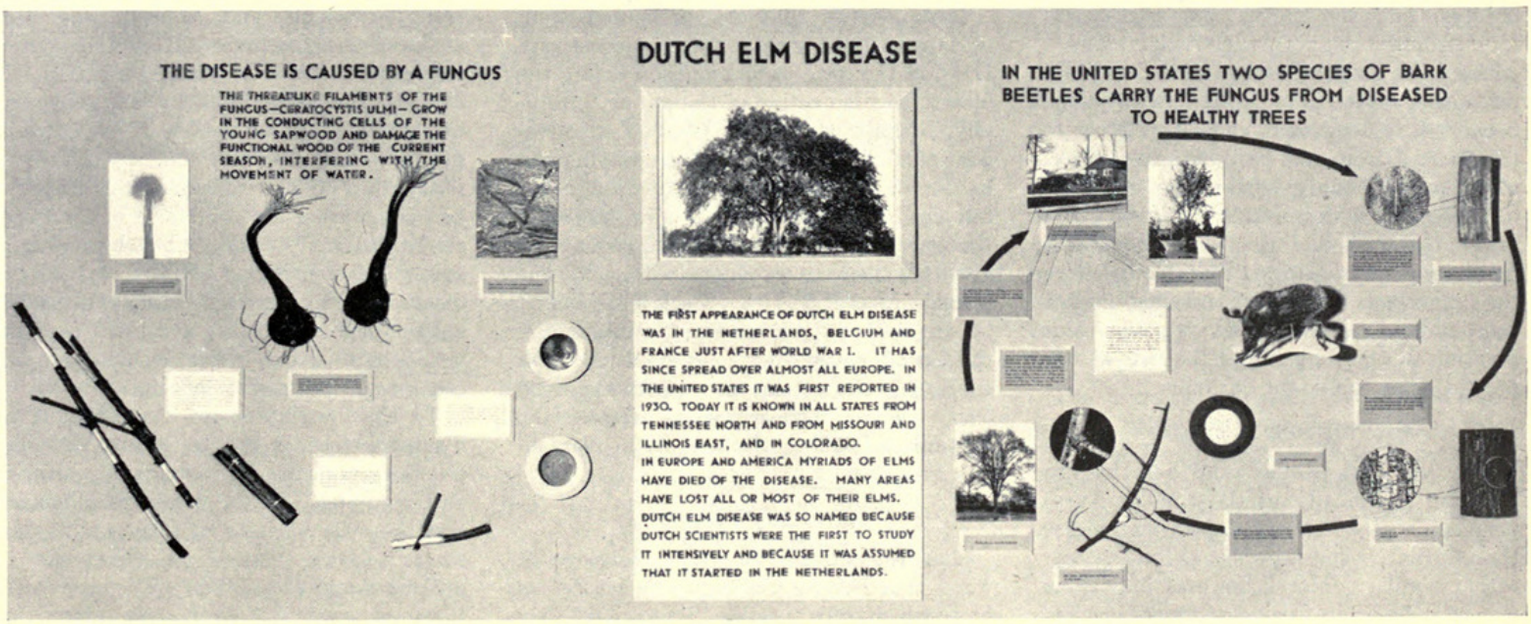
Carpathian-elm burls from France are prized for veneers, and large quantities of the logs used to be imported annually into the United States. It was in such logs that the Dutch-elm-disease fungus was introduced into the New World. The disease was first reported here in Ohio in 1930. Three years later a new and abundant infection was found around New York City. Soon thereafter, the source of the infection was traced to Carpathian-elm logs at the port of New York. From these logs the causative fungus was isolated and specimens of two species of beetles that spread the fungus were obtained. So close was the relationship between the logs and the introduction of the disease that, in 1934, it was possible to make the following statement: "Every Dutch-elm-disease infection yet discovered in America is related geographically to entry piers where imported elm-logs were unloaded or to railroads which hauled them."

Now that the horse had been stolen, the barn door was locked: the United States Department of Agriculture issued a quarantine directive, effective October 21, 1933, regulating importation of elm logs in order to prevent further introduction of the fungus. But the parasite had already become quite well established and its spread by its coleopterous carriers was gaining momentum. Twenty-seven thousand elms were destroyed in the first five years after the disease was introduced into the New York area. By 1937 it had reached into Maryland, Virginia, West Virginia, and Indiana. A federal control-program made definite progress against the disease until 1940, when adequate funds and labor could no longer be mustered. The elm killer was not eradicated, true enough, but intensity of infection in several states was substantially reduced.

After 1940 the disease spread rapidly through the northeastern states and beyond. Today it is known to occur in all states from Tennessee northward and from Missouri and Illinois eastward and in the provinces of Quebec and Ontario. Outlying infections have occurred in Colorado. In Illinois the first case of Dutch elm disease was found in 1950 near Mattoon. One case was known in that year. In each succeeding year the number of cases and counties represented increased until, in 1954, 2,067 new cases were reported from 55 counties and, in 1955, an estimated 5,000 new cases from 75 counties. In Champaign-Urbana alone more than 2,500 trees have been killed in but three years.

WILTING AND DISCOLORATION

The first symptom that attracts notice in Dutch elm disease is wilting and discoloration of leaves of one or more branches of the tree. This is called "flagging" because the infected branch stands out like a flag



DUTCH ELM DISEASE: PART OF EXHIBIT EXPLAINING ITS CAUSE, EFFECT, AND CONTROL

from the rest of the tree that, at this stage, is a normal healthy green. Eventually many branches show this wilting and discoloration as the disease spreads. Infected elms may die within a few weeks or live for several years. Positive diagnosis of Dutch elm disease can be made only by laboratory culture of the fungus from infected wood because other fungus diseases cause symptoms similar to those of Dutch elm disease. Specimens for culture should be 8 to 10 inches long and at least one-half inch in diameter and should be taken from a live wilting branch that shows brown streaking or discoloration on the surface of the wood under the bark or in the outermost ring of wood. Such a symptom is typical of several fungus diseases of elm.

Specimens to be submitted for diagnosis of Dutch elm disease should be wrapped in waxed paper before mailing to the laboratory. In Illinois send them to the Natural History Survey in Urbana; in most other states, to the agricultural experiment station. Under sterile conditions in the laboratory, chips of the discolored wood are removed and placed on a plate of nutrient jelly. If the fungus is present in the wood it will, in five days at room temperature, grow out into the jelly and form characteristic colonies encircling the chips. Through microscopic examination, the fungus can be positively identified. The sender of the specimens will then, of course, be notified of the results of the diagnosis.

The Dutch elm disease provides a most instructive example of the intimate relationship that can exist between a plant pathogen and its vector, a biological agent of dissemination. In the United States three organisms play the role of villains in the elm-disease story: the causative fungus (*Ceratocystis ulmi*) and two insects, tiny creatures with big names—the smaller European elm bark-beetle (*Scolytus multistriatus*) and the native elm bark-beetle (*Hylurgopinus rufipes*). The fungus alone—without the insects— would probably be of no consequence as a decimator of elms because it is dependent upon its vectors to transport it from tree to tree. The beetles alone may possibly hasten the death of weakened or dying elms by tunneling between the bark and the wood, but these insects were in the United States long before the fungus was brought in and they did not cause much concern. However, the combination of the fungus *and* the beetles has proved catastrophic for our elms.

HOW DISEASE IS SPREAD

The elm bark-beetles (and here we are referring specifically to the smaller European elm bark-beetle, a more efficient vector than the native species whose habits, though rather similar, differ in several important respects) breed in weakened or dying elms or in freshly cut elm wood and feed on healthy elms. These facts are the crux of the story. Weakened or dying elms or recently-cut elm trunks and branches with the bark intact are sought out by the beetles for a breeding place. Dutch-elm-diseased trees offer a particularly inviting site. The female beetle penetrates the bark and lays her eggs in a gallery that she digs between the bark and the wood. The larvae hatched from the eggs excavate feeding-tunnels that radiate from the egg-gallery.

In Dutch-elm-diseased wood, the fungus grows and fruits abundantly in these tunnels and galleries. The mature beetles cut their way out of the bark and emerge. If they are leaving Dutch-elm-diseased wood, spores of the fungus are likely to be clinging to their bodies. The beetles fly immediately to *healthy* trees, where they feed on bark and wood, principally in the crotches of twigs. It is through the feeding wounds made by the beetles that Dutch-elm-disease fungus is introduced into the tree. While the beetles feed, fungus spores clinging to their bodies may become dislodged and get into the sap stream of the tree. The fungus then develops and rapidly spreads, and eventual death of the tree results.

It is upon the close relationship between the bark beetles and the disease that control measures are based. At the present time, no treatment is known that can cure a tree once it is diseased (*exception:* sometimes immediate removal of a flagging branch will eliminate the infection), and no method of immunizing trees against the fungus has proved effective. Therefore control measures are aimed at the bark beetles in an attempt to prevent the insects from carrying the fungus from infected to healthy trees. In the struggle toward this goal, two objectives are paramount: (1) to prevent the beetles from feeding on healthy trees and (2) to reduce beetle populations through elimination of breeding sites.

Bark beetles may be prevented from feeding on trees by spraying the trees with DDT in the form of an emulsion before the insects become active in the spring. Actually, because of the long residual effectiveness of such DDT sprays, the spraying can be done any time between leaf drop in the fall and the appearance of new leaves in the spring. A second spraying may be given in July to prevent feeding by the second brood of beetles. These sprays must be so applied that *all* bark surfaces are thoroughly covered with the emulsion. For continuous protection, trees must be sprayed every year. Each spraying increases the amount of DDT on the bark and covers all new branches.

'SANITATION' MEASURES

The destruction of all dead and dying elm wood that can be used by bark beetles as breeding grounds is called "sanitation." By thorough sanitation, which should extend over as wide an area as possible, bark-beetle populations can be considerably reduced, and thereby the chances of the transfer of the fungus from diseased to healthy trees become less. In addition, the destruction of such elm wood removes a possible source of build-up of the fungus.

Two additional aspects of the Dutch-elm-disease problem should be mentioned: the attempts to breed and select elms that are resistant to the fungus, and the need for public education about the disease.

All members of the genus *Ulmus*—the elms—appear to be susceptible to the disease. Some, however, are considerably more resistant than others. Our American elm (*U. americana*) is, unfortunately, one of the most susceptible. Quite resistant species are the frequently cultivated Chinese elm (*U. parvifolia*) and the Siberian elm (*U. pumila*). The attempts to breed and select strains of various elms that are highly resistant to the disease (such attempts have been made principally by the Dutch) have so far produced at least two strains that are almost immune, the "Christine Buisman" and "Bea Schwartz" elms. Already these trees have been set out in many areas in Europe and America to replace elms destroyed by the disease. Further work can be expected to produce additional resistant strains.

COMPLETE DESTRUCTION

The Dutch elm disease is capable of almost complete destruction of our American elms. This sobering fact should be more generally known than it appears to be. The disease is too often regarded by Mr. John Q. Public as something that "can't happen here" in his community. But it can—and perhaps will—spread to wherever elms are planted and wherever the insect vectors are able to thrive. Along with the realization of the appalling possibilities of the disease should go the assurance that adequate control is possible and, indeed, has been achieved in many areas. Here, then, enters the important role of public education. In areas to which the disease has not yet spread and even in those where the disease is present, one finds too frequently apathy or resignation to loss of elms. Such apathy and resignation are the result of ignorance of the facts. How many times I have heard statements such as: "The Dutch elm disease? Oh, there's nothing we can do against it," and "Yes, a control program would be fine, but sanitation and spraying are too costly for our community."

To the first statement the reply, as indicated before, is that adequate control *is* possible by means of programs of sanitation and spraying. If the responsible officials and the other citizens of a community are aware of this, control programs can be organized and carried out. The alternative to control might well be the task of removing

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SOUTHWEST EXPEDITION BREAKS NEW TRAILS

By PAUL S. MARTIN
CHIEF CURATOR OF ANTHROPOLOGY

THIS SEASON the 1956 Southwest Archaeological Expedition will move headquarters about 130 miles westward from Pine Lawn, New Mexico, into eastern Arizona. The "new" area fits in a triangle roughly bounded by the towns of Show Low, St. Johns, and Springerville, Arizona. The area is "new" in the sense that it has never before been worked archaeologically.

In a sense, we are "pursuing" the Mogollon Indians, for our present hypothesis is that when they abandoned the Pine Lawn–Reserve area they moved first northwestward and then northward. Therefore our project may be considered in one sense a continuation of our old one, and in another sense a new task.

The new area is separated from the old by three mountain ranges that may have had important ecological influences on the culture in its "new" home. It is quite likely, also, that we shall find some early (pre-A.D. 1000) or even very early (pre-Christian era) evidences of occupation; and if so, it will be interesting to find what happened when the indigenous inhabitants met the Mogollon Indians from the Pine Lawn–Reserve area.

TRIBES MAY HAVE MERGED

We feel that the late efflorescence of the Hopi and Zuni cultures in A.D. 1300–1400 may be largely the result of inspirations and innovations transmitted to these people by the Mogollon Indians. In fact, it is quite probable that the Mogollon Indians eventually moved into Hopi and Zuni towns or merged with them in some manner. We may have had then the mingling of two cultures and peoples. In fact, I am making the wild guess that the Zuni language—a language that cannot as yet surely be fitted into any linguistic grouping and thus appears to stand alone—may be the Mogollon language! This is certainly going out on a limb, and someone may saw it off from under me, for it is a guess merely based on hunches and probabilities.

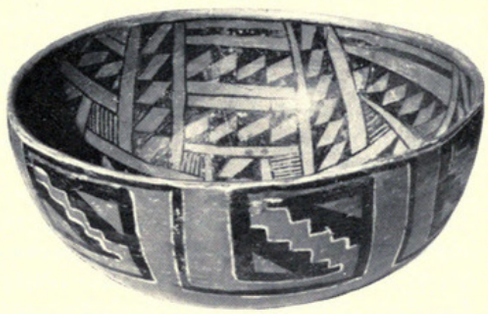
Certainly none of these hypotheses and wild guesses will be confirmed or even partly substantiated by our expedition this summer. Our first task is to ready our camp for future work—the cataloguing, photographing, and classification of objects to be dug up.

If we have time and money left, we shall probably not dig during this season but instead devote our efforts to reconnaissance work—that is, to searching for and making notes about ancient ruins in an area embracing approximately 700 square miles. This is no small task, indeed, and we shall certainly not complete it all this summer; but we may be helped in this work by a student from the University of Arizona.

The scope of our aims in the new area may be illustrated by listing some of our accomplishments in twelve seasons of digging in the Pine Lawn–Reserve area:

1. We obtained and published data on population growth and decline, on the changing of a method of subsistence from gathering wild foods to farming, on interrelationships between settlement patterns, economic activities, and on certain aspects of the social and religious life in this previously unstudied area.

2. The concept was gradually developed that the major subcultures of the Southwest were not separate isolated developments but were all derived from a primitive common Inter-Mountain culture that extended from Oregon and Idaho southward to the northern parts of Mexico and probably flourished as early as 11,000 years ago.



EXAMPLE OF MOGOLLON POTTERY

This bowl, believed to have been made about A.D. 1300, was brought to light in the Foote Canyon Pueblo dig in New Mexico by the 1955 Southwest Archaeological Expedition. The 1956 expedition will seek for both earlier and later types of prehistoric pottery.

3. We uncovered about 5,000 years of continuous history—the longest established and best worked-out sequence in the Southwest (this history throws light on the incipient stages in the growth of civilizations and on what causes a civilization to grow).

4. The earliest pottery in the Southwest was found.

5. We discovered an unusually primitive variety of corn believed to be the oldest or one of the oldest yet discovered in the Southwest (this has brought about revolutionary changes in archaeological hypotheses and interpretations).

6. We recovered the largest and most diverse collection of ancient food plants ever found in North America.

Many other details could be listed, but enough has been said, I think, to indicate that the twelve seasons in Pine Lawn–Reserve area (1939–55, except the war years) were successful. But far beyond this aspect lies another deeper appeal and satisfaction in our work. We have been fascinated by the beauty and compelling orderliness of the development of human societies, and we have been able to pass this on to thousands of others by lectures, popular articles, and monographs. The society we were studying was just one cell in the Organism of Society and the development of this cell that was revealed to us by our sweat and shovels was a powerful confirmation of our belief that man, unaided, except by his Creator, will attain great heights.

The technical aspects of our 1955 season now are being written up by my colleague, Dr. John B. Rinaldo; while I, in between visitors, telephone calls, and other duties, have been slowly writing a popular book on the history of the Mogollon Indians. Just what it will be called is not settled, but this book is intended for the layman interested in this subject, be he sixteen years of age or sixty.

DUTCH ELM DISEASE EXHIBIT OPENED

(*Continued from page 4*)

and disposing of scores, hundreds, or thousands of dead elms. And here a reply to the second statement can be made by recalling the words of a speaker at a recent conference on the disease: "I have heard the statement 'We should let them [elms] all die and be rid of the problem.' Let such a statement be challenged by the fact that the cost of removing one large city elm would take care of that same tree for the lifetime of the individual that made the statement, if not more." And, remember, after a community spends money to protect elms from the disease, the trees will still be there but when a community spends money to remove dead trees, denuded streets and lowered property values are the result. If people are made aware of the facts concerning Dutch elm disease and if they act on the knowledge that they will then have, the American elm will not need to go the way of the American chestnut.

The Museum's Dutch-elm-disease exhibit, now on view in Stanley Field Hall, was produced by Dr. John W. Thieret, Curator of Economic Botany, and Samuel H. Grove, Jr., Artist-Preparator. Materials used in the preparation of the exhibit were supplied by Dr. Richard J. Campana, Section of Applied Botany and Plant Pathology, Natural History Survey, Urbana, Illinois; Instituut voor Toegepast Biologisch Onderzoek in de Natuur, Baarn, Netherlands; United States Department of Agriculture, Beltsville, Maryland; The Oliver Corporation, Chicago; Standard Oil Company, Chicago; and Department of Plant Pathology, New York State College of Agriculture, Cornell University, Ithaca, New York.