

U.S. Dept. of Agriculture

CHESTNUT TREE BLIGHT

LETTER FROM THE
SECRETARY OF AGRICULTURE

TRANSMITTING

IN RESPONSE TO SENATE RESOLUTION
OF APRIL 30, 1912, INFORMATION RELATIVE
TO THE STUDY AND INVESTIGATION
OF THE SO-CALLED CHESTNUT
TREE BLIGHT



MAY 9, 1912.—Referred to the Committee on Agriculture and Forestry
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CHESTNUT TREE BLIGHT.

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, May 8, 1912.

The PRESIDENT OF THE SENATE.

SIR: In accordance with the resolution of the Senate, under date of April 30, directing that the Secretary of Agriculture "submit to the Senate, at the earliest practicable day, the results thus far secured in the study and investigation of the so-called chestnut-tree blight, and the amount of money thus far expended in said study and investigation," I have the honor to report as follows:

Observations on the disease known as the chestnut-tree blight, or the chestnut-bark disease, were begun in this department in the summer of 1907, as soon as any office was organized to do this class of work. The results secured in the study and investigation of this disease have been set forth in detail from time to time in the following publications, which are inclosed herewith, and constitute a part of this report:

- Bureau of Plant Industry Bulletin No. 121, Part VI, The Immunity of the Japanese Chestnut to the Bark Disease, February 10, 1908.
- Forest Service, unnumbered circular: Extent and Importance of the Chestnut Bark Disease, October 21, 1908.
- Bureau of Plant Industry Bulletin No. 141, Part V, The Present Status of the Chestnut Bark Disease, August 30, 1909.
- Farmers' Bulletin No. 467, The Control of the Chestnut Bark Disease, October 28, 1911.

A series of 34 photographs, mounted on 20 sheets, with explanatory legends, illustrating various phases of the disease, are also appended, and constitute a part of this report. (Pls. I-XVI.)

- A summary of results follows:
- (1) The disease is caused by a parasitic fungus which kills the tree by girdling it at various points. Trees of all ages and conditions are attacked without discrimination.
 - (2) A tree once attacked never recovers. It takes from two months to four years to kill a tree, according to the size of the tree and the point of attack. The average length of life of a diseased tree is three years. Trees killed by this disease sprout readily from the trunks and roots, but the sprouts are in turn infected and killed.
 - (3) All species and varieties of chestnut now grown in this country are subject to the disease, except the Japanese and Korean varieties, which are resistant. The Japanese and Korean chestnuts are small trees, fair nut producers, but probably valueless for timber. No other species of trees have as yet been parasitized by the fungus, but it is not impossible that other species, such as oaks and walnuts, may later become attacked.
 - (4) The disease is spread by the spores of the fungus, which are sticky in character. They are probably not diffused by wind to any appreciable extent, but are spread by rain, insects, probably also by birds, small mammals such as squirrels, and by man. Unbarked timber and cordwood from diseased trees and diseased chestnut

nursery stock may carry the disease bodily for great distances. The majority of infections take place through wounds made by bark-borers. The relation of insects to the disease appears to be very intimate.

(5) The origin of the disease is unknown. Its obvious spread from a center—the vicinity of New York City—suggests that it is not a native disease; and the resistance of Asiatic species of chestnut to the disease suggests that it may have been imported from Asia with the Japanese chestnut. No evidence has been secured to connect the considerable losses of chestnut timber in the Southeastern States in past years with this disease; these losses were more probably due to attacks of insects.

(6) The disease was first called to public attention in 1904, but it probably had already been present on Long Island for some years.

(7) The value of the chestnut stand is variously estimated at between three hundred and four hundred million dollars. This disease has already caused an estimated minimum damage of \$25,000,000.

(8) Judging by the history of the disease to date, it may be expected to spread throughout the range of the chestnut tree during the next two years, unless checked by human effort. Whatever is done to control the disease by any methods known at present must be attempted immediately, else the disease will be beyond control by any effort ever likely to be put forth.

(9) As shown on the accompanying map (Pl. I), the disease is now known to occur in at least 10 States, viz: Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, and Virginia. In all of Connecticut, New Jersey, and Delaware, and in western Massachusetts, eastern New York, eastern Pennsylvania, and northeastern Maryland, the chestnut trees are already generally infected, and a large per cent are already dead.

(10) Outside of this area of general infection the disease occurs at scattered points ("advance infections"). These consist mostly of single infected trees, or small groups of trees, often many miles apart.

(11) Analogy with pear blight and peach yellows and with animal and human diseases that are controlled by destruction or isolation of the foci of infection suggests early destruction of the advance infections as the only possible means of controlling the disease or limiting its range. There is no contagious disease known that does not yield to sanitation and quarantine. The destruction of diseased trees can not possibly be an effective means of control, however, in localities where the disease has already become general.

This method of destroying advance infections has been employed extensively by private owners to check the progress of the disease in their own holdings. But since general cooperation is necessary to make any sanitation finally effective, it appears necessary to organize private effort under State control. This has already been done in Pennsylvania under special law, and is about to be done in Virginia under special law; and under the general laws now existing, in West Virginia and probably some other States. This department indorses the work of these States, and particularly the early and vigorous action of Pennsylvania.

(12) Results to date indicate the following lines of activity as desirable and necessary to be carried out by this department and the various States in cooperation:

(a) The determining of the exact range of the disease, and the locating and cutting out of all advance infections. This work to be done in Virginia, West Virginia, western and probably southern Maryland, Ohio, western Pennsylvania, central and western New York; possibly also in Kentucky, Tennessee, and North Carolina, following the methods now employed by the Chestnut Blight Commission of Pennsylvania. In all localities, and particularly in those States where no State quarantine of any sort is contemplated, it will be necessary to instruct private owners regarding the disease in order that they may take such measures as they see fit to protect their own property.

(b) The careful inspection of all nurseries containing chestnut trees, and all chestnut nursery stock.

(c) Determining by extensive local investigation the best methods of rapidly utilizing and marketing the timber of trees dying and dead from this disease, in order to protect timber owners against total loss, and to reduce infection. This work to be done in all localities where infection is already general.

(d) Determining what changes in general forest management are necessary in those localities where the chestnut tree is already doomed, and so far as practicable putting such changes immediately into practice.

(e) Continuing experiments on tree surgery and tree medication, in the hope of saving valuable orchard and ornamental trees. Any positive results from this line of work will also be applicable to other tree diseases, including those of fruit trees.

(f) Continuing search for a resistant American stock, and breeding from resistant Asiatic stock, in order particularly to rehabilitate the chestnut-orchard industry; at the same time breeding also for timber trees. Results of the greatest value to the chestnut-orchard industry can not fail to be secured from this line of work.

(g) Making careful studies of the many unsolved scientific problems involved in the disease. Some of the more important of these are: The relation of the disease to climate; the relation of the parasite to the varying tannin content of the tree; the origin of the disease; the relation of birds and insects to the distribution of the disease; the nature and degree of resistance in the Asiatic varieties.

(h) Determining in detail the relation of the disease to the future of the chestnut timber in the proposed Appalachian Forest Reserves, and making special effort to keep the disease out of this territory.

With the exception of about \$400, expended by the Forest Service in 1908 in the work set forth in the inclosed circular by E. R. Hodson, all expenditures have been made in the Bureau of Plant Industry. The amount thus far expended in this study and investigation is \$14,885.96 (estimated), which is itemized as follows:

For the fiscal year ending June 30, 1908 (estimated).....	\$350. 00
For the fiscal year ending June 30, 1909.....	1, 365. 81
For the fiscal year ending June 30, 1910.....	1, 814. 27
For the fiscal year ending June 30, 1911.....	2, 210. 51
For the fiscal year 1912, to date (estimated).....	9, 145. 37
Total.....	14, 885. 96

I have the honor to be, sir, your obedient servant,

JAMES WILSON, *Secretary.*

THE IMMUNITY OF THE JAPANESE CHESTNUT TO THE BARK DISEASE.

By HAVEN METCALF, *Pathologist in Charge of the Laboratory of Forest Pathology.*

THE EXTENT OF THE BARK DISEASE.

The bark disease of the chestnut, caused by the fungus *Diaporthe parasitica* Murrill, has spread rapidly from Long Island, where it was first observed, and is now reported from Connecticut, Massachusetts, Vermont, New York as far north as Poughkeepsie, New Jersey, Pennsylvania, and possibly Delaware. It is no exaggeration to say that it is at present the most threatening forest-tree disease in America. Unless something now unforeseen occurs to check its spread the complete destruction of the chestnut orchards and forests of the country, or at least of the Atlantic States, is only a question of a few years' time.

AN IMMUNE VARIETY.

Observations made by the writer during the past year indicate that all varieties and species of the genus *Castanea* are subject to the disease except the Japanese varieties (*Castanea crenata* Sieb. and Zucc.). All of the latter that have been observed in the field or tested by inoculations have been found immune. This fact can hardly fail to be of fundamental importance to the future of chestnut nut culture. Although the nuts are distinctly inferior in flavor to the European varieties, such as Paragon, the Japanese chestnut is already grown on a large scale as a nut-producing tree. There are, however, many trade varieties of dubious origin. Some of these may prove later to be subject to the disease. Immunity tests of all known varieties of chestnuts have been undertaken.

Attempts will also be made to hybridize the Japanese with American and European varieties, with the hope of combining the immunity of the former with the desirable qualities of the latter.

However excellent as a nut and ornamental tree, the value of the Japanese chestnut as a forest tree is doubtful. It can be recommended only experimentally at present for forest planting. It certainly will not take the place of the American chestnut. The tree is said to attain a height of 50 or 60 feet in Japan. As seen in this country, it is a handsome tree, dwarfish and compact in habit, and rather slow growing. It has hardly had time to show how large it can grow.

The immunity of the Japanese chestnut, together with the fact that it was first introduced and cultivated on Long Island and in the very locality from which the disease appears to have spread, suggests the interesting hypothesis that the disease was introduced from Japan. So far, however, no facts have been adduced to substantiate this view.

[Reprint of Forest Service unnumbered circular, issued Oct. 21, 1908.]

EXTENT AND IMPORTANCE OF THE CHESTNUT BARK DISEASE.

By E. R. HODSON.

INTRODUCTION.

Three years ago a destructive fungous disease of the chestnut first attracted attention and almost immediately assumed the character of an epidemic. It seems to be one of the most serious diseases which has ever attacked an American forest tree, and has done great damage locally in and around New York City, and is now spreading rapidly in all directions to forest tracts in Connecticut, New York, New Jersey, and even into Pennsylvania.

The disease was first studied by Dr. W. A. Merrill, of New York, and during the past 18 months it has been under investigation by Dr. Haven Metcalf, of the Bureau of Plant Industry. The technical details given in this circular have been derived chiefly from the publications of the former and information supplied by the latter.

MANNER OF INFECTION.

The disease is caused by a fungus known as *Diaporthe parasitica* or *Valsonectria parasitica*, the spores of which enter the tree through wounds on branches or trunk. Dead twigs also offer a means of entrance, and there are probably other ways, not yet known, by which the trees become infected.

From the point of entrance the fungus spreads in all directions throughout the cambium and inner bark until it completely girdles the branch or trunk it has attacked. It has been found that a few of the outer annual rings of the wood are also attacked, and it is very likely that the fungus penetrates some of the medullary rays in search of the food material which they contain; but the real seat of the injury is the inner bark and the growing layer of the wood.

SYMPTOMS.

When a tree is first attacked the disease is not noticeable, and is likely to be overlooked. In many instances the trees are attacked first on the smaller branches. These are soon girdled, and the foliage turns yellow and then wilts. By these wilted branches the disease can be detected from a distance. The girdled branches or trees do not usually die until the second year, except when they are attacked very early in the season, or when the infected limbs are small.

On limbs with smooth bark the diseased patches are sunken and discolored, with small brownish or yellow knobs scattered over the

surface. On the edge of the affected area in the growing season there is a ring of greenish, yellowish, or bright yellow excrescences which resemble horns and are very conspicuous, so that in young trees the disease is easily detected even before the branches wilt. In very dry weather, however, these horns may be nearly or entirely suppressed. Where the bark is thick, as on large trees, it is not changed in appearance, but the brownish knobs of the fruiting bodies show in the cracks, and the bark sounds hollow when struck.

On account of its rapid action in killing or wilting small branches, the disease can not remain long undetected if the trees are under inspection. At the end of a single year the disease has usually made its presence conspicuous by a large number of dead and dying trees.

LOCALITIES AFFECTED.

In 1905 the disease had already spread over a considerable area around New York City, where it apparently originated. In the present year it is spreading rapidly in a westerly direction over northern New Jersey, where in Morris County large tracts have recently been attacked. New York City is about the center of the infected area. Last year the chestnut tracts in Westchester and Nassau Counties in New York, Fairfield County in Connecticut, and Bergen County in New Jersey were severely attacked, and now Morris Essex, and Monmouth Counties, N. J., can be added.

In Connecticut the disease is very severe at Stamford. It has been found near Danbury and Waterbury, and is known to extend along the coast to New London. It is also reported in southeastern Massachusetts and as far north as Wellesley.

On Long Island it is common in the western part and along the northern shore to Huntington. It is likely that it occurs on the island wherever there is chestnut, although it has not yet been reported from the eastern end. It extends up the Hudson to Poughkeepsie, and across the river to the west; it has been found, though not in great abundance, at Turner and Warwick, and has been reported at Marlborough. Near the Connecticut line it occurs as far north as Pawling and is very destructive from Katonah all the way southward to New York City.

In New Jersey the disease is very abundant in the northern and eastern parts, particularly near the coast in Bergen, Essex, and Monmouth Counties. Southward it is found along the Delaware River to Trenton, and abundantly along the coast near Chapel Hill and Eatontown in the northern part of Monmouth County. Recently a belt around Morristown and German Valley has become badly infected, and the disease has been discovered in wild trees at Newark and Fenton, Del., and at various points near Philadelphia, Pa. In Pennsylvania it is nowhere abundant yet, although it exists at Easton, South Bethlehem, and Morrisville, and is reported as far north as the Pocono Mountains and as far south now as Philadelphia. It has also been found near Baltimore, Md., and in Bedford County, Va.

The range at present, then, includes eight States: Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and Massachusetts. Pennsylvania, so far as known, is not infected to any great extent, except in the eastern border, while Massachusetts, Maryland, and Virginia are touched only at one or two points.

HOW THE DISEASE SPREADS.

The yellow fruiting bodies so common on the diseased trees are constantly giving off millions of summer spores all through the growing season. These are transported by various agencies to healthy trees, where they gain entrance through wounds in the bark. Wind is probably the principal agency, but the spores are no doubt carried by animals, birds, insects, and by shipment of infected material.

The disease spreads locally through the gradual distribution of the spores from tree to tree, and at a distance chiefly through the shipment of infected material, such as nursery stock, bark, nuts, and other products. There is a possibility that long-distance infection is also effected by means of migratory birds.

There are a number of facts which support the view that the wind has been the principal agency in spreading the disease over the present area. For instance, trees in open spaces exposed to winds, such as those along roads, at the edges of woods, or near streams or ponds, are apt to be infected sooner than the trees in more sheltered situations; trees on slopes or in depressions with diseased trees on higher ground near them usually become infected, evidently because they have been exposed to the wind-scattered spores from above; and in thinned stands, if the disease is present in the neighborhood, almost every chestnut becomes affected. In this instance the frequency of wounds is probably a large contributory cause. Dense woods, as a rule, act as a bar to the progress of the infection, except where the disease is very prevalent in the vicinity, in which case nothing seems to check its spread.

AMOUNT OF DAMAGE.

The amount of loss caused by this disease is especially great, because it has developed in a region where the chestnut trees are extensively used for ornamental and park purposes. For this reason the losses have been acutely felt. There is, of course, no satisfactory basis for estimating the value of trees which are useful chiefly for æsthetic purposes, but the loss is certainly several million dollars.

In Prospect Park, Brooklyn, there are but 6 chestnut trees left alive out of 1,400. In Forest Park, at Jamaica, Long Island, practically all the chestnut trees are diseased and many are dead. The same applies to Bronx Park in New York City. In Nassau County, in western Long Island, few chestnut tracts have escaped serious damage. In Westchester County, N. Y., it is apparently only a question of a short time when nearly all the chestnuts will be destroyed. Many estates have sustained losses in scenic beauty which it is impossible to estimate. In the part of New Jersey adjacent to New York City the damage has been of the same character; parks and country estates have lost large number of fine chestnut trees which would not have been sold at any price.

Although so far the injury to ornamental trees has attracted the most attention, the damage is not confined to these alone. Indeed, a far more serious phase of the epidemic is the menace to commercial forest tracts. Already many large tracts in at least five States have been attacked, and though great damage has been done in certain localities, it is very small compared with what it will be if the disease continues to spread.

A favorable feature in the situation is that so far the disease has done most damage in the vicinity of the sea, and there are some indications that back from the sea, where there is less atmospheric moisture, it may be less virulent and may spread less rapidly.

The damage which would result from the destruction or extensive depreciation of the commercial chestnut forests would be many times that from the loss of ornamental trees. Chestnut is one of the most rapidly growing and most useful of American forest trees, and it plays a very important part in the forests of the eastern United States. The wood is exceedingly durable and has, therefore, been extensively used for posts, poles, and railroad ties, while its grain, color, and ease of working give it a place among furniture and finishing woods. It is, moreover, a very vigorous sprouter and lends itself admirably to forest management. With the exception of white pine, chestnut probably makes the most profitable timber crop that can be grown in the northeastern part of the United States.

UTILIZATION OF DEAD AND DISEASED TREES.

Since the fungus does not work in the wood to any extent and ceases its activities when the tree is dead, the wood is not damaged as a result of the disease. In many cases only a part of the tree is affected, while the rest is healthy and can be utilized without difficulty.

Dead trees are looked upon with suspicion, especially if they are killed by a disease, and the wood is popularly thought to be weaker than seasoned live timber. In the case of this fungus there is no ground for such a prejudice; as a matter of fact, the dead material is fully as strong as any other timber if it is utilized within a few years, before the ordinary agencies of decay cause it to deteriorate.

In most of the places where the disease prevails the problem of cutting and marketing small amounts is a difficult one. The damage from the disease is sudden, and it is often hard to find a market on short notice, especially for small quantities.

In order to market the material, owners should encourage the contractors and pole buyers, who as a class are also vitally interested in the perpetuation of the chestnut, to go into sections where the disease is doing damage. Where the tracts are large enough or several are located close together, a portable sawmill might be put in. Where the quantity of chestnut is small, the best disposal is for ties, cordwood, and fence posts. Owners of small tracts where the disease has appeared can often cooperate to great advantage in order to find a market or make a lumbering operation possible.

MEASURES OF PREVENTION.

The chestnut-bark disease is not like ordinary fungous diseases, which destroy a tree here and there after a number of years; it is even more virulent than the well-known pear blight, which it resembles in many particulars. It destroys quickly and spreads rapidly, and it is of the utmost importance to those who are interested in chestnut forests to secure a means of checking or stamping it out and of preventing its spread to localities which are as yet unaffected.

Seedlings and sprouts are attacked with equal virulence and old and young trees are killed alike. There is therefore no system of

forestry which can be used to control the disease. Two methods of checking its spread and lessening the source of the infection are available:

1. To cut out the diseased trees.
2. To institute a quarantine against the shipment of infected material.

In a forest tract the diseased trees should be cut outright—all trees which show the least sign of infection should be removed. In other situations, where the trees have a peculiar value, it may be possible to save them by cutting off the diseased parts only; but if the trunk of a tree is attacked, the whole tree, no matter how valuable it is, should be cut at once, for it is practically useless to try to save it.

Since the disease generally spreads less rapidly in dense stands than in thin ones, it will often be possible, by close inspection and the prompt removal of infected trees, to stamp out the disease altogether from a forest tract. For the same reason, however, if many diseased trees are to be removed and their removal would make the stand very open, it will often be better to make a clean cut of all the chestnut.

All diseased bark should be removed and burned. After that is done the wood is practically free from infection and can be used or stored with safety.

Even greater effort should be directed toward preventing the spread of the disease to localities which are as yet unaffected than to stamping it out in places where it already has a firm hold.

For this reason definite legislation seems necessary, and it is very desirable that each State concerned should enact a law providing for a quarantine against infected chestnut products, chiefly nursery stock. The law should also provide for systematic and thorough inspection of the disease and require the cutting out of infected trees wherever they are a menace to healthy stands of chestnut.

The nature of the disease and the necessity of fighting it should be made known to the people throughout the region affected by means of the press and by enlisting the aid of the granges and other organizations interested.

It is to be hoped that some natural limitation to the destructiveness of the disease may be found and that it may be checked by natural causes. But its rapid spread and its great virulence make waiting dangerous. Prompt and energetic measures should be taken to stamp it out wherever it appears.

THE PRESENT STATUS OF THE CHESTNUT BARK DISEASE.

By HAVEN METCALF, *Pathologist in Charge*, and J. FRANKLIN COLLINS, *Special Agent*,
Investigations in Forest Pathology.

HISTORY OF THE CHESTNUT BARK DISEASE.

In 1904 Mr. H. W. Merkel, of the New York Zoological Park, observed a disease which was destroying large numbers of chestnut trees in the city of New York. This disease is what is now known as the chestnut bark disease. Even at that time it is certain that it had spread over Nassau County and Greater New York, and had found lodgment in the adjacent counties of Connecticut and New Jersey. No earlier observation than this is recorded, but it is evident that the disease, which would of necessity have made slow advance at first, must have been in this general locality for a number of years in order to have gained such a foothold by 1904. Conspicuous as it is, it is strange that the fungus causing this disease was not observed or collected by any mycologist until May, 1905, when specimens were received from New Jersey by Mrs. F. W. Patterson, the Mycologist of the Bureau of Plant Industry. In the same year Dr. W. A. Murrill began his studies of the disease, publishing the results in the summer of 1906. By August, 1907, specimens received by this bureau showed that the disease had reached at least as far south as Trenton, N. J., and as far north as Poughkeepsie, N. Y., and was spread generally over Westchester and Nassau Counties, N. Y., Bergen County, N. J., and Fairfield County, Conn.

PRESENT DISTRIBUTION.

The present distribution of the chestnut bark disease is shown on the accompanying map (fig. 1). By this it will be seen that infection is now complete in the general vicinity of the city of New York. Outside of this area the disease already occurs at scattering points in a number of States. In every case its occurrence has been definitely authenticated by specimens which have been examined microscopically. Reports have been received indicating that the disease is found at many other places, but not being substantiated by specimens these localities have not been shown on the accompanying map. It is only fair to state, however, that such reports have been received from points as remote as Cape Cod, Wellesley, and Pittsfield, Mass.; Rochester and Shelter Island, N. Y., and Akron, Ohio.

The bark disease is entirely different from a disease which during the past 20 years has caused the death of many chestnut trees on the Atlantic slope, particularly south of the Potomac River. The latter disease, which is now being studied by the Department of

Agriculture, is associated with insects, is much slower in action than the bark disease, and produces a stag-headed condition of the tree. It can be quite confidently stated that the bark disease does not yet occur south of Virginia and at only a few points in that State.

Investigations are in progress to determine the origin of the bark disease in America and the details regarding its spread. The theory advanced in a previous publication of this bureau,¹ that the Japanese chestnuts were the original source of infection, has been strengthened by many facts. It yet lacks much of demonstration, however, and is still advanced only tentatively.

While the disease has spread principally from the vicinity of New York there is much to indicate that it occurred at other points at an early date. Chester's *Cytospora* on a Japanese chestnut, noted at Newark, Del., in 1902, may have been the bark disease. Observations by the junior writer indicate that this disease may have been present in an orchard in Bedford County, Va., as early as 1903, and that in Lancaster County, Pa., it probably was present as early as 1905. All other points shown on the map outside of the area of general infection appear to have been infected only within one or two years.

The bark disease appears practically to exterminate the trees in any locality which it infests. A survey of Forest Park, Brooklyn, showed "that 16,695 chestnut trees were killed in the 350 acres of woodland in this park alone. Of this number about 9,000 were between 8 and 12 inches in diameter, and the remaining 7,000 or more were of larger size."

In a recent publication Dr. W. A. Murrill estimates the financial loss from this disease "in and about New York City" at "between five and ten million dollars." The aggregate loss throughout the whole area of country affected must be much greater.

The bark disease occurs on both chestnut and chinquapin, regardless of age, origin, or condition. It does not occur on any other tree so far as known. All reports of its occurrence on the chestnut oak (*Quercus prinus*) have proved to be unfounded. It is not yet known whether the goldenleaf chinquapin of the Pacific coast (*Castanopsis chrysophylla*) is subject to this disease.



FIG. 1.—Map of the eastern portion of the United States, showing the distribution of the chestnut bark disease. The heavily shaded part shows the counties wherein infection is already complete. The round dots show other points where the disease is positively known to occur.

¹ Bureau of Plant Industry, U. S. Department of Agriculture, Bulletin 121, Pt. VI. 1908.

According to Sudworth, the range of the native chestnut is "from southern Maine to northwestern Vermont (Winooski River), southern Ontario, and southern shores of Lake Ontario to southeastern Michigan; southward to Delaware and southeastern Indiana, and on the Allegheny Mountains to central Kentucky and Tennessee, central Alabama, and Mississippi." The range of the chinquapin is "from southern Pennsylvania (Adams, York, Franklin, and Cumberland counties) to northern Florida and eastern Texas (Neches River)." The bark disease may, therefore, be expected to occur at any point within these limits, as well as in any other localities where the chestnut is grown as an ornamental or orchard tree.

CAUSE AND SYMPTOMS.

The disease is caused by the fungus *Diaporthe parasitica* Murrill (also known as *Valsonectria parasitica* (Murrill) Rehm). The spores of this fungus, brought by some means from a previously diseased tree, enter the bark through wounds; possibly also in other ways. The leaves and green twigs are not directly affected. From the point of infection the fungus grows in all directions through the inner bark until the growth meets on the opposite side of the trunk or limb, which in this way is girdled. The wood is but little affected. Limbs with smooth bark attacked by the fungus soon show dead, discolored, sunken patches of bark covered more or less thickly with the yellow, orange, or reddish-brown pustules of the fruiting fungus. In damp weather or in damp situations the spores are extruded in the form of long irregular "horns," or strings, at first greenish to bright yellow in color, becoming darker with age. Plate XVII, figure 3, shows a part of a branch of a diseased chestnut tree magnified $3\frac{1}{2}$ diameters. In this illustration the typical appearance of the pustules in damp weather and the projection of the spores of the fungus in the form of "horns," or threads, are shown. These threads may be especially conspicuous near the edges of diseased areas. If the spot is on the trunk or a large limb with very thick bark there is no obvious change in the appearance of the bark itself, but the pustules of the fungus show in the cracks of the bark and, on account of the destruction of the layers beneath, the bark often sounds hollow when tapped. A patch usually grows fast enough to girdle the branch or trunk that it is on during the first summer.

The damage may not be immediately apparent, since the water supply from the roots continues to pass up through the comparatively uninjured wood to the leaves, but when in the following spring the new leaves are put out they are usually stunted and soon wither. The appearance of such trees is very characteristic. Plate XVII, figure 1, shows large chestnut trees killed by the bark disease. In this illustration the trees to the left show the characteristic stunted foliage, which indicates that they were girdled during the previous year, while the tree on the right having no foliage was presumably girdled by the fungus at least two summers before the photograph reproduced was taken. Plate XVII, figure 2, shows an orchard tree with recently girdled branches. Nothing else except an actual mechanical injury—breaking off of trunk or limb—produces such an effect as is shown in these illustrations. The imperfectly developed leaves often persist on the dead branches throughout the summer.

The great damage which the disease has done thus becomes most apparent in the last week of May or the first week in June, giving rise to the false but common idea that the fungus does its work at this time of the year, when in reality the harm is done during the previous summer. If the first attack is on the trunk, of course the entire tree dies. If, on the other hand, the small branches are first involved, the tree may live for several years.

It is very easy for a person not familiar with fungi to confuse this parasite with various other fungi which occur commonly on the dead wood of chestnut and other trees, such as species belonging to the genera *Calocera*, *Cytospora*, and *Cytosporina*. The superficial resemblance is sometimes very strong, but a microscopical examination instantly reveals the true nature of the organism in question. On account of this common confusion no dependable diagnosis of the bark disease can be made in a new locality without a microscopical examination of specimens by an expert.

RESTRICTION OF SPREAD.

HOW THE FURTHER SPREAD OF THE BARK DISEASE MAY BE LIMITED.

BY THE INSPECTION OF DISEASED NURSERY STOCK.

It becomes more and more evident as this disease is studied that diseased nursery stock is the most important factor in its spread to distant points. In that part of the country where it is already well established in the native chestnuts its progress is rapid and sure, but there is no evidence at present that it is able to pass to remote districts, tens or hundreds of miles away, except on diseased nursery stock. Of course it is conceivable that the spores are carried by birds. Such distribution would, however, follow in general the great lines of bird migration north and south and hence would not be an important factor in the western spread, except locally. During the summer of 1908 nearly every chestnut nursery and orchard of importance in the Atlantic States north of North Carolina was visited, and very few were found free from the bark disease. Several cases were observed where the disease had obviously spread from the nursery to adjacent wild trees. This is the only way in which the disease is likely to spread beyond the Alleghenies.

It is therefore obvious that every State in which the chestnut or chinquapin grows should as speedily as possible pass a law putting the chestnut-bark disease on the same footing as other pernicious diseases and insect pests, such as the San Jose scale, against which quarantine measures are taken. The Department of Agriculture will be glad to give detailed suggestions or advice regarding the framing of such laws. Inspectors who already have legal power to quarantine against this disease should now take special care that no shipment of chestnut stock escapes their rigid inspection.

A campaign of education should also be undertaken by pathologists and inspectors in every State in order to acquaint the public with the nature and appearance of the bark disease, so that it may be quickly recognized and stamped out in any particular locality in which it appears. The Department of Agriculture will cooperate in the following ways: Specimens from suspected trees sent in by any

person will be promptly examined and the presence or absence of the disease reported. Typical specimens showing the disease (with the fungus previously killed by soaking in formalin to insure against any infection from this source) will be sent upon application to any inspector, forester, pathologist, or other State or experiment station officer, to any nurseryman or orchardist growing chestnuts, or to any botanist or teacher of botany. So far as the supply permits lantern slides and photographs will, upon application, be loaned for special lectures, exhibits, etc., to the officers of States, experiment stations, or colleges. By these means the inspectors first, and then the general public, may become familiar with the appearance and work of the disease in localities that it has not yet reached, and when it does appear may be able to recognize it before it is too late to take efficient measures against it.

Although its present distribution is that shown by the map (fig. 1), the bark disease may be confidently looked for in any orchard or nursery in the United States that contains chestnut trees. All such places should therefore be rigidly inspected at the earliest possible date.

BY THE PROMPT DESTRUCTION OF DISEASED TREES.

When the bark disease is first noticed in any locality all the affected trees should be immediately cut down unless, as in the case of orchard and some few ornamental trees, they are of sufficient individual value to warrant special treatment. Diseased trees if untreated are doomed to death in any case. If permitted to stand, every such tree becomes a center of infection, certain to spread the disease to all neighboring trees, and so long as it will soon die if left to itself the sooner it is cut down the better.

When cut, the brush should be immediately gathered and burned in order to destroy the fungus in the bark. Whenever the bark is removed from the trunk—as, for example, when the trees are to be used for poles—it should be immediately burned with the brush. Even when the tree is to be used for firewood an effort should be made to cut off at least all the diseased patches of bark on the trunk and large limbs when the tree is cut and to burn this bark along with the brush; otherwise the brush and the piled wood will continue to spread infection, since it has been found that the fungus continues alive on dead bark for at least six months after cutting.

Sprouts arising from the stumps of cut trees will be free from the disease for the first year at least, but must then be carefully inspected to be sure that no infection has persisted.

BY THE TREATMENT OF DISEASED TREES.

During the past two years the Office of Investigations in Forest Pathology has been conducting certain experiments and collecting information in regard to the best methods of treating diseased trees.

At present it is impossible definitely to record general beneficial results from any of the sprayings which have been undertaken or have been under observation. This may in part be due to the fact that it is yet too early to judge satisfactorily all the results and in part, perhaps, to the infrequency of sprayings.

Observations and experiments seem to bear out the statement that it is very improbable that any method of spraying can interfere with the growth of the fungus if it has once established itself in the inner bark, but it may be of considerable importance in preventing the development of spores which come from other trees or from other parts of the same tree.

It has already been demonstrated that the crotches of branches and enlarged bases of sprouts are very susceptible to infection because they are favorable places for the lodgment of water, dust, spores, etc. In a large majority of cases infections are definitely known to have originated at a point where the outer bark had been injured in some way, leaving the inner living bark exposed, or where the entire bark over a more or less limited area had been stripped from the tree or cracked and split away from the wood. Certain injuries which are known to have afforded entrance for the disease have been of such a nature that they might easily be overlooked, while others have been quite obvious, even to the careless observer. Among the latter may be mentioned broken limbs, split limbs, branches which have been carefully cut but not properly treated with tar or paint, bruises from hoes, plows, and cultivators; also poor grafts and diseased grafting scions. Among the former may be included bruises from boot heels, climbing spurs, holes made by borers and other insects, knife and saw cuts, and frost cracks.

Almost the only treatment that can at present be safely recommended as surely retarding the spread of the disease to a greater or less extent is one which will never be of practical use except in the case of orchard trees or certain valuable ornamental trees. It consists essentially in cutting out the infected branches or areas of bark and carefully protecting the cut surfaces from outside infection by means of a coat of paint or tar. This cutting must be thoroughly done and the bark of every infected place entirely removed for a distance of at least an inch (where the size of the branch permits) beyond the characteristic, often fan-shaped, discolored areas produced by the growing fungus in the inner bark. All small infected twigs or branches should be cut from the tree, the cut being made well back of the diseased area. A pruning knife with an incurved tip, a hollow gouge, or any other clean-cutting instrument will serve for cutting out diseased spots. So far as the exigencies of the case will permit, all borers' holes should be cut out. It has been repeatedly observed in the field that infection often starts where borers are at work, or even at the old holes made by them. The paint or tar may be applied by means of a good-sized brush, care being taken to cover every part of the cutting. Treatment should begin, or observations at least, at the base of the tree and the fact ascertained whether the disease has already girdled the trunk. If such is the case it will be a waste of time to attempt any treatment; instead, cut the tree down at once. A rigid watch must be kept, especially during the growing season, for new infections or infections which were overlooked in the earlier examinations, and if any are observed they must be treated promptly as above mentioned. Constant vigilance is necessary to keep the disease in check. It is suggested that examinations be made about June 1, July 15, and September 1. During a very rainy or foggy season, when conditions are particularly favorable for the growth of fungi, it may be advisable to inspect as often as once a month.

In regions in which the disease is so widespread that almost every tree is infected, as, for instance, within 25 miles of the city of New York, it is extremely doubtful whether any individual treatment will pay. Under such conditions immediate reinfection is almost sure to occur at one or more of the small unnoticed abrasions or injuries which are quite certain to exist on most trees. In a region, however, where only isolated cases have yet appeared it is quite possible to stamp out the disease, or at least to prevent its rapid spread, by promptly cutting out and carefully burning all diseased bark and limbs, thus destroying these new sources of infection. If a tree is too badly infected to be worth treating it should not be left standing, for it will then become a continual menace to all surrounding chestnuts.

The Office of Investigations in Forest Pathology asks the cooperation of all persons who have observed the disease or experimented with it in any way. If such people will send in an early report of the kind of treatment used, time of treatment, methods employed, and results obtained (even if adverse), it may be possible to arrive at an earlier and more definite conclusion in regard to the possibilities or impossibilities of control than would otherwise be the case.

CONCLUSIONS.

It is to be hoped that in the economy of nature some limiting factor will arise to check the spread of the bark disease before it has wrought the same destruction throughout the country that it already has in the vicinity of New York. But at present there is nothing in sight that promises even remotely to check its spread into new territory except the general adoption of the measures advocated in these pages. It can not be argued that because of its apparently recent origin and rapid spread it will soon disappear of itself. Such diseases as pear blight and peach yellows have been in the country for more than a century and yet show no sign of abating except when actively combated by modern quarantine methods. Nor can any conclusions be drawn from the fact that chestnuts in the Southern States have suffered from a disease during the past twenty years, since, as already stated, that is a totally different thing from the bark disease.

Where the bark disease is already firmly established and has attacked 50 per cent or more of the chestnut trees, as in the vicinity of the city of New York, it is probably too late to try to do anything, but where the disease is just appearing there is no reason to doubt that strict quarantine methods will apply as well to this as to any other disease, whether of plants or animals. The question to settle is simply which is more costly—to use the methods recommended or to lose the trees. The people concerned must decide.

THE CONTROL OF THE CHESTNUT BARK DISEASE.

By HAVEN METCALF and J. FRANKLIN COLLINS.

THE DISEASE.

HISTORY AND DISTRIBUTION.

The chestnut bark disease was first recognized as a serious disease in the vicinity of New York City in 1904, and the first publication regarding it appeared in 1906. There is reliable evidence, however, that it was present on Long Island at least as early as 1893. Its origin is unknown, but there is some evidence that it was imported from the Orient with the Japanese chestnut. This view is not, however, held by all investigators. But whatever may have been its time or place of origin, it is certain that it has now spread into at least 10 States, as is shown by the accompanying map (fig. 2). In the vicinity of New York City and through adjacent counties it has killed practically all chestnut trees. Throughout a much larger neighboring area, as shown in figure 2, practically all chestnut trees are infected. Outside of this area, throughout the country from the northern border of Massachusetts and from Saratoga County, N. Y., to the western border of Pennsylvania and the southern border of Virginia, scattering areas of infection are known to occur and may be expected at any point.

So far as is now known, the bark disease is limited to the true chestnuts—that is, to the members of the genus *Castanea*. The American chestnut, the chinquapin, and the cultivated varieties of the European chestnut are all readily subject to the disease. Only the Japanese and perhaps other east Asian varieties appear to have resistance. In spite of popular reports to the contrary, it can be quite positively stated that the bark disease is not now known to occur on living oaks, horse-chestnuts, beeches, hickories, or the golden-leaf chinquapin (*Castanopsis chrysophylla*) of the Pacific coast.

FINANCIAL LOSSES.

The bark disease appears ultimately to exterminate the chestnut trees in any locality which it infests. A survey of Forest Park (Brooklyn) showed "that 16,695 chestnut trees were killed in the 350 acres of woodland in this park alone. Of this number, about 9,000 were between 8 and 12 inches in diameter, and the remaining 7,000 or more were of larger size." Three years ago the financial loss from this disease "in and about New York City" was estimated at "between five and ten million dollars."

The writers regard \$25,000,000 as a conservative estimate of the financial loss from this disease up to 1911. In many localities the greatest damage has been among chestnuts grown for ornamental purposes, which have a value greatly in excess of their value as lumber. Depression in the value of real estate, especially suburban or near-suburban, owing to the death of the chestnut trees, must be taken into account in an estimate of this kind, as well as the loss of the trees themselves.

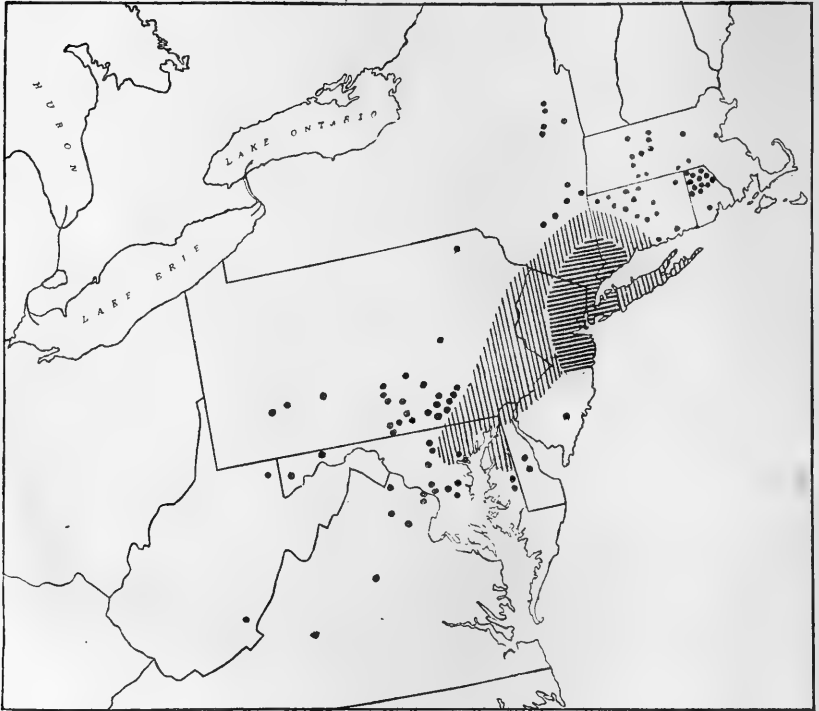


FIG. 2.—Map of the northeastern part of the United States, showing the distribution of the chestnut bark disease. The horizontally lined part shows the approximate area wherein the majority of chestnut trees are already dead from the bark disease. The part marked by vertical lines shows the approximate area wherein infection is already complete. The round dots show the location of advance infections of the disease. Many of these have already been eradicated. The map has been compiled from both observations and correspondence. The writers are under especial obligations to Dr. Perley Spaulding, Prof. A. H. Graves, Mr. I. C. Williams, Mr. W. H. Rankin, Mr. J. F. O'Byrne, Mr. F. W. Besley, Dr. Ernest S. Reynolds, and Mr. H. G. MacMillan, for data along this line. According to Dr. G. P. Clinton (Connecticut Agricultural Experiment Station, Report of the Botanist, 1909 and 1910) there are many more points of infection in Connecticut than are shown on this map.

CAUSE AND SYMPTOMS.

The chestnut bark disease is caused by a fungus parasite known under the technical name of *Diaporthe parasitica* Murrill. When any of the microscopic spores (reproductive cells) of this fungus gain entrance into any part of the trunk or limbs of a chestnut tree they give rise to a spreading "sore" or lesion, which soon girdles the tree. If the part attacked happens to be the trunk, the whole tree in consequence is killed, perhaps in a single season. If the smaller branches are attacked, only those branches are killed, or only those portions of

branches beyond the point of attack, and the remainder of the tree may survive for several years (fig. 3).

Some of the symptoms are quite prominent. Limbs with smooth bark attacked by the fungus soon show dead, somewhat discolored, sunken areas (occasionally with a raised margin), which continue to enlarge and soon become covered more or less thickly with yellow, orange, or reddish-brown spots about the size of a pinhead. These spots are the pustules of the fruiting fungus. In damp weather or in damp situations, masses of summer spores are extruded in the form of long, irregularly twisted strings or "horns," which are at first bright yellow to greenish yellow or even buff, becoming darker with age (Pl. XVII, fig. 3). If the lesion is on the trunk or a large limb with very thick bark, there is no obvious change in the appearance of the bark itself, but the pustules show in the cracks and the bark often sounds hollow when tapped. After smooth-barked limbs or trunks are girdled the fungus continues to grow extensively through the bark, sometimes covering the entire surface with reddish-brown



FIG. 3.—Large chestnut tree partly killed by the bark disease. Note the sprouts with leaves near the top, the dwarfed leaves on the lower right-hand limb, and the healthy lower branches with leaves.

pustules (fig. 4). These pustules produce mostly winter spores (ascospores), although occasionally the long strings of summer spores (Pl. XVII, fig. 3) are also produced, even on bark that has been dead at least a year.

After a branch or trunk is girdled, the leaves change color and sooner or later wither. Such branches have a very characteristic appearance and can hardly be mistaken for anything else, except in certain localities where the work of twig-girdling insects may produce a similar appearance in the spring. In case the girdling by the fungus is completed late in the season, the leaves of the following spring assume a yellowish or pale appearance and do not develop to their full size (fig. 3). If the girdling is completed between spring and midsummer the leaves may attain their full size and then turn a somewhat characteristic reddish-brown color, which can easily be detected at a long distance. Later this leaf coloration changes to a more brownish tinge and the leaves are commonly persistent for a considerable time. The chestnut fruits (burs) on a spring-girdled

branch may or may not attain full size, according to whether the girdling by the disease was completed late or early in the spring. These burs commonly persist on the tree during the following winter, thus producing the only symptom which is at all conspicuous during the leafless season. The great damage which the disease has done in the late summer thus becomes most evident at the beginning of the next season, and that done in the spring becomes evident later in the same season, giving rise to the false but common idea that the fungus does its work at the time of year that the leaves change color, when in reality the harm was done much earlier.

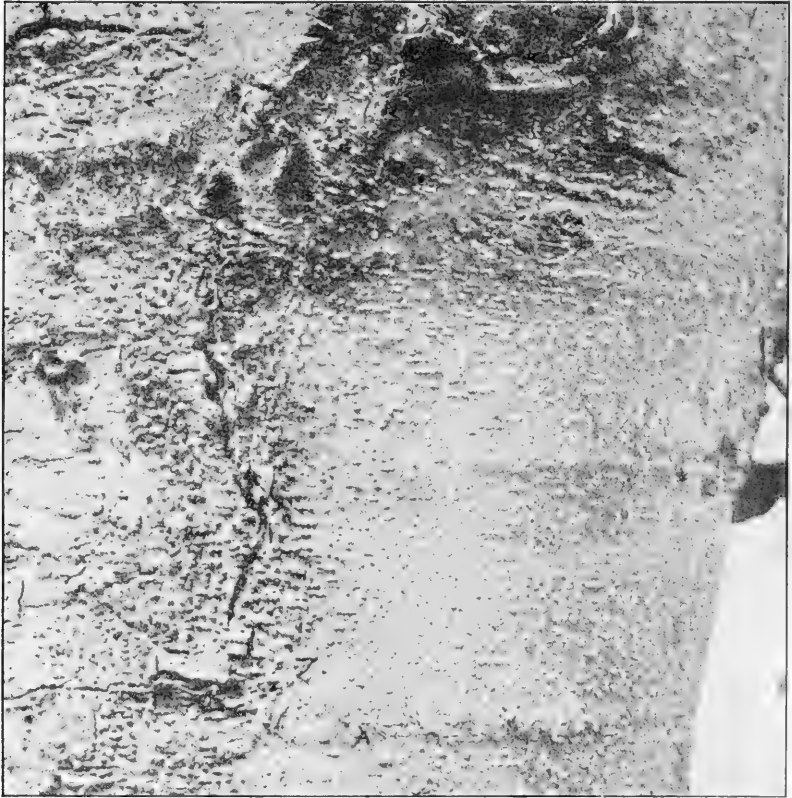


FIG. 4.—Dead chestnut bark showing pustules of the parasitic fungus bearing winter spores.

Perhaps the most easily seen as well as the longest persistent symptom of the bark disease is the prompt development of sprouts, or "suckers," on the trunk of the tree (fig. 3) and at its base, or somewhat less frequently on the smaller branches. Sprouts may appear below every girdling lesion on a tree, and there are usually many such lesions. These sprouts are usually very luxuriant and quick growing, but rarely survive the second or third year, as they in turn are killed by the fungus. The age of the oldest living sprout, as determined by the number of its annual rings, is an indication of the minimum age of that portion of the infection immediately above

it. Sprouts are sometimes produced as a result of other injuries; for instance, trees girdled by borers may develop sprouts, but these are generally less rapid in growth and are distributed with greater uniformity over the trunk.

MEANS OF SPREAD AND ENTRANCE.

The disease is spread by the spores of the fungus, of which there are two kinds. As both kinds of spores appear to be sticky, there is no evidence that they are transmitted by wind except where they may be washed down into the dust and so blown about with the dust. The spores are spread easily through short distances by rain; particularly they are washed down from twig infections to the lower parts of the tree. There is strong evidence that the spores are spread extensively by birds, especially woodpeckers, and there is also excellent evidence that they are spread by insects and by various rodents, such as squirrels. The disease is carried bodily for considerable distances in tan bark and unbarked timber derived from diseased trees. One of the most prolific sources of general infection has been the transportation of diseased chestnut nursery stock from infected to uninfected localities.

When the spores have once been carried to a healthy tree, they may develop in any sort of hole in the bark which is reasonably moist. These may be wounds or mechanical injuries, but by far the most common place of infection is a tunnel made by a borer. Borers' tunnels are moist, even in dry weather, and in them the spore finds surroundings favorable to its development. In many parts of the country where the disease is prevalent there is very direct evidence that bark borers, and particularly the two-lined chestnut borer (*Agrius bilineatus*), are directly associated in this way with 90 per cent or more of all cases of this disease. We are informed that the Bureau of Entomology will issue a circular on the insects associated with the chestnut bark disease.

The writers have no definite evidence, experimental or otherwise, to show that a tree with reduced vitality is more susceptible to infection, or that the disease spreads more rapidly in such a tree, than in a perfectly healthy and well-nourished tree of either seedling or coppice growth, provided that such reduced vitality does not result in or is not accompanied by bark injuries through which spores can gain entrance.

THE CONTROL OF THE DISEASE.

ELIMINATION AND QUARANTINE.

FUNDAMENTAL OBSERVATIONS AND EXPERIMENTS.

No method of immunizing individual trees against the bark disease is yet known, and no method of treating or curing them when once attacked is certain in its results. While this is unfortunate from the standpoint of the owner of orchard trees and large ornamental trees of great individual value, no method of dealing with single trees—surgery, medication, spraying, etc.—however successful in itself, would meet the demands of the present situation. It is not

practicable at present to apply any individual method of treatment to forest trees; the individual tree is not worth it, and will not be for many years. Therefore, so far as the chestnut forests are concerned, we do not need to regret particularly that no individual treatment has yet been discovered that is entirely effective.

Fortunately, however, there is a method of dealing with the situation which is applicable to the country as a whole and which, so far as tested, is practicable. Early in the course of the writers' investigations it became evident that the disease advances but slowly in a solid line, but instead spreads from isolated centers of infection, often many miles in advance of the main line of disease. That such is the case is evident from a glance at figure 2. It therefore seemed probable that if these advance infections could be located at a reasonably early stage they could be eliminated at relatively little expense, thus preventing further spread from these points at least. Accordingly, the country within approximately 35 miles of Washington, D. C., was chosen in the fall of 1908 as preliminary territory in which to test this method of control. This section has since been gone over fairly thoroughly once a year. As will be seen by figure 2, 14 points of infection were located, and the infected trees destroyed. Most of this work was done by the senior writer. The largest infection was a group of nursery trees that had been imported from New Jersey; the smallest, a single lesion on a small branch of a large forest tree. In one case 11 forest trees in a group were infected, the original infection having been two trees, dating apparently from as early as 1907. Up to the present time (June, 1911) the disease has not reappeared at any point where eliminated and the country within a radius of approximately 35 miles from Washington is apparently free from the bark disease, although new infections must be looked for as long as the disease remains elsewhere unchecked. It is therefore believed that this method of attack will prove equally practicable in other localities, and if carried out on a large scale will result ultimately in the control of the bark disease.

LEGAL CONSIDERATIONS.

In carrying such a scheme of control into effect on a large scale, however, legal difficulties are at once encountered. The bark disease threatens the extinction of the chestnut throughout its range. As it has already been found in at least 10 States and the District of Columbia, it is essentially a national issue, but there is no law whereby the Federal Government can attempt to cope with the emergency. Each State must act on its own initiative and control the disease or let it go as its officers and legislative bodies see fit. Herein lies one of the most serious aspects of the matter; for if one State elects to undertake control of the disease it will be seriously handicapped if neighboring States do not. Any method of elimination, isolation, or quarantine in dealing with any disease of plants, domestic animals, or human beings necessitates general cooperation. It is not practicable to try to control the bark disease solely by the cooperation of individual owners of chestnut woodland, since a single indifferent or obstinate person can nullify the efforts of an entire community. The control of the chestnut bark disease must therefore be undertaken by the separate States under special legislation.

Possibly in certain States the crop and woodland pest laws, which ordinarily apply only to nursery stock, may be broad enough to include this disease, but in most States the first thing to be done is to obtain the necessary legal authority and an appropriation for action along the following lines, as has already been done in Pennsylvania.

THE METHOD IN DETAIL.

Locating advance infections ("scouting").—The first thing to be done in each State is to determine the exact range of the disease in that State, and particularly to locate the advance points of infection. This is by far the most difficult feature of the entire program, because the work must be directed and in large measure carried out by experts; otherwise diseased trees will be left, and the results can not be depended upon. It is best intrusted to professional plant pathologists, or at least to botanists familiar with fungi and the collecting of fungi, and even these must have some preliminary knowledge of this particular disease. The symptoms of the disease are too obscure and the means of locating it too intricate to make it possible for a person without a professional knowledge of plant diseases to deal successfully with the situation, no matter how well informed in agriculture or forestry or how experienced in the care of trees. It is suggested that in most States this part of the work would be best handled by the pathologists of the State agricultural experiment stations.

For assistants the pathologists having this work in charge should choose the best scientific observers obtainable, regardless of other considerations, but persons with some knowledge of plant pathology are to be preferred. College students trained in these lines are usually available, for the summer vacation at least, and make in many respects the most desirable "scouts" for this work. But all "scouts" must be carefully and individually trained by the expert in charge.

Attention should first be directed to the advance spots of infection already known to exist, and when found the diseased trees should be destroyed or marked for destruction. No difficulty will be experienced in locating infections 2 years old or more, but the greatest difficulty will be met in locating infections of the current year. Every tree in the immediate vicinity of older infected trees must be carefully gone over. Many dubious cases will be found, and from such trees samples of the suspected bark must be taken and sent to some laboratory for expert judgment. It is absolutely necessary to have arrangements with some laboratory whereby such work can be done and the results promptly reported.

After the spots already known to exist have been delimited and the trees destroyed or marked for destruction, the search should be continued. It is best next to clearly define the location of the main line of advance of the disease, back of which infection is general. Working away from this line as a base, a complete survey of the remainder of the State must be made, until it is reasonably certain that all spots have been located.

Scouting is best discontinued as soon as the leaves change color in the fall, since from October to April, inclusive, the symptoms are very obscure. Practically no sign of the disease is visible from a distance, except in those cases where the burs persist on the older trees.

Even the pustules of the fungus become weathered, so that even a close examination of a tree may not yield visible results. But the destruction of trees already marked can continue through the winter.

Destroying advance infections.—Many of the advance infections will be found to consist of single trees or of less than half a dozen trees. These may perhaps be destroyed by the person who finds them, especially if remote from other infections; but the greater part of the work of elimination is best handled by other persons under separate direction. Undoubtedly this work can be best directed in each State by the State forestry officials.

The work of elimination should be done as soon as possible after the diseased trees are located, but may be done at whatever time of year is most convenient, since new infections will be detected by the scouting of the following year. The marked trees should be cut down. So far as is now known, the timber may be safely utilized in various ways, provided it is barked. The bark and brush should be piled over the stumps and, as soon as practicable, burned. If it is not practicable to have the fire over the stumps, the stumps should be barked to the ground; but in any case the bark and brush must be burned.

It will be readily seen that the task of locating the disease, and the subsequent one of eliminating it, call for very different talents. The "scouting" calls for carefully trained and absolutely accurate scientific observers working under the most highly specialized direction that can be obtained. The work of elimination calls not for scientific knowledge, but for executive ability, tact in dealing with owners and in otherwise administering the law, and a knowledge of forestry and of lumbering, market, and transportation conditions. In a word, the first is a task for pathologists, the second for foresters. Another advantage of thus dividing the work is that a certain rivalry will usually develop, resulting in more thorough work on both sides. It is, moreover, of the utmost importance to have as many different forces and interests as possible in any given State working toward the common end of controlling this disease.

Establishing the "immune zone."—After all advance spots of infection are eliminated, attention must be turned to the main line of advance—the edge of the area of general infection. Here the problem will present local differences. It may prove necessary in some States to destroy all chestnut trees, diseased or healthy, in a belt 10 to 20 miles wide, or possibly less. Advantage must be taken of natural barriers to infection, such as unforested areas or wooded areas without chestnuts. In this way an "immune zone" will be established, across which the disease can not easily be transmitted by merely local agents. Back of this line the chestnut trees may be abandoned to the disease. Every effort should be made, however, to have them cut down and the timber utilized as soon as possible, since they remain sources of distant infection as long as any spore-laden bark or diseased sprouts remain on them.

Quarantine.—Whether any restrictions are placed upon the movement of chestnut products from the area of complete infection to the protected territory will depend largely on local conditions and must be left to the judgment of State authorities. Barked timber can probably be moved with comparative safety. It will always be desirable to limit the movement of unbarked chestnut timber and fire-

wood and of chestnut tan bark. An inspection of local conditions will readily determine whether the danger from these sources is sufficiently great to warrant the business inconvenience which would be caused by the quarantine of any or all chestnut products.

Program for the second year.—The work for the second year will consist mostly of reinspection of the advance spots where the bark disease has been eradicated the previous year and of general scouting to locate new spots. If the work of the first year has been thoroughly done and there has been time to complete the elimination of all spots located, only scattering infections may be expected. From this time on the persons in charge of scouting will have the bulk of work and responsibility.

THE EXAMPLE OF PENNSYLVANIA.

Pennsylvania enjoys the distinction of being the first and so far the only State to undertake in any way the control of the chestnut-bark disease. In the summer of 1910 the Main Line Citizens' Association—an organization of citizens residing along the main line of the Pennsylvania Railroad near Philadelphia—appointed a committee of seven, under the chairmanship of Mr. Harold Peirce, to determine the status of the disease in that locality and to see what could be done toward controlling it. An extensive local survey of the disease was made under the direction of Mr. I. C. Williams, deputy State forest commissioner. The committee soon became convinced that the problem was of State and even national importance, and could only be solved by legislation and by the broadest cooperation. Accordingly they devoted their energies to securing the passage by the Pennsylvania Legislature of the following bill, which has now become a law. This law is almost unique in conservational legislation, and on account of its important bearing as precedent for similar laws in other States it is here reproduced in full.

AN ACT To provide efficient and practical means for the prevention, control, and eradication of a disease affecting chestnut trees, commonly called the chestnut-tree blight; providing for the destruction of trees so affected; creating a commission to carry out the purpose of this act; fixing penalties for violation of the provisions hereof; and making an appropriation therefor.

SECTION 1. *Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met; and it is hereby enacted by the authority of the same:* That a commission to consist of five members, to be appointed by the governor for a period of three years from the date of the approval of this act, and to be called "The Commission for the Investigation and Control of the Chestnut-Tree Blight Disease in Pennsylvania," is hereby created, with power to ascertain, determine upon, and adopt the most efficient and practical means for the prevention, control, and eradication of a disease of the chestnut tree commonly known as the chestnut-tree blight disease; and for this purpose, in collaboration with the department of forestry, or otherwise, to conduct scientific investigations into the nature and causes of such disease and the means of preventing its introduction, continuance, and spread; to establish, regulate, maintain, and enforce quarantine against the introduction and spread of such disease; and, from time to time, to adopt and prescribe such regulations and methods of procedure as to it may seem necessary and proper for carrying into effect the purpose of this act, and exercising the powers and authority hereby conferred: *Provided,* That in the work of collaboration by the commission with the department of forestry said department may employ such means, and make detail of such men, and do such other things, as may seem to be necessary or expedient to accomplish the purpose of this act.

SEC. 2. Any member of the commission, or any of its duly authorized agents or employees, shall have the right, at any time, to enter upon any premises, wild lands, farms, fields, private grounds, and inclosures for the purpose of examining into the condition of any chestnut tree or trees thereon, and determining whether or not such

trees, or any of them, have been attacked or infected by the chestnut-tree blight; and whenever this disease is found to exist, such commissioners, their duly authorized agents and employees, shall, in all practicable ways, cooperate with the owners of such trees in and for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; shall specifically advise and direct such owner how he shall proceed for the accomplishment of these ends; and shall leave with such owner, his agent, tenant, or other representative having charge of such trees, a notice, in writing, containing a description or plan specifically designating the trees so found to be diseased, and full and specific instructions for the treatment of such trees, or for the removal and destruction of designated parts thereof, or of an entire tree or trees, as the case may require.

Sec. 3. If any owner of such trees, so found to be diseased by the said commission, its duly authorized agents or employees, shall neglect or refuse to cooperate in applying the necessary remedies for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; or shall neglect or refuse to comply with the requirements of the notice aforesaid, prescribing the treatment which shall be applied to such trees, so found to be diseased, within 20 days from the time such notice shall have been served, the said commission may at once proceed, through its duly authorized agents and employees, to do whatever may be found by it to be necessary and proper to accomplish the cure, control, or eradication of such disease and the prevention of its spread to other chestnut trees; and for this purpose, whenever it may be found necessary may remove, cut down, and destroy, or cause to be removed, cut down, or destroyed, any trees or parts of trees so found to be infected with such disease; and shall immediately thereafter duly certify to the owner of such trees, so treated or destroyed, or to his tenant, agent, or other representative in charge of such trees, the amount of the cost or expenses actually incurred by the commission in the treatment, removal, or destruction of such trees; and if the amount of such expense, so certified, shall not be paid by such owner of said trees, so treated, removed, or destroyed, within 60 days after it shall have been so certified, the same may be recovered by the said commission, from such owner, by an action in the name of the Commonwealth, in the same manner as debts of like amount are now recoverable, and when recovered may be used by said commission in carrying out the purposes of this act.

Provided, however, That any owner or owners of trees, his or their tenants, agents, or representatives, who may be dissatisfied with any decision, order, or notice of any member of the commission, or any of its agents or employees, directing or prescribing the treatment, removal, or destruction of trees belonging to or controlled by them, shall have the right within 10 days from the time of the service upon them of such order or notice to appeal therefrom, in writing, to the commission, which shall thereupon, without avoidable delay, direct a reexamination of the premises or trees in question, by competent experts, who shall make report of their findings to the commission; which shall then fix a time and a place for a hearing before it, upon such appeal, and notify the person making appeal thereof. All further proceedings under such order or notice shall be suspended until the decision of the commission shall have been formally rendered.

Sec. 4. Whenever, in the judgment of the commission, it may be necessary to destroy chestnut trees not affected by the chestnut-tree blight, for the purpose of establishing a quarantine to prevent and control the spread of the disease, the owner of such trees shall be reimbursed for the loss of all the good and unaffected trees so destroyed; the amount to be paid therefor to be not greater than the stumpage prices of such trees, prevailing at the time in the locality where such trees grew; such value to be determined by the commission, by such method or procedure as it may adopt, and payment therefor to be made from the fund hereinafter specifically appropriated for the use of the said commission in performing the duties required by this act. Should any owner of trees be dissatisfied with the amount awarded to pay for the destruction of such good and unaffected trees, said owner shall have all the remedies now existing, or which may hereafter be provided by law, for the protection of his interests.

Sec. 5. Any person who shall willfully violate any of the provisions of this act, or any of the regulations of the commission intended to assist in carrying this act into effect, or shall willfully resist or interfere with any agent or employee of the said commission in the performance of his duties in accordance with the regulations and orders of the commission, under the provisions hereof, shall be deemed guilty of misdemeanor, and shall upon conviction thereof be punished by a fine not exceeding \$100, or by imprisonment not exceeding one month, either or both, at the discretion of the court. The word "person," as used in this act, shall include not only individuals or natural persons, but as well artificial persons, existing only in contemplation of law, and shall be construed to mean partnerships, limited partnerships, joint-stock companies, and corporations, and the officers, agents, and employees of the same.

SEC. 6. The members of the commission shall serve without pay, but shall be reimbursed for all actual expense incurred by them in exercising the powers conferred upon them and performing the duties required by this act. The employees of the commission shall receive such compensation for their services as the commission shall determine will fairly compensate them for the work to be done. The commission shall be furnished with suitable rooms in the Capitol building at Harrisburg, or elsewhere, by the Superintendent of Public Grounds and Buildings. The sum of \$25,000 is hereby specifically appropriated, to be immediately available upon the approval of this act, for the payment of such expense as may be incurred by the commission, for such scientific research and for office expenses, as in their judgment may be necessary to comply with the provisions hereof, said appropriation to be available until the 1st day of June, A. D. 1913; and the further sum of \$250,000, or so much thereof as shall be necessary, is hereby specifically appropriated, to be available only upon the approval of the governor, for the performance of all other duties herein required to be done; as, for quarantine, removal of diseased trees or other trees, conducting outside investigations and operations, and every other means of eradication and control, as to it may seem necessary in complying with the provisions hereof.

SEC. 7. All acts or parts of acts inconsistent herewith are hereby repealed.

The commission authorized by the bill has been appointed by the governor of Pennsylvania and consists of the following persons: Mr. Winthrop Sargent, chairman; Mr. Harold Peirce, secretary; Messrs. Samuel T. Bodine, George F. Craig, and Theodore N. Ely. Persons desiring information regarding the work on this disease in Pennsylvania should address the executive officer of the commission, Mr. Samuel B. Detweiler, 1112 Morris Building, Philadelphia, Pa.

INSPECTION OF DISEASED NURSERY STOCK.

As has been indicated, diseased chestnut nursery stock has in the past been a most important factor in the spread of the bark disease. On account of a well-grounded fear of this disease much less nursery stock is being moved now than formerly, but there is still enough to constitute a serious source of danger. It is therefore obvious that every State in which the chestnut grows, either naturally or under cultivation, should as speedily as possible pass a law putting the chestnut bark disease on the same footing as other pernicious diseases and insect pests, such as peach yellows and the San Jose scale, against which quarantine measures are taken. Many inspectors already have legal power to quarantine against the bark disease on chestnut nursery stock, and they should now take special care that no shipment, however small, escapes their rigid inspection.

The most serious practical difficulty in inspecting nursery stock for this as for other fungous diseases lies in the fact that practically all State inspectors are necessarily entomologists, and are not trained in recognizing the more obscure symptoms of fungous diseases. Nursery trees affected by the bark disease rarely show it prominently at the time when shipped; the threads of summer spores or the yellow or orange pustules are rarely present, and usually all the inspector can find is a small, slightly depressed, dark-colored area of dead bark, usually near the ground, which is easily overlooked or mistaken for some insignificant injury. Upon cutting into such a spot, the inner bark shows a most characteristic disorganized "punk" appearance, quite different from that of any other bark injury; but it is impossible to adequately describe this appearance without recourse to colored illustrations. Occasionally a yellowish-brown band, either girdling or partly girdling the young tree, may be seen; this is very characteristic, but is so prominent a symptom that it may be noticed at the nursery, and presumably trees so affected will not be shipped.

If infected trees are set out they develop the disease with its characteristic symptoms the following spring. But on account of their small size such trees are girdled and die before the end of the summer, often in two or three weeks. Meanwhile they are spreading the disease to neighboring orchard and forest trees. Orchardists and nurserymen purchasing chestnut trees are therefore warned to watch them closely during the first season, no matter how rigidly they may have been inspected.

INDIVIDUAL TREATMENT OF DISEASED TREES.

Where valuable ornamental, shade, or orchard chestnut trees become infected in one or more spots, the life and usefulness of such trees can be prolonged for several or for many years, depending largely upon the thoroughness with which the recommendations herein given for cutting out the diseased areas (lesions) are carried out. These recommendations are based upon the results of extensive experiments with hundreds of lesions during the past four years. These experiments were performed for the most part by the junior writer.

The essentials for the work are a gouge, a mallet, a pruning knife, a pot of coal tar, and a paint brush. In the case of a tall tree a ladder or rope, or both, may be necessary, but under no circumstances should tree climbers be used, as they cause wounds which are very favorable places for infection. Sometimes an ax, a saw, and a long-handled tree pruner are convenient auxiliary instruments, though practically all the cutting recommended can be done with a gouge with a cutting edge of 1 or 1½ inches. All cutting instruments should be kept very sharp, so that a clean and smooth cut may be made at all times.

By cutting with the gouge into a diseased area a characteristically discolored and mottled middle and inner bark is revealed. All of this diseased bark should be carefully cut out for at least an inch beyond the discolored area if the size of the branch will allow it. This bark should be collected in a bag or basket and burned. If the cutting is likely to result in the removal of the bark for much more than half the circumference of the branch or trunk, it will probably be better to cut off the entire limb or to cut down the tree, as the case may be, unless there is some special reason for attempting to save the limb or tree. The fungus usually, though not always, develops most vigorously in the inner bark next to the wood. When this is the case, not only all the diseased bark and an inch of healthy bark around it must be removed, but at least two or three annual layers of wood beneath the diseased bark must also be gouged out. Special care should be taken to avoid loosening the healthy bark at the edges of the cut-out areas. Except in the early spring this is not difficult after a little experience in manipulating the gouge and mallet, provided the gouge is kept sharp.

Small branches which have become infected should be cut off, the cut being made well back of the disease—at least 2 or 3 inches, if possible.

All cut-out areas and all the cut ends of stubs should be carefully and completely painted with coal tar. A good grade of paint has

been recommended by some authorities as superior to tar, but it is more expensive. If the tar is very thick, the addition of a little creosote will improve it for antiseptic purposes as well as for ease in applying. If the first coat is thin, a second one of fairly thick tar should be applied within a few weeks or months. Other coats should be applied later whenever it becomes necessary.

The entire tree should be carefully examined for diseased spots and every one thoroughly cut out and treated in the way already described. In case of suspicious-looking spots a portion of the outer bark can be cut out with the sharp gouge as a test. If this cut shows the characteristically discolored bark the spot can be considered as diseased and cut out accordingly; if the cut shows healthy bark, it need merely be treated with tar or paint, as other cuts are treated. In examining a tree for diseased spots it is always best to begin at the base of the trunk and work up, for if the trunk is girdled at the base it is useless to work anywhere on the tree.

When the spores of the fungus are present, especially in the form of threads, or "horns," they are readily washed down the branches and trunk by every rain, and are thus carried down to or toward the base of the tree. As a result the base of a tree, the crotches, and other places which afford easy lodgment for the spores are particularly subject to infection.

Although spraying with any of the standard fungicides appears to have no effect whatever in stopping the progress of the disease after it has once started in the inner or middle bark, there is little doubt that it is of use in preventing infection from spores washed down by rain from the upper part of a tree or from spores which have been transported from other trees. For this reason the spraying, after each rain, of the parts of a tree below a spore-bearing lesion is recommended, but only on an experimental basis. If no spore-bearing lesions occur on the tree, there is less apparent reason for spraying. The scattering of slaked lime about the base of a tree and the whitewashing of the trunk and larger limbs have shown apparently beneficial results in preventing infections and perhaps also depredations of borers.

A tree which is being treated for individual infections must be carefully watched and the diseased spots promptly cut out as they appear. For this purpose each tree should be examined very carefully two or three times at least during the growing season.

The Department of Agriculture asks the cooperation of all persons who have experimented with the disease in any way, and in return is ready to give specific advice, based upon extensive experience with the disease, as to the best methods of attempting its control or as to what are likely to be the most profitable systematic observations or experiments.

ADVICE TO CHESTNUT ORCHARDISTS.

In view of the uncertain future of the chestnut tree, the Department of Agriculture advises against planting chestnuts anywhere east of Ohio, at least until it is settled what efforts will be made by the individual States to control the bark disease. The only exception is that Japanese chestnuts may be grown if raised from imported seeds and not grafted on American stocks. If the seed is raised in America,

the trees are more than likely to be hybrids with the American chestnut and to vary greatly in resistance to the bark disease. If grafted on American stocks, the stocks readily succumb to the disease, and so the whole tree is killed, no matter how resistant the scion may be. However, the nut of the true Japanese chestnut is of poor quality at best, and it is an open question whether it can ever be made a commercial success.

West of the natural range of the American chestnut, however, the situation is quite different. Obviously the western chestnut orchardist has before him a great opportunity. No matter how successful efforts to limit the bark disease in the East may be, the nut crop will be reduced for some years, and the business of growing fine orchard chestnuts in the East will be depressed for the same length of time. There is no apparent reason why, with rigid inspection, both of any purchased stock and of the orchards themselves, all chestnut orchards and nurseries from Ohio to the Pacific coast can not be kept permanently free from the bark disease; therefore all persons interested in growing the chestnut in the West as an orchard tree are earnestly advised not to secure any chestnut nursery stock from eastern nurseries; to be sure that stock from any source is rigidly inspected; to watch with the utmost care their own nurseries and orchards; and to destroy immediately by fire any trees that may be found diseased.

There is presumptive evidence that the bark disease was introduced into America on the Japanese chestnut, but until this point is definitely settled orchardists west of Ohio are advised not to import nursery stock of this variety. Seed can probably be imported with a reasonable degree of safety, however.

ADVICE TO OWNERS OF CHESTNUT WOODLAND.

Owners of chestnut woodland anywhere within the area of complete infection are earnestly advised to convert their trees into lumber as quickly as possible. The trees that are not already killed will soon die in any case and the timber will quickly deteriorate in quality. Such trees are a continual source of further infection, and, moreover, large areas of dead chestnut trees, by harboring bark and wood inhabiting insects, are likely to start some insect epidemic. Indeed, with the quantity of dead chestnut timber now standing it will be remarkable if some serious infestation of insects extending to sound trees does not follow.

Owners of chestnut woodland outside the area of general infection are counseled to watch for the first appearance of the disease, and when it appears to cut down immediately all affected trees, bark them, and burn the bark and brush, over the stump if practicable. Such procedure will distinctly retard the spread of the disease in that particular woodland, even if no concerted efforts at elimination are made by neighboring owners. It is to be expected, however, that in all cases of this kind the owner will have the cooperation of the State authorities in a general quarantine movement.

It is almost needless to add that until we know what action is to be taken in all the chestnut-growing States and what the results are likely to be, chestnut woodland is a poor investment. Furthermore, in forest management, as in improvement cuttings, etc., there should be discrimination against the chestnut.

ADVICE TO OWNERS OF ORNAMENTAL CHESTNUT TREES.

Until the future of the chestnut tree is better known, or at least until we know what legalized action is going to be taken in the States concerned, the owners of chestnut-timbered land available for building should pursue a very conservative policy. Houses should not be located with sole reference to chestnut groves or to isolated ornamental chestnut trees. Houses so located should be discriminated against in purchasing homes in so far as the death of the chestnut trees would injure the appearance of the place.

When ornamental trees become diseased they had better be cut down at once and, if practicable, large trees of other species moved in to take their places. In expert hands the moving of large trees is a perfectly practicable and successful procedure and, although more expensive, is much more satisfactory than waiting for nursery trees to grow.¹

All owners of diseased ornamental chestnut trees are specifically warned against "fake" tree doctors. Large sums of money have been paid out in many cases for treatment that has been worse than useless. Reliable tree specialists will have nothing to do with trees affected with the chestnut bark disease, or, if they do anything, do it with the distinct understanding in advance that it is entirely at the owner's risk. Of course, if an owner desires to employ tree surgeons to experiment, that is another matter.

ADVANCING POPULAR KNOWLEDGE OF THE DISEASE.

In the localities where infection is general or complete (fig. 2) everyone knows what the chestnut bark disease is and what its symptoms are and everyone appreciates its seriousness; but in these localities it is too late even to attempt its control. On the other hand, in Delaware, Virginia, West Virginia, western and southern Maryland, western Pennsylvania, central and northern New York, Massachusetts, and Rhode Island very few people know the symptoms of the disease. On this account no one notices it until it is thoroughly established, and by the time public sentiment is sufficiently aroused to authorize the necessary legislation and bring about united action for public protection it is too late for such action to be of service. Obviously, then, every effort should be made by all State and other officials having such matters in charge to acquaint every citizen with the prominent symptoms of the bark disease and to familiarize him with the fact that unless prompt and united action is taken there is every indication that the chestnut tree in the States above mentioned will become practically extinct within 10 years.

COOPERATION OF THE DEPARTMENT OF AGRICULTURE.

In this campaign of education the Department of Agriculture will cooperate in the following ways: Copies of this bulletin or of other publications of this department relating to the bark disease, and also

¹ In case such action is not immediately desirable or possible, a very good, though temporary, scenic effect can be obtained by lopping off the ends of the larger branches of the dead and dying chestnut trees, removing the bark, and planting some rapid-growing vine at their foot, which soon covers them. One of the best for this purpose is the Japanese kudzu vine (*Pueraria thumbergiana* (S. and Z.) (Benth.)), on account of its extraordinarily rapid growth. Such vine-covered stumps must be carefully watched, however, for in a very few years they decay and are liable to be blown over.

typical specimens of the disease, will be sent to any person applying for them. Two specimens will be sent to each person—one showing the appearance of the disease on smooth bark, and the other the later development of the fungus on thick bark. In both these specimens the fungus will have been killed by soaking in formalin to insure against any infection from this source.

So far as the supply permits, lantern slides and photographs will, upon application, be loaned for special lectures, exhibits, etc., to the officers of States, experiment stations, colleges, and schools where agriculture is taught, as well as to tree wardens and other officials whose work may bear directly upon local campaigns of publicity.

This department will always examine any suspected specimens of this disease sent to Washington by mail, and will report the findings as promptly as possible. Before sending specimens, however, all persons are urged to read the paragraphs on symptoms on pages 6 to 9 in order to select the specimens intelligently. For example, if the end of a girdled and withered branch is sent, it is not possible to make a dependable diagnosis unless a portion of the girdling area happens to be included. This is the only part where the fungus is surely present, and the fungus itself must be seen in order to be absolutely sure of the disease. Portions of the bark that show the small orange or reddish-brown pustules, about the size of the head of a pin, should always be sent, if these can be found. These commonly occur near the lower edge of the girdling area:

PUBLIC COOPERATION.

With many people familiarized with the appearance of the chestnut-bark disease and its possibilities of harm, the disease will be noticed and stamped out by private effort in many places when it first appears and the public will understand and be ready to cooperate in any official measures of control as soon as these become necessary in any locality.

All possible forces must be enlisted in a campaign of publicity. The cooperation of all newspapers, particularly local papers, can be easily secured in all the States where the chestnut is an important tree. A portion of the program for Arbor Day, 1912, should be devoted to a consideration of this disease. Teachers of nature study, botany, or agriculture in the public schools can do great service by teaching their pupils how to recognize the disease and by training them to be on the lookout for its first appearance in the home community. Such a body as the "Boy Scouts" can, if properly trained, become in every community a most efficient force for locating the disease. The boys will readily appreciate that such work is real "scouting" against a most insidious and destructive public enemy. And, finally, many private owners of chestnut trees will be eager to cooperate with the State authorities in the early elimination of advance infections if only they are able to recognize such infections.

THE PROTECTION OF THE SOUTHERN STATES.

It must be remembered that the bark disease has as yet done only a small fraction of the damage that it is undoubtedly capable of doing. The best chestnut timber of America is south of the Potomac River

and there the bark disease is present in only a few spots. For this reason it is of extraordinary importance that these few spots be eradicated and that the disease be soon controlled immediately north of the Potomac. If the bark disease once becomes well established in the chestnut forests of the South, it will be well-nigh impossible to control it, on account of the sparsely settled and mountainous condition of much of that country and for other reasons which do not obtain farther north.

SUMMARY.

(1) The chestnut-bark disease was first noted near New York City in 1904 and is now present in at least 10 States. It attacks the American chestnut, the European chestnut, the chinquapin, and, rarely, the Japanese chestnut.

(2) The total financial loss from this disease is now estimated at \$25,000,000.

(3) The disease is caused by a fungus, and the entrance of a spore at any point where the bark is broken may cause infection. The disease spreads primarily in the inner bark and produces characteristic lesions which girdle the tree at the point attacked.

(4) Conspicuous symptoms are the development of bunches of sprouts below the girdling lesions; the half-formed yellowish leaves in the spring on the previously girdled branches, the reddish-brown leaves on branches girdled in summer, and the yellow, orange, or reddish-brown pustules of the fruiting fungus on the bark. It is practically useless to attempt systematic location of the disease from October to April, inclusive.

(5) The spores may be carried considerable distances on chestnut nursery stock, tan bark, and unbarked timber; also by birds, insects, squirrels, etc., which have come in contact with the sticky spore masses. Water quickly dissolves these spore masses and the minute spores are in this way carried along with water, as, for instance, with rain water running down a tree. Borers' tunnels form the most common places of entrance for spores.

(6) The only known practical way of controlling the disease in a forest is to locate and destroy the advance infections as soon as possible after they appear and, if the disease is well established near by, to separate the area of complete infection from the comparatively uninfected area by an immune zone. Advance infections should be located by trained observers and destroyed by cutting and burning. As the disease develops almost entirely in the bark, this must be completely destroyed (burned).

(7) In order to carry out the above methods it is essential that the several States concerned secure necessary legislation and appropriations, following the example of Pennsylvania, as no law exists whereby the Federal Government can undertake such work and cooperation among private owners without State supervision is impracticable.

(8) Chestnut nursery stock should be rigidly inspected for the disease and only perfectly healthy plants passed.

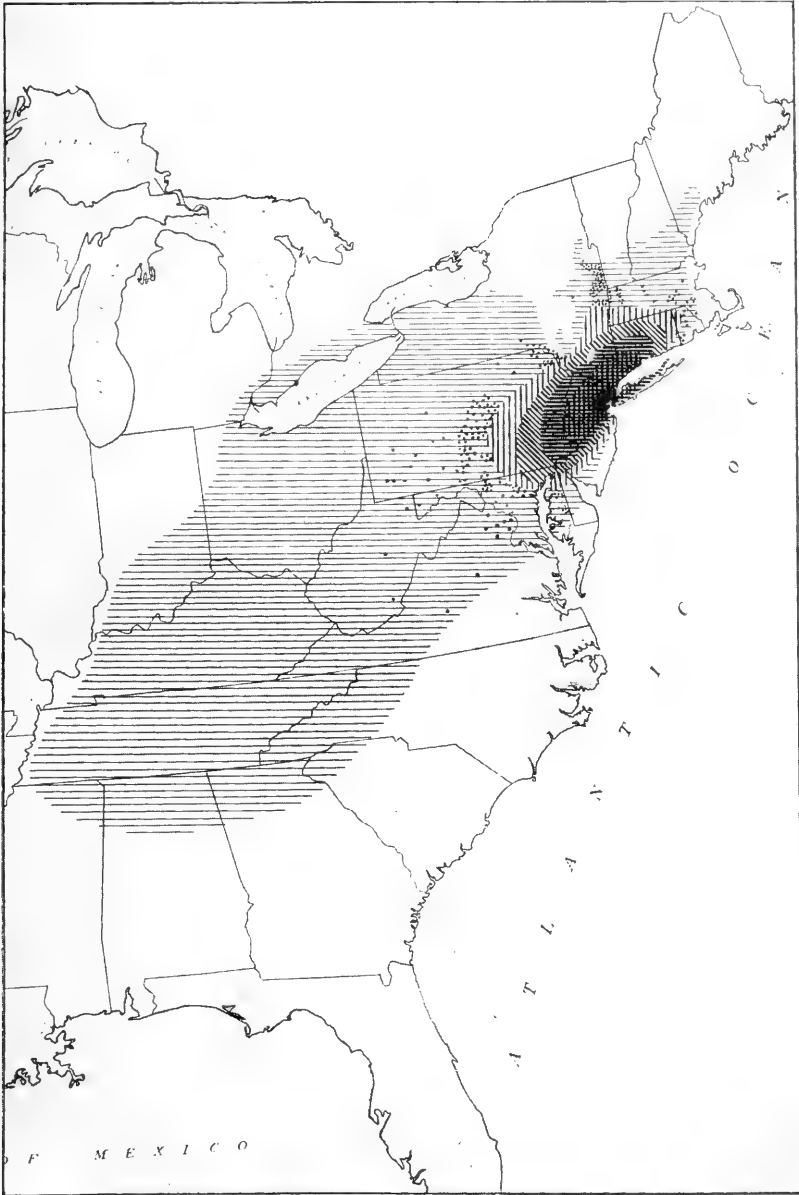
(9) The life of valuable ornamental trees may be greatly prolonged by promptly cutting out all diseased areas and removing all disease-girdled branches and then covering the cuts with tar. Spraying is

of no use in stopping the fungus after it has once started growth in the bark.

(10) It is recommended that owners of infected woodland cut down and utilize the diseased chestnut timber as soon as possible.

(11) For the present the planting of chestnuts anywhere east of Ohio is not advised, but there is no apparent reason why chestnut orchards west of Ohio may not be kept free from the disease.





KNOWN DISTRIBUTION OF THE CHESTNUT BARK DISEASE FEBRUARY 1, 1912.

[Horizontal lines show the botanical distribution of the American chestnut tree. Dots represent advance infections. Thicker lines, arranged concentrically about New York City, show various degrees of general infection and death.]



FIG. 1.—TYPICAL GROUP OF LARGE CHESTNUT TREES DYING WITH THE BARK DISEASE. NEAR BROOKVILLE, N. Y.

[Note appearance of foliage.]



FIG. 2.—DEAD CHESTNUT TREES ALONG A BOULEVARD, NEAR RICHMOND HILL, N. Y.

[Note healthy condition of trees of other species.]



FIG. 1.—THE MOST SOUTHERN POINT OF INFECTION—A GROUP OF DISEASED CHESTNUT TREES AT FONTELLA, BEDFORD COUNTY, VA.

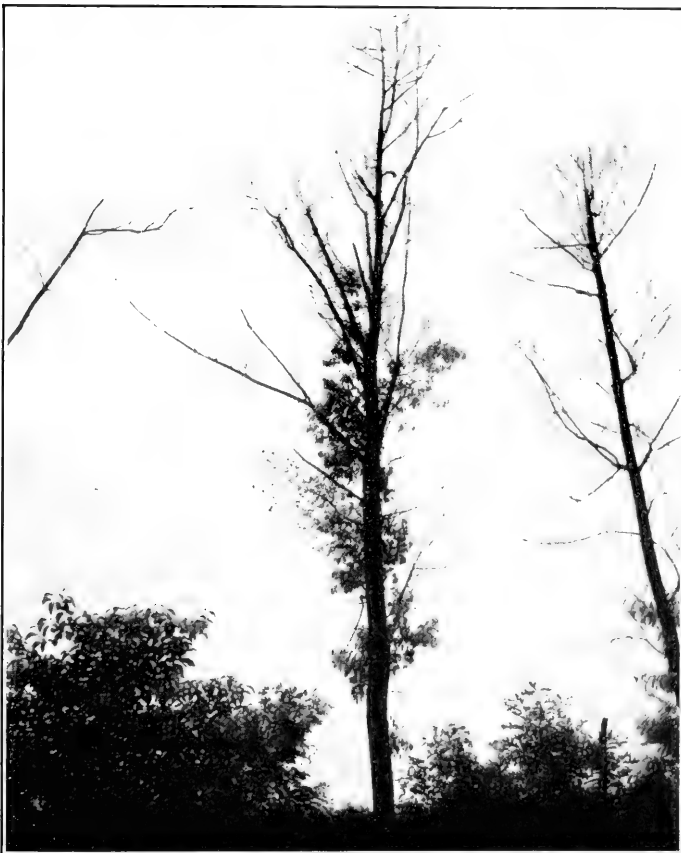


FIG. 2.—FOREST TREE NEARLY DEAD. PARKTON, MD.

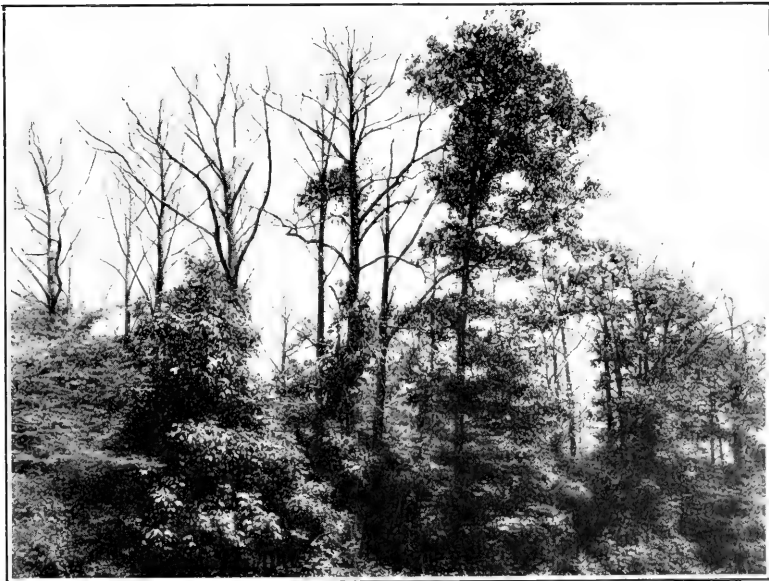
[Note characteristic sprouts and dwarfed leaves of the only surviving branches.]



FIG. 1.—TREE WITH SOME LARGE BRANCHES GIRDLED, WESTBURY, N. Y.
[Note appearance of foliage.]



FIG. 2.—TREE WITH SMALL BRANCHES GIRDLED, BUCK, PA.
[Note appearance of foliage.]



COMPLETE DESTRUCTION OF CHESTNUT TREES IN MIXED STAND.

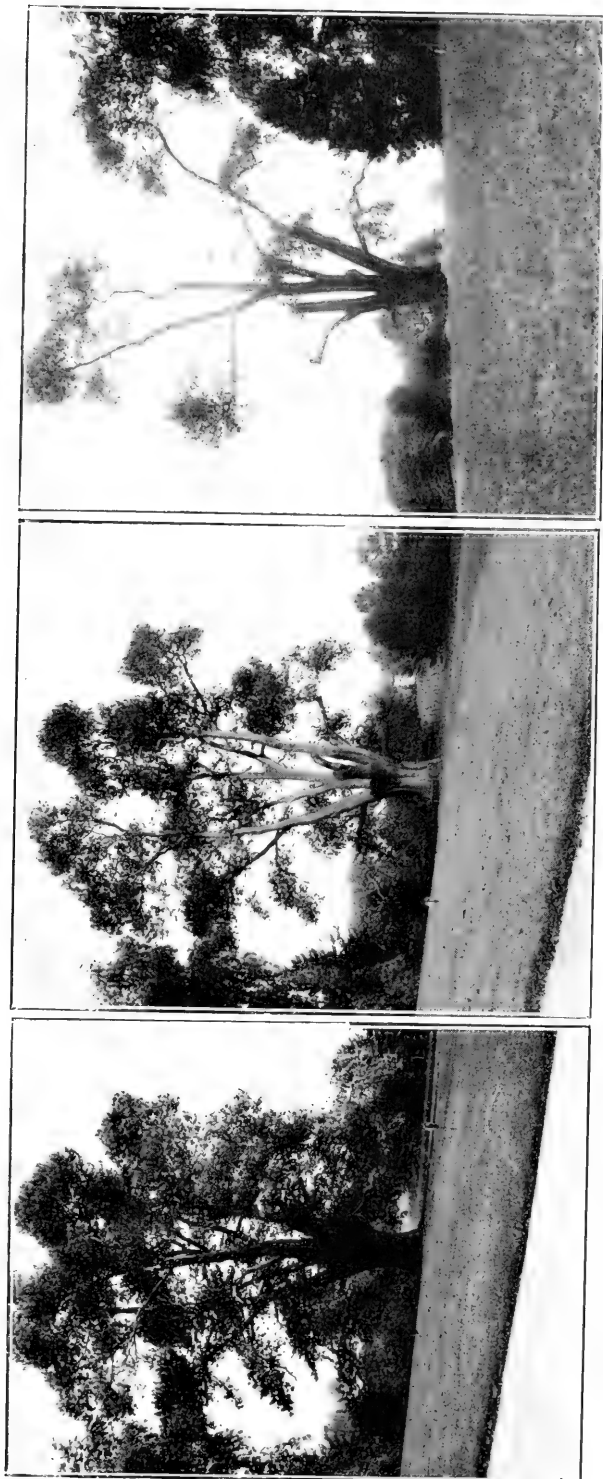
[Note healthy condition of trees of other species. Views along the Long Island Railroad.]



FIG. 1.—COMPLETE DESTRUCTION OF CHESTNUT TREES IN NEARLY PURE STAND.
[Many of the trunks have been dead long enough to shed their bark. Near Brooklyn, N. Y.]



FIG. 2.—COMPLETE DESTRUCTION OF CHESTNUT TREES IN A NEARLY PURE STAND.
[Note healthy condition of other species. Forest Park, near Brooklyn, N. Y.]



VIEWS OF THE SAME TREE, TAKEN ON THREE SUCCESSIVE YEARS, 1909, 1910, AND 1911 RESPECTIVELY. WYNGCOTE, PA.
[The branches have been cut off as fast as they were killed. The tree will die this summer (1912).]



GRAFTED VARIETIES OF ORCHARD CHESTNUTS, NEARLY DEAD. MARTIC FORGE, PA.
[Note the suckers on the trunk and the appearance of the foliage.]

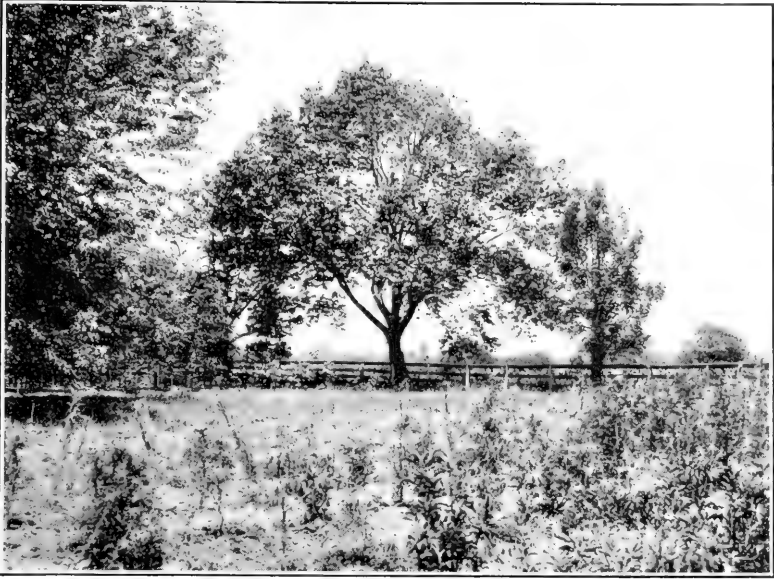


FIG. 1.—EARLY STAGE OF DISEASE. INFECTION OF A SMALL BRANCH IN THE TOP OF THE TREE. WESTBURY, N. Y.



FIG. 2.—EARLY STAGE OF DISEASE. END OF BRANCH GIRDLED AT UPPER RIGHT-HAND OF PICTURE. LANCASTER COUNTY, PA.

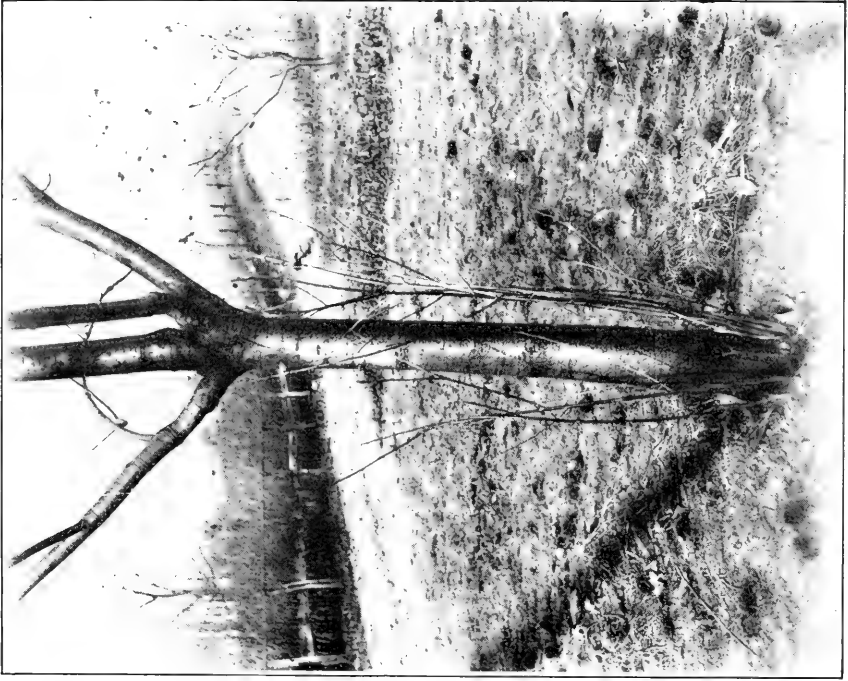


FIG. 2.—ORCHARD CHESTNUT, GIRDLED AT BASE, WITH CHARACTERISTIC GROWTH OF SPROUTS WHICH HAVE BEEN IN TURN GIRDLED AND KILLED BY THE DISEASE.

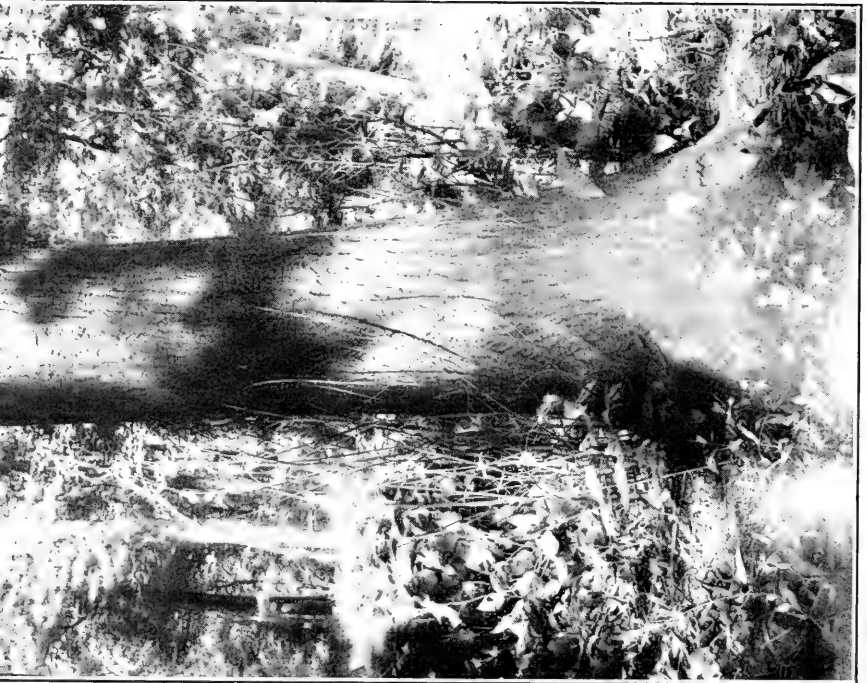


FIG. 1.—LARGE FOREST CHESTNUT TREE GIRDLED AT BASE, SHOWING CHARACTERISTIC GROWTH OF SPROUTS. MOST OF THESE SPROUTS ARE ALREADY GIRDLED BY THE DISEASE.



DEAD CHESTNUT TREES, WITH BARK IN SUCCESSIVE STAGES OF DECAY, SHOWING PUSTULES OF THE FUNGUS IN WHICH THE WINTER SPORES ARE BORNE.



LATE STAGES OF DECAY OF BARK AND OUTER LAYERS OF WOOD.



FIG. 1.—DEAD AND DYING SPROUT GROWTH, PORT JEFFERSON N. Y.
[Note healthy condition of trees of other species.]



FIG. 2.—TYPICAL GROUP OF DEAD CHESTNUT TREES. NEAR BROOKLYN, N. Y.

[Note dead suckers on the trunks. From left to right: The first trunk shows the disease less than 1 year old; the second from 2 to 3 years old; the third 4 or more years old; and the fourth about 3 years old.]



FIG. 1.—EXTERNAL APPEARANCE OF A YOUNG LESION OF THE CHESTNUT BARK DISEASE, SHOWING THE SPREAD OF THE DISEASE FROM AN INSECT PUNCTURE.



FIG. 2.—THE SAME AS FIG. 1, WITH THE OUTER BARK REMOVED TO SHOW THE CENTRIFUGAL SPREAD OF THE MYCELIUM OF THE PARASITIC FUNGUS.



SMALL CHESTNUT TREE IN POT ABOUT 3 MONTHS AFTER ARTIFICIAL INOCULATION WITH SUMMER SPORES FROM A PURE CULTURE OF THE FUNGOUS PARASITE. TREE GIRDLED AT BASE, LEAVES ABOVE WITHERED; VIGOROUS SUCKERS GROWING UP FROM BELOW GIRDLED POINT.



EXAMPLES OF TREE SURGERY, SHOWING HEALING PROCESSES AFTER CUTTING OUT LESIONS, IN TREATMENT OF ORCHARD TREES.



FIG. 1.—LARGE CHESTNUT TREE KILLED BY THE BARK DISEASE.

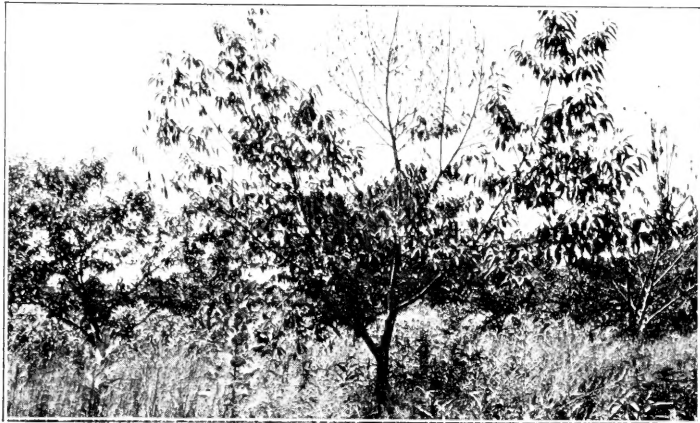


FIG. 2.—AN ORCHARD TREE, SHOWING RECENTLY GIRDLED BRANCHES.

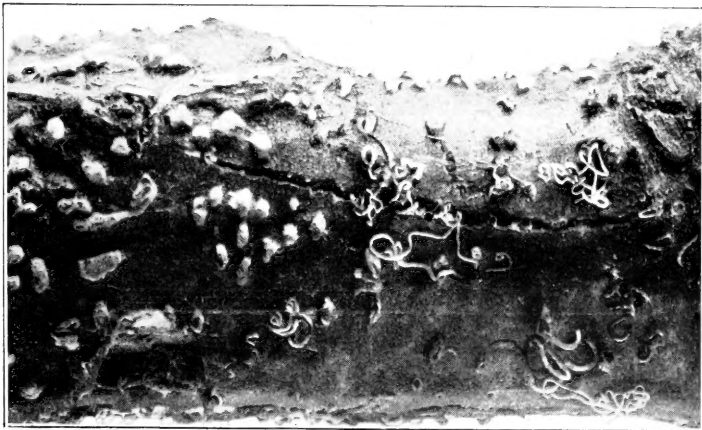


FIG. 3.—PART OF A DISEASED BRANCH OF A CHESTNUT TREE, SHOWING TYPICAL PUSTULES AND FORM OF SPORE DISCHARGE IN DAMP WEATHER.

[Magnified 3 diameters.]

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