Commonwealth of Pennsylvania

FINAL REPORT

OF THE

Pennsylvania Chestnut Tree Blight Commission

JANUARY 1 TO DECEMBER 15, 1913

1112 Morris Building, 1421 Chestnut Street,
PHILADELPHIA, PA.

HARRISBURG, PA.:
WM. STANLEY RAY, STATE PRINTER
1914

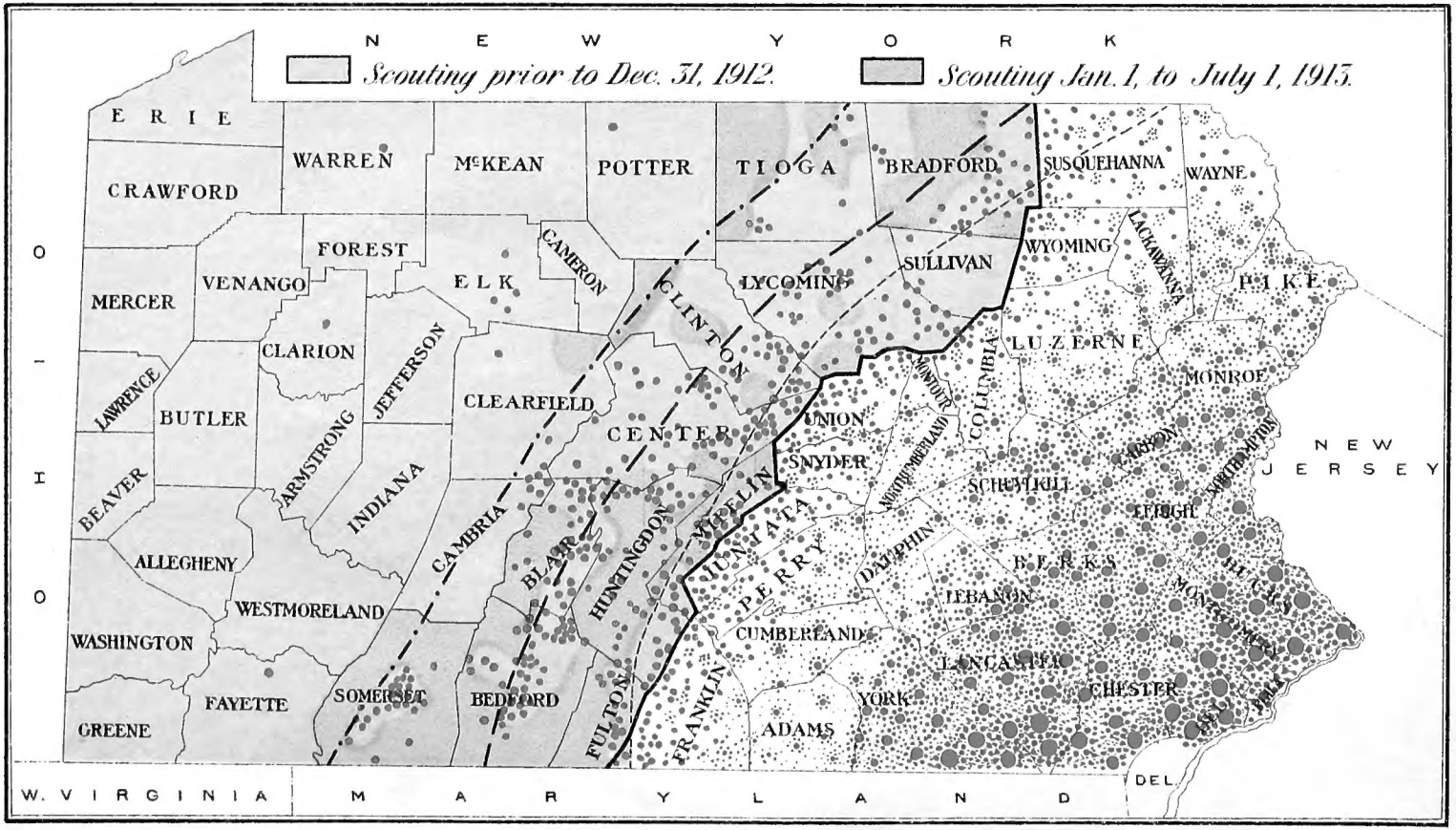

FIG. 1.

SCOUTING AND INFECTION MAP OF PENNSYLVANIA TO JULY 1, 1913.

The dots show the relative progress of the chestnut blight across the State. Each dot in the Western District represents a known spot of infection of from one to one thousand trees. The percentage of blight is shown diagrammatically in the Eastern District. The solid black line is the boundary between the Eastern and Western Districts. The light dotted line is the line of advance infection as determined in 1911. The heavy broken line is the advance line as determined in 1912.

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Harold Peirce, *Secretary*.....Haverford
Samuel T. Bodine.....Villa Nova
George F. Craig, ...Rosemont
Theodore N. Ely.....Bryn Mawr

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Thomas E. Francis, Field Manager, Western District
Joseph R. Wilson, Field Manager, Eastern District
David T. McCampbell, Chief Clerk

Irvin C. Williams, (Pennsylvania State Forestry Department), Collaborator

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Paul J. Anderson, Field Pathologist
F. P. Gulliver, Geographer
Caroline Rumbold, Physiologist in charge of Tree Medication
Joseph Shrawder, Chemist
Roy G. Pierce, Tree Surgeon
Keller E. Rockey, Forester in charge of Demonstration Work

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to

Hon. John K. Tener

Governor of the Commonwealth of Pennsylvania

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LETTER OF TRANSMITTAL.

THE COMMISSION FOR THE INVESTIGATION AND CONTROL OF THE CHESTNUT TREE BLIGHT IN PENNSYLVANIA

1112 Morris Building, Broad and Chestnut Streets

Philadelphia, December 9th, 1913.

HON. JOHN K. TENER, *Governor,*

Harrisburg, Penna.

Sir: We have the honor to transmit herewith our report of the operations of this Commission for a portion of the year 1913, this being also the final report of the Commission.

Eastern Asia, the home of the San Jose scale, has been found to be also the home of the chestnut blight. The disease has been found definitely in northeastern China; probably it is also present in Japan. There is no reason to doubt that it found its way to this country in the same way that the San Jose scale did, on nursery stock, and at about the same time, or perhaps somewhat later. Any system of strict inspection of imported nursery stock could have kept it out of this country, but no such system was then in use. It would probably not have been possible at that time to secure a law authorizing such inspection because of the lack of public appreciation of the seriousness of imported fungous and insect epidemics.

The oldest known spots of chestnut blight infection are in the neighborhood of New York City. Here again the disease could have been checked at an early date and never found its way into Pennsylvania, but nothing of the sort was even attempted. In fact, even up to 1911, no official work was done in New York upon the disease. In 1908 Murrill* advocated cutting out all chestnut trees within half a mile of diseased trees, but this plan was never put into practice in New York. In general, the greatest conservatism has prevailed regarding the seriousness of the disease. The view that the fungus was native to America, and its great virulence due to winter injury and other temporary climatic effects upon the trees, has been strenuously advocated. The Commission from the first, however, adopted the theory of the Department of Agriculture that the disease was of foreign origin and hence to be considered in the light of a dangerous invader. This view has since been amply

*Journal of the New York Botanical Garden, Vol. 9, No. 98, p. 30.

justified. Pennsylvania was the first state to treat the epidemic seriously, but by the time the Commission was able to begin work the disease was spread over the eastern half of the State too completely to make its eradication there possible.

Twenty years ago such an epidemic as the present one would have attracted little attention, but now the prices of all classes of timber have been for some years increasing, and promise to continue to increase indefinitely. It is obvious that every possible care must be taken of the present forest stand; upon this point there is no longer disagreement. In Pennsylvania the chestnut is especially valuable, standing in intimate relation to many of the leading industries of the State. It is distributed throughout the State, comprising at least one-fifth, possibly one-third, of the timber. It is naturally adapted to poor, hilly land not suited for agriculture, and will produce profitable yields of extract wood, fence posts, rails, etc., in 25 to 30 years; and ties, poles, and saw timber in 40 to 50 years. Because of its comparatively rapid growth, its superior ability to perpetuate itself by means of sprouts, and the great variety of its uses, the chestnut may be considered the most important forest tree in the State. The ease with which chestnut can be managed according to the principles of forestry made it, before the appearance of the blight, one of the principal species depended upon to solve the problem of the future timber supply of the State. On steep slopes, where the per cent. of chestnut is high, serious deterioration, washing of the soil, and reduction in water supply will undoubtedly follow the destruction of the chestnut trees.

The complete loss of the present commercial stand of chestnut in Pennsylvania, which, now that the Commission has ceased work, seems absolutely certain, is a calamity which will be fully realized only in the future. In matters of this kind we have obligations to the future, aside from the particular emergency in hand. This is not the last tree disease that will sweep over the State. All efforts to control this disease would be justified even if we only learned how to control the next one. Methods which may not be practicable now will be highly practicable twenty years from now on account of the steady increase which is bound to come in timber values. The mere fact that this campaign against the chestnut blight has been undertaken at all shows a great advance of thought over that of previous years.

With these facts in mind, it is obvious that three courses were possible, when the extent and seriousness of the chestnut blight was first realized in Pennsylvania.

First,—Do nothing.

Second,—Conduct scientific investigations of the disease with the

hope of determining by laboratory methods and very small field experiments some method of control.

Third,—Conduct scientific investigations, and at the same time immediately attack the epidemic by any and every means that seemed to afford any possibility of checking or even delaying the course of the disease. To follow the first method would have been to emulate simply the example of New York and New Jersey. The second course had many points in its favor, but it was obvious that such a course would yield no results in time to be used on the present epidemic, though possibly of the largest ultimate value. The third course appealed to the Commission as the only one possible under existing circumstances. The greatest handicap was the extent to which the disease was already present in the State.

In the eastern half of the State the disease was obviously beyond control. In the western half the best course available, and in fact the only method that has been proposed at all for control of the disease, was that of cutting out the advance infections. While this method is open to many criticisms, nothing better has been proposed even to the present time. The Commission adopted the cutting out methods advocated by the U. S. Department of Agriculture with two exceptions: (1) Spots of considerable size were cut out in some cases; that is, the cuttings were not limited to strictly advance infections. (2). No immune zone was established at first, although this might have been done later. The method was essentially that advocated by Murrill in 1908, except that trees were not cut to as great a distance as half a mile from the source of infection. Detailed reports of the cutting out work are appended. It is sufficient to say here that the progress of the disease in the western half of the State has been set back five years, and west of the line extending from Bradford to Somerset counties there is little infection, and what infection there is dates from 1913. There is no reasonable doubt that the disease could have been kept *instatu quo* indefinitely, had the work of cutting out continued. As set forth in the appended reports, the methods of cutting out have been improved, the cost determined and reduced, and winter scouting established as a practical method. These methods developed by the Commission are now in active use in the States of Virginia and West Virginia, where the campaign of eradication is being vigorously pursued.

One of the most valuable results of the Commission's work was the establishment of the fact that the wood of a blighted tree is entirely fit for use, and if utilized soon after the death of the tree from blight, can be disposed of in the regular way and at normal values. The Commission has advocated the cutting out of all diseased trees, since on account of the prejudice against blighted poles

and timber, and the possibility of the market becoming glutted, this is the best plan. Also the cutting of diseased trees was urged because it would reduce the sources of infection. Since utilization was all that remained to be done in the eastern half of the State, the Commission secured a special reduced freight rate on blighted lumber, determined what demand there was in and out of the State for chestnut lumber and other chestnut products, and proceeded to bring owners and dealers together. This work had just reached the point of its highest efficiency when the Commission ceased work. As there is no longer any means of inspection and certification of diseased lumber, the reduced freight rate is no longer available.

When the Commission began work but few investigations had been made of the chestnut blight, and other States, as well as the U. S. Department of Agriculture, were working on the disease without special funds. The Commission by its example and by its direct efforts, assisted in securing Congressional and State appropriations, and practically all of the scientific work and all of the practical work which has been done on this disease since 1910 was made possible by the efforts of this Commission. A National law was passed which requires strict inspection of all imported nursery stock and the prohibition from entry of certain classes of stock, and which makes the repetition of such an event as the importation of the chestnut blight impossible, or at least highly improbable. The work of this Commission was one of the greatest factors in bringing about the passage of this law.

Not only has the work of the Commission aroused public attention throughout the Eastern States regarding this disease, but the public is awakened as never before by the example of the destruction of one species to the necessity of conservation of all timber resources. In this State the Commission has carried on a liberal educational campaign in which it has had the hearty co-operation of the State Forestry Department, the Conservation Association, such organizations as the Boy Scouts, various lumber and trade associations, and many other organizations, institutions, and individuals.

In conclusion, it seems necessary to call sharp attention to the real lesson to be learned from the chestnut blight epidemic—viz.: the necessity of more scientific research upon problems of this character; to be undertaken early enough to be of some value in comprehending, if not controlling the situation. We have seen that the blight might have been kept out of the country in the first place by inspection, or once in, that it might have been destroyed, or at least checked before it had gotten widely distributed. But instead it was permitted to enter, and to spread for many years without scientific notice, and for several more years without any organized at-

tempt to control it, or even to study it seriously. Are we doing any better now with reference to the future?

China has been shown to be the home of the chestnut blight. China, then, would seem to be the obvious place to study it; but no pathologists are there, and state and federal parsimony has so far failed to provide for any investigations of the disease on its home ground by American pathologists.

It has been proposed to replace the chestnut in southern New England by plantings of white pine, in itself the most important eastern timber tree; but the white pine is in turn subject to a newly imported disease, the blister rust. It is not certain that very serious and united efforts are being made to investigate and control this disease even in the States that introduced it. As in the case of the chestnut blight, scepticism has even been expressed as to its seriousness. Again, it would seem that the obvious place to determine the seriousness of the blister rust was in Europe, its home; yet to date neither state nor National government has dispatched a scientist on this errand. In this connection it may not be amiss to call attention to the fact that in Pennsylvania there is, aside from the employees of this Commission, only one professional plant pathologist! Yet the preventable damage which this one plant disease—chestnut blight—has done, would pay for the work of more plant pathologists than are now at work in the entire world.

The Commission closes its work with regret, knowing well that the blight will now spread over the State without hindrance. There is some satisfaction in knowing, however, that the work left undone in Pennsylvania has been actively taken up in Virginia and West Virginia, and that the States of Ohio and North Carolina are making studies preparatory to combatting the disease as soon as it appears in those States. The scientific research carried on by the Commission will be continued by the U. S. Department of Agriculture. We may be certain that the war against this and other foreign epidemics will not cease until science is so far advanced in both theory and practice that they can be controlled.

Very truly yours,

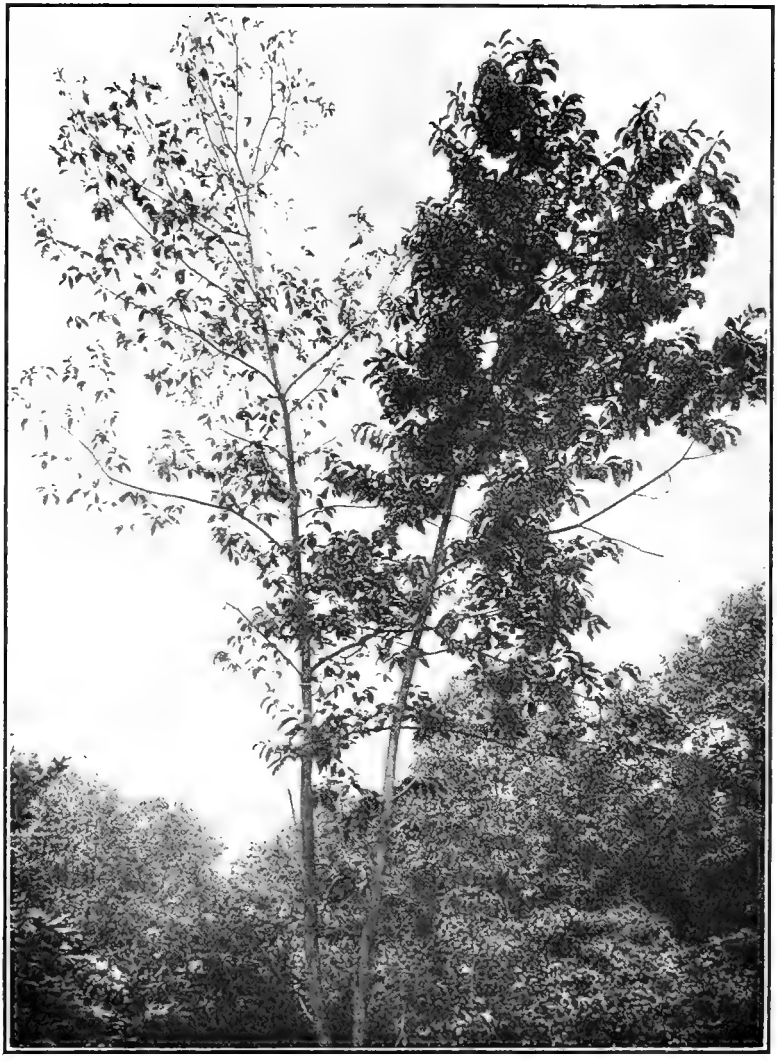
WINTHROP SARGENT,

Chairman.

Report of

Hon. I. C. Williams

Deputy Commissioner of Forestry, Collaborator



A common mark of the blight. Small leaves which developed in the early spring on a top recently girdled by the blight, showing midsummer condition. Withered leaves above the canker; sprouts below.

A HISTORY OF THE EARLY PENNSYLVANIA EFFORT TO COMBAT THE CHESTNUT BARK DISEASE.

BY HON. I. C. WILLIAMS, DEPUTY COMMISSIONER OF FORESTRY, COLLABORATOR, HARRISBURG, PA.

Preliminary to the final report of the Chestnut Blight Commission, it is thought desirable to make a statement detailing the history of the chestnut bark disease in Pennsylvania so far as known, and of the efforts to combat it, leading up to the formation of the Commission under the law of 1911, and the extended work of repression begun at that time.

The attention of the Pennsylvania Department of Forestry was first attracted to the appearance of the chestnut bark disease in this State by a letter from Mr. Harold Peirce, of Haverford, dated July 18, 1908, reporting its presence in Lower Merion Township, Montgomery County, and by an article appearing in the November, 1908, number of "Conservation," from the pen of Dr. John Mickleborough, of Brooklyn. Subsequent correspondence with Dr. Mickleborough revealed the fact that he had been a student of the disease for over a year and had become familiar with it in all of its ordinary aspects. To these two gentlemen, therefore, the State is primarily indebted for the subsequent efforts made to study more particularly, and to attempt to control this vicious tree disease.

The facts relating to the discovery of the disease in America and its identification are pretty well known. It was first detected by Dr. Hermann W. Merkel, in the Bronx Zoological Park, New York City, in 1904, although it is almost certain that it existed in that neighborhood for probably more than a year prior to Dr. Merkel's discovery. Referred for identification to Dr. W. A. Murrill of the New York Botanical Garden, he published a description of it in 1906*, and by him the fungus was named *Diaporthe parasitica,* so called because it was believed to be the only parasitic species of the genus. The naming of the fungus has since been corrected by means of the researches of Anderson, Clinton, Farlow, Shear and Stevens, and it is now known systematically as *Endothia parasitica.*

Some controversy has been had over the origin of the disease and the case is probably not yet settled. Dr. Clinton's contention is and has been, that it is a native fungus, which, by means of weather con-

*See "Torreya," Vol. 6, No. 9.

ditions and possibly other factors, has taken on new attributes. Dr. Metcalf, his co-worker Prof. Collins, Dr. Shear, and others believed and still maintain that it is of foreign origin, introduced into America by the importation of horticultural stock. Its first known appearance in the region of New York City and its spread in concentric zones from that point as a centre of infection, lent much plausibility to this theory. The recent discovery made by Mr. Frank N. Meyer, of the same fungus in northeastern China, where it is parasitic on *Castanea,* and where, it appears, the host trees have become rather highly resistant to its attack, leads further probability of correctness to Metcalf's theory.

Possibly a great hope for America lies in this Chinese discovery. Pathologists and foresters are anxiously looking forward to the results of experiments now being made and which will be attempted, we hope, on a much larger scale in the future. The regrettable, ever-present fact is that this disease is with us here and now, and must be reckoned with from every angle of attack. There seems to be no present diminution sufficient to warrant the belief that it is likely to wear itself out, or that our trees will become sufficiently resistant to ward off the attack prior to the destruction of the trees themselves.

Subsequent correspondence between Dr. Mickleborough and the Department of Forestry culminated in a letter from him under date of March 9, 1909, in which he outlined a definite plan for the examination of a supposedly infected territory in southeastern Pennsylvania, and offered his services to the Commonwealth for carrying out plans of investigation. The proposed inspection was approved by the Department on March 17, 1909, and the services of Dr. Mickleborough thus enlisted. The first inspection visit was made by him in company with the writer, March 29, 1909, at Mt. Holly, in Cumberland county, but where no evidence of the disease was found at that time.

Prior to the beginning of this work in 1909, Dr. Mickleborough had been invited by Dr. Jane Baker, physician in charge of the Chester County Insane Hospital, to speak before an educational conference at Embreeville, Chester county. At this time the disease was not generally prevalent in that region, but a number of infected chestnut trees were found.

The work of inspection over the southeastern portion of the State thus undertaken under the direction of the Department of Forestry, as stated above, was conducted by Dr. Mickleborough, and carried through or into almost every county east of the Susquehanna. During the progress of this examination the chestnut blight was not found north and west of the South Mountain, although prior to this time the United States Department of Agriculture had reported the

existence of two spot infections in the western portion of the State, near Altoona, and a re-examination of the material relating thereto by Dr. Metcalf and his assistants, seemed to leave no doubt as to the correctness of this report. Certain it is that in May, 1909, there was no large or extended infection west of the Susquehanna. Had there been in existence at that time the means to carry on work of control along both sides of the Susquehanna River, who can tell what the result might have been, looked at in the light of our present knowledge?

The report of Dr. Mickleborough's inspection and study was published by the Department in the autumn of 1909. This is a 16-page pamphlet illustrated by drawings showing a portion of the structural formation of the fungus, and by a Lumiere color photograph of a stem section of chestnut covered externally by the fruiting fungus. This specimen of infected chestnut wood was sent in from Pike county, in the upper Delaware valley, and was incubated and developed in a moist cell in the Department of Forestry during the summer of 1909.

In the early part of the study of this bark disease, it was believed that the Japanese species of *Castanea* was either immune or highly resistant to attack. Several specimens of Japanese chestnut were under observation on Long Island, and fairly gave rise to this belief. One grove examined near Westbury, in June, 1909, showed the Paragons and common chestnuts badly attacked. The Japanese showed no attack at all.

Through the courtesy of the Hicks nursery at Westbury, forty-five young chestnut trees supposed to be Japanese, and one hundred grafting scions were sent to the chestnut orchard of Mr. Levi Wise, at Gap, Lancaster county, Pennsylvania, and distributed among four persons of the neighborhood for planting and testing out for immunity. The bark disease was at that time particularly prevalent in the chestnut woods at this place. Some of the newly planted trees died from other causes, but enough of them were attacked and killed by the blight to show that these particular trees, at least, were not immune.

On the 29th day of March, 1910, Dr. Mickleborough delivered a lecture on the subject of this tree disease before the Main Line Citizens' Association at the Merion Cricket Club, Haverford, Pa. This meeting was arranged largely through the efforts of Mr. Peirce, who at that time was the owner of several acres of chestnut woodland, and of which tract Dr. Mickleborough made a rather extended examination, finding the chestnut blight present in a number of trees. This discovery and the lecture delivered on the subject brought the matter prominently to the attention of the citizens of that neigh-

borhood, and later led to some very important developments with respect to studying and combating the disease.

Following this address by Dr. Mickleborough, Mr. Peirce was in correspondence with the Department of Forestry, calling attention to the inroads being made upon the chestnut trees by this disease in the neighborhood of his residence, requesting the Department to render such help as it might be able in assisting the people to understand the situation better, and, if possible, to eliminate or at least attempt to control the trouble. This correspondence culminated in the calling of a meeting on May 23, 1910, at the house of Mr. Robert W. Lesley, at Haverford, which was attended by a number of the residents and land owners of the neighborhood, by Dr. John W. Harshberger, the botanist, representing the University of Pennsylvania, and by the Deputy Commissioner, representing the Pennsylvania Department of Forestry.

The preliminary arrangements for beginning an extensive survey of this region were discussed at this meeting. The Department representative made his report to the Forestry Commission at its meeting held on June 3, 1910. On motion of Dr. Rothrock, the Commission directed that the Department render the desired help, and on the same day a letter to this effect was sent to Mr. Peirce, the secretary of the citizens' meeting. On September 1, 1910, a corps of inspectors from the Department in charge of the Deputy Commissioner, arrived at Haverford and Ardmore, prepared to begin their work. Offices were speedily fitted up in the building of the Merion Title and Trust Company at Ardmore, and the first inspection of trees was made on the property of Mr. Lesley on Saturday, September 3rd. From this date forward until December 19, 1910, the work was vigorously carried on, and a close inspection made of 296 properties, covering most of the region extending from Overbrook to Paoli, and from the Schuylkill River on the north, to a considerable distance south of the Pennsylvania Railroad. A draft of each property was prepared showing the location of all chestnut trees and indicating those which at that time were apparently free of disease, as well as those showing the infection. Each property owner was then furnished with a copy of the report and draft relating to his own land.

To show the interest taken in this work by members of the Main Line Citizens' Association, it is necessary only to state that the work was carried on almost entirely at the expense of the association. The individual contributions for the purpose amounted to $2,707.70.

During the progress of this inspection, a second public meeting was held in the auditorium of the Merion Cricket Club, at which

time a preliminary report was submitted and discussion had with respect to the situation as it then existed. This meeting was attended by a large number of ladies and gentlemen, members of the association, and much interest was shown in the progress reported. The final report of the committee of the association having the work in charge was printed and rendered to the members under date of May 8, 1912. This committee was as follows: Messrs. Harold Peirce, Chairman; Theodore N. Ely, Allan Evans, Edgar C. Felton, William Righter Fisher, Alba B. Johnson, and Robert W. Lesley.

In a letter bearing date the 12th day of March, 1909, addressed to the Commissioner of Forestry at Harrisburg, Dr. Mickleborough used this language. "As to remedy, the best that can be suggested by anyone at present is *Control* and not *Extermination,* for various reasons. This I think is also true of the San Jose scale." It will thus be seen that the original idea involved in the attack on the chestnut blight in Pennsylvania was *control,* just as the Department of Agriculture of this State has always aimed at *control* of the San Jose scale, suggested in the letter just quoted. After the preliminary studies were completed, no one believed that extermination or eradication could be accomplished with the means at hand; but it was thought then, and is still the belief of those who are most closely associated with the work, that a *control* is possible, and that it was much more possible then than now, after the lapse of a period of five years.

During the progress of the inspection along the Main Line, it became apparent that more than a local effort was demanded if any substantial progress were to be made towards preventing the spread of the disease. Steps were taken to enlist the active interest of the Governor and the Legislature, (then in session). On the evening of April 10, 1911, Governor Tener sent a special message to both houses of the Legislature, calling direct attention to the situation, and asking the help of the General Assembly to combat the disease. The Governor's message was as follows:

"Commonwealth of Pennsylvania,
"Executive Chamber,
"Harrisburg, April 10, 1911.

"Gentlemen of the Senate and House of Representatives of the Commonwealth of Pennsylvania:

"I have the honor to call your attention to a new and virulent disease of the wild chestnut tree, commonly known as chestnut blight, recently discovered near New York City, and hitherto unknown in America. The disease has continued to spread, destroying the chestnut trees in the neighborhood of New York City and well up the Hudson. It has invaded Long Island, beginning at the western end, sweeping eastward, practically covering the island. It has

progressed to the southwest, through the whole of the State of New Jersey, and all the chestnut trees there appear to be doomed to destruction. It has entered Pennsylvania and is prevalent in the Delaware Valley. It has been discovered in the following counties: Pike, Monroe, Northampton, Bucks, Montgomery, Chester, Philadelphia, Delaware, Lancaster, and southern Berks. In isolated places it has crossed the Susquehanna, and is now detected in eastern York, eastern Perry and one portion of southwestern Perry. Other points of infection have been found near Altoona and Greensburg.

"Experiments made by the Department of Agriculture at Washington demonstrate that it is possible to prevent the spread of the disease by removing spot appearances as they are detected, and de stroying the trees in which the disease occurs. By this means the region around Washington has been freed from the blight for at least two years, and it has not re-invaded this area. In the southeastern portion of Pennsylvania, where the infection is severe and almost complete, little hope exists for saving the trees, but in that portion of the State west of the Susquehanna and north of the Blue Mountains, it is hoped, by prompt action on the part of the State, to prevent further damage. If this disease can be held within the southeastern portion of the State, it will mean the saving of the wild chestnut trees in the other parts of the Commonwealth, the value of which extends into the millions of dollars.

"I therefore recommend that the Legislature give immediate attention to this important subject and that a Commission be created with sufficient power and appropriation of moneys to determine upon and employ efficient and practical means for the prevention, control, and eradication of this disease, and that said Commission be authorized, in conjunction with the Department of Forestry, or otherwise, to conduct scientific investigations into the nature and causes of such disease and to adopt such means to prevent its introduction and spread as may be found necessary.

"JOHN K. TENER."

The next day, April 11, 1911, a bill having this purpose in view, and which had been previously carefully drawn and vigorously criticised, was simultaneously introduced in both House and Senate. This bill became a law by the signature of the Governor, June 14, 1911*. The law creates a Commission of five members and vests them with almost plenary power to carry out its mandates. An appropriation of $275,000 became available at once. The appointment of the members of the Commission followed after an interval of about two weeks. Organization was effected, officers and assistants chosen, and on August 23, 1911, the Commission was prepared to proceed with its work.

While the major effort of the Commission from the beginning was to get a control, the subject of eradication was vigorously debated, and, as will be seen in subsequent pages, determined efforts at eradication were undertaken under the advice and direction of

*See Pamphlet Laws, 1911, page 922.

the Commission. The feeling was that if there be any merit in such effort, opportunity ought not to be lacking to prove it. The early announced and decisive plan involving the cutting-out method, proposed and outlined by Dr. Murrill, contributed very considerably toward the decision to try out this method.

The Murrill plan (§) was as follows:

"Owners of standing chestnut timber within the affected area are advised to cut and use all trees, both old and young, that stand within half a mile of diseased trees, unless protected from infection through wind-blown spores by dense forest growth or some other natural barrier. This may not prevent the spread of the disease through the agency of storms, birds and squirrels, but it will at least retard its progress. Old weathered chestnut trunks that have been dead several years have no power to spread the disease, and these may be cut at leisure for the tannic acid factory or for firewood. Trees of good size recently killed should be turned into lumber as soon as possible; the fungus affects only the bark, but other fungi may afterwards impair the value of the wood if allowed to stand too long. Discarded branches and young trees of no value that are cut near the edge of the infected area should be burned at once in order to destroy the spores they contain; but if they are well within the zone of infection, such precaution is useless."

Every element in the Murrill plan has been employed both by the Commission and by the State Department of Forestry. The fact that subsequently Dr. Murrill partially shifted his ground*, did not seem sufficient reason to warrant the abandonment of a plan of attack which in many cases was productive of satisfactory results.

The history of what work the Commission did, and of the results accomplished form the substance of several preliminary reports submitted to the Governor from time to time. The final report is what follows.

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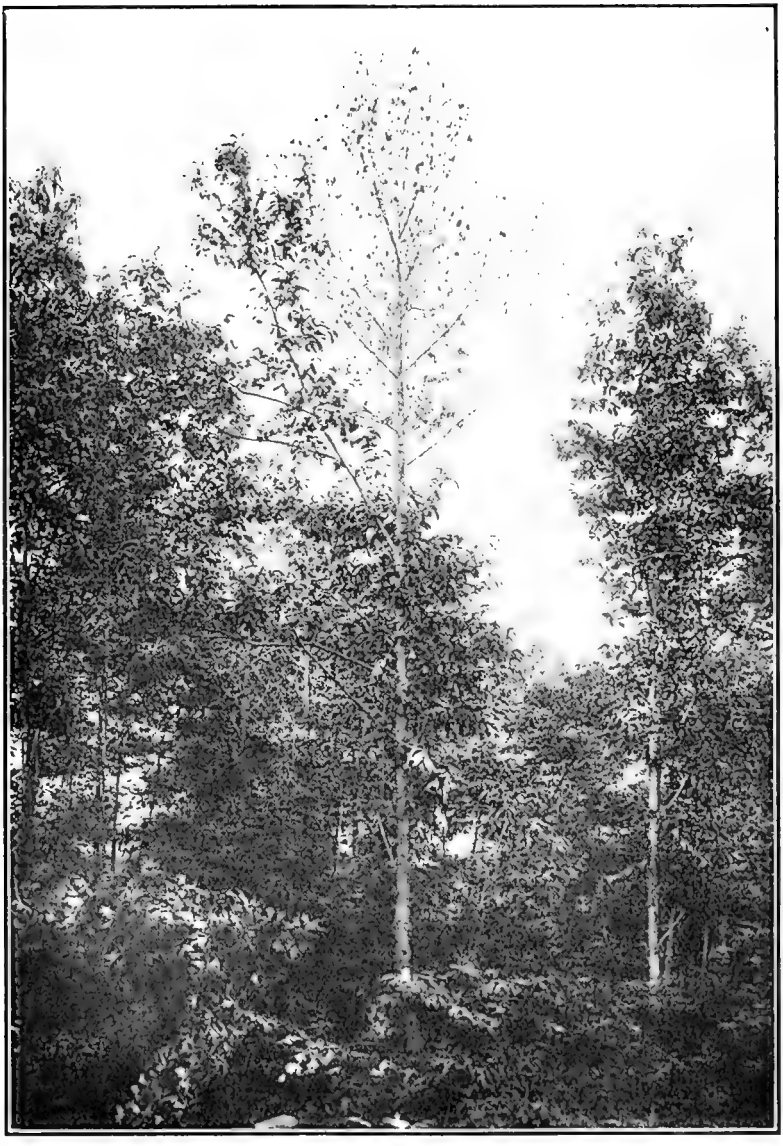
§W. A. Murrill: Journal of the New York Botanical Garden, Vol. 9, No. 98, p. 30. February, 1908.

*Harrisburg Conference Report, 1912, pp. 194, 201, 202.

Report of

Mark A. Carleton

General Manager Pennsylvania Chestnut Tree
Blight Commission



Summer condition of a blighted tree. The withered leaves of the top above the canker, and the vigorous sprouts below the canker are characteristic signs.

THE FIGHT TO SAVE THE CHESTNUT TREES; FINAL REPORT OF THE GENERAL MANAGER.

By MARK A. CARLETON, GENERAL MANAGER,
PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION.

In closing the active work of this Commission, it is a great satisfaction to be able to report constant progress to date, and the attainment of good, practical results. The work began two years ago in the midst of much skepticism as to its possibilities, but the optimism of the Commission and the wisdom of its methods of operation have in the main, been amply confirmed by the results since obtained.

PROGRESS OF FIELD WORK.

A more or less definite division has been maintained between the slightly infected Western portion of the State and the badly infected Eastern portion, known respectively as the Western and Eastern districts. In a previous report it was stated that in the Western part of the State the blight had been eradicated to the extent covering nearly one-half of the area of the State. This area so far as is known to date has been maintained free from the disease. In a few cases new infections were found which have been removed. It is important to note in this connection not only the fact that the progress of the disease has been checked in Western Pennsylvania, but that we have without much doubt prevented the blight from gaining a foothold in Ohio, and nearby portions of New York and West Virginia.

In the Eastern District since January first of this year, the field work has developed almost entirely into a campaign of utilization, no rigid sanitation work having been conducted except for the protection of chestnut orchards and nurseries.

EFFECTIVENESS OF THE CUTTING-OUT METHOD.

In the two years work no facts have yet been obtained which would indicate the advisability of any change in our present method of "cutting out" diseased trees and thorough cleaning of the stumps for the eradication of the disease. A number of tracts where the disease has been eradicated by Commission employees have again been inspected recently, giving results, which are in the main, favorable. Of course, improvements have been made as to details all

along. It is not a pleasant prospect to consider the serious results likely to follow after this method of eradicating the disease, conducted by the Commission, is obliged to cease.

BENEFICIAL INSECTS.

It will be of interest to quote here the words of the Forest Entomologist, of the U. S. Department of Agriculture, in his comment on a widely disseminated press notice of that Department, November 22nd, 1912, apparently based on the work of F. C. Craighead.

"The beneficial work of these insects can, however, be greatly encouraged if the owners of the timber will dispose of the diseased trees in the principal centers of infection, as recommended by the Chestnut Blight Commission of Pennsylvania, and other State and Federal officials. Thus, if the large majority of the infection is disposed of, the beneficial insects will concentrate on the remaining scattering and isolated infections, and thus more completely destroy the fruiting bodies and contribute to the protection of the remaining living trees. In fact, it is a question of the owner securing the greatest benefit from the natural agencies of control by doing his share of the work."

NURSERY INSPECTION.

The inspection of nursery stock has been made even more rigid than before. Not only has it been required that every individual tree should be inspected by a competent employee of this Commission, but in shipping it has been required also that every individual tree should be tagged. A copy of the revised regulations governing the inspection and shipment of nursery stock is appended to this report, which shows the form of tags required to be attached both to individual trees and to bundles of trees. The fact that several of the most serious infections in the State have been caused heretofore by the planting of diseased nursery stock in new localities is sufficient reason for so rigid an inspection.

DISCOVERY OF THE CHESTNUT BLIGHT IN CHINA.

It has recently been proved by authentic specimens and artificial cultures of the material transmitted by the Explorer of the U. S. Department of Agriculture, that the chestnut blight exists in Eastern China.* This fact makes it all the more probable that the beginning of the disease in this country may have come about by the

*Science, Vol. 36, No. 937, p. 825, Dec. 13, 1912.

Winter condition of a chestnut tree with a blight-girdled top.

introduction of such diseased stock from China or Japan. That new centers of infection are often started by the introduction of diseased nursery stock, is a common observation.

PROTECTION OF ORCHARDS AND NURSERIES.

It has been the policy of the Commission for sometime to protect orchards and nurseries from outside infection in all cases where the owners have expressed a desire for such protection, and have themselves taken care to control the disease as much as possible. This work has been successful much beyond our expectations. The largest and most important orchards thus protected are located at Sunbury, Paxinos, and Berwick. The owners of neighboring forest tracts have been required to remove all diseased chestnut trees within one-half mile of the nearest point of the orchard in each case. An interesting result in one of the most important of these cases is the fact that these owners have been able to sell the products of their diseased trees for an amount considerably above the entire cost of removal, sanitation work, etc.

PREVENTION OR REMEDY.

At this writing no specific remedy has been found for the disease. However, later information confirms the statements previously published that the disease may be largely prevented from entering healthy trees by contant and regular spraying with Bordeaux Mixture made up in proportions of 5 pounds of lime, 5 pounds of copper sulphate, and 50 gallons of water. The application of this mixture simply prevents any new germination of spores, but has no effect whatever, in cases where the disease has already started in the tree. Because of the cost, it is, of course, not applicable in forests.

CONTROL OF THE DISEASE IN ORCHARDS.

By cutting out the cankers and coating with antiseptic solutions and water proofing afterwards, the blight can be fairly well controlled in chestnut orchards and in certain valuable lawn or park trees. In connection with this treatment a spray of the Bordeaux Mixture as above noted should be used occasionally. Excellent results along this line of experiment are shown in a large orchard at Paxinos, and in several of the public parks of the State.

FAKE TREATMENTS, THEORIES OR CAUSES, ETC.

As often happens in the case of a public campaign against a serious epidemic, we have been constantly besieged by the gratuitous offers of various and sundry remedies for the blight, which include applications of fertilizers to the soil, insertions of flowers of sulphur and other compounds in holes bored in the trees, applications of coatings of different chemicals to the body of the tree, and numerous other treatments, all of which we believed in the beginning to have no value. However, all parties having theories to advance or remedies to propose have been given a chance to prove their claims by experimenting on trees controlled by the Commission for such purposes at Emilie, Bucks county. A number of parties have taken advantage of the opportunity. Recently, an examination was made of the various treatments by a competent Board of Reviewers, whose conclusion was that not one of the treatments tried had any deterrent effect upon the chestnut blight.

Many of the persons above mentioned were apparently sincere in the claims they made, and were simply ignorant of the true cause of the disease. Instances have come to our attention, however, of parties practicing certain methods of treatment and charging for the same, who are plainly impostors. Employees of the Commission have no doubt benefited many people by exposing the methods of these impostors.

EXAMINATIONS OF INDIVIDUAL TREES.

Excellent opportunities have been afforded the tree surgeon of the Commission and his assistants to counteract the influence of false theories and worthless remedies such as above mentioned, in responding to the numerous requests for the examination of individual trees. These requests have continued to come to the Commission headquarters right up to the time of closing our work. No other line of work has been so effective in arousing the personal interests of the people. No request from any part of the State has been ignored. In this connection much incidental advice has been given to property owners as to the general handling of lawns and orchards, and the management of small woodlots.

PUBLIC PARKS AND FARMS.

In co-operation with the officials of Wildwood Park, at Harrisburg, the Commission has completely eradicated the blight from that Park, about 150 diseased chestnut trees having been removed or

treated out of a total of 1,290 trees. Here in a few cases the peeled stumps were creosoted to show that method of sanitation. Considerable help has also been given to the management of Fairmount Park. Arrangements have also been made for the entire removal of blighted chestnut trees from the State Live Stock Board's Farm, in Delaware County. In the event of the continuation of our work, it was also planned to eradicate the blight thoroughly from the Valley Forge Park grounds.

BLIGHT-EATING BEETLES.

It has been announced by the Bureau of Entomology, U. S. Department of Agriculture, that several species of beetles have been found eating the spores of the blight fungus, and it is stated that "should these insects prove as beneficial as the observations indicate, they are certain to be an important factor in the natural control of the dreaded chestnut blight disease." It is worthy of note in this connection that the insect investigations of this Commission have shown that a number of insects also carry large quantities of blight spores, and may thus indirectly assist in the dissemination of the blight. One of these insects which was found to carry an enormous number of spores is one of the beetles above mentioned as eating the fungus.

CORDWOOD AND THE SPECIAL TARIFF.

Since writing the last report, there has been a considerable shipment of chestnut cordwood, shippers taking advantage of the special tariff issued by the Pennsylvania Railroad. At last accounts the prospects were that there would be much business in this line right along in the future, being encouraged by the special low rates.

PROMPTNESS IN UTILIZING CHESTNUT.

Observations made by Commission employees in company with commercial lumbermen have shown that already in certain localities, diseased chestnut has been dead so long that deterioration is beginning. We have, therefore, made it plain to owners of such chestnut and have advertised the fact as much as possible, that promptness is necessary in getting rid of the diseased trees, if the owners wish to obtain the most value possible from the trees.

INTENSIVE LOCAL UTILIZATION.

Our most difficult line of work has been that of utilization. Facts as to the conditions could easily be obtained, but the difficulty has been in bringing the buyer and seller together. Recently a plan was

adopted, which if we would be able to continue its operation, would without question, hasten very rapidly the utilization work. This plan, the details of which are given elsewhere, is to canvass particular localities thoroughly, finding out just what can be offered in the way of different chestnut products, ascertaining the local market for the same, and then determining so far as possible, where else the surplus may be marketed. In connection with the carrying out of this plan, up to this writing as many as a dozen portable saw mills have been located in one county, and in other localities many practical operations had already been started, thus tending to rapid and clean cut work in utilizing blighted chestnut.

RESISTANCE AND IMMUNITY.

The discovery of the chestnut blight in China makes it now all the more probable that resistant chestnut stocks may be obtained in that country. It was, therefore, a wise movement last fall when we took advantage of the opportunity to obtain a considerable amount of seed of what is probably the most important chestnut in Eastern China. A large quantity of the nuts were planted at Paxinos, and the seedlings at this date which are from six to fifteen inches high, are looking well. From the nuts sent also to the State Forest Nursery at Greenwood, 75 seedlings are at present growing, and from those sent to Asaph, Pa., there are now 182 plants, averaging ten inches in height. All of these seedlings will be of much value in cross-breeding and other ways in the important future work of developing blight resistant orchard trees. In this connection it should be noted that in a recent bulletin issued from the Arnold Arboretum a considerable discussion is given of the possibilities in developing blight resistant chestnut trees from Chinese introductions, a number of the latter now being grown at the Arboretum. The two mentioned as the most important include the one of which we now have seedlings. So far these Chinese chestnuts grown at the Arboretum have not become blighted.

According to the Kew Index, there are seven species of chestnut and twenty-one of the chinquapin in the world. From all these species there should be many other chances of obtaining blight resistant trees that may be used in breeding and making our own stock better.

CHESTNUT BLIGHT EXHIBITS.

Several exhibits of specimens showing the work of this Commission have been placed in public institutions which will remain as monuments of our work. An excellent exhibit has been placed at

the Carnegie Museum at Pittsburgh. Another has been finally completed in the State Museum at Harrisburg, and a third one at the Commercial Museum in Philadelphia is not yet finished, but has been planned on rather a large scale. It was contemplated also to place another exhibit in the Everhart Museum at Scranton, which may yet be done. An excellent exhibition of specimens and illustrations of our work was made in connection with the State Forestry Exhibition at Horticultural Hall, Philadelphia, in May.

PUBLICATIONS.

When this final manuscript is published, there will have been issued the following publications of this Commission:

Report of The Pennsylvania Chestnut Blight Conference. (Unnumbered).

Bulletin No. 1—The Chestnut Blight Disease.

Bulletin No. 2—Treatment of Ornamental Chestnut Trees Affected with the Blight Disease.

Report of the Pennsylvania Chestnut Tree Blight Commission, July 1st to December 31st, 1912. (Unnumbered).

Bulletin No. 3—Field Studies in Blight.

Bulletin No. 4—Chestnut Blight Fungus and a Related Saprophyte.

Bulletin No. 5—The Symptoms of Chestnut Tree Blight and a Brief Description of the Blight Fungus.

Bulletin No. 6—The Chestnut Tree. Methods and Specifications for the Utilization of Blighted Chestnut.

Bulletin No. 7—Morphology and Life History of the Chestnut Blight Fungus.

Final Report of the Chestnut Tree Blight Commission. Numerous descriptive and educational circulars, charts, etc.

CO-OPERATION.

Very effective co-operation has continued to be maintained with the Office of Forest Pathology, of the U. S. Bureau of Plant Industry. Recently the salaries of all pathologists connected with the Commission have been carried by that office, and there has been constant communication and co-operation in reference to all research work.

Much excellent help has continually been given by the State Forestry Department at Harrisburg, the Deputy Commissioner, Hon. I. C. Williams, being assigned as a collaborator with this Commission.

The authorities of the University of Pennsylvania have been exceedingly courteous in granting ample space for laboratory work

in the new Zoology Building. Room has also been given for laboratory work in tree medication in the Botanical Building. Franklin and Marshall College, at Lancaster, and the State College of Pennsylvania, have also provided room for laboratory work in the field investigations.

There has been a liberal interchange of ideas and helpful suggestions through correspondence with the State Conservation Commission at Albany, N. Y., the State Forester and State Pathologist of New Jersey, the State Forester of Maryland and of Massachusetts, and with officials in Virginia, West Virginia, and Maryland.

MUCH IMPORTANT WORK UNFINISHED.

The cessation of the work at this time is particularly unfortunate because so many important investigations, not yet finished, would likely have had a very practical and beneficial bearing upon the actual eradication of the disease.

First.—Very little is known about the bast miner—the insect which, as stated in another place, is probably one of the most important carriers of blight spores. A full knowledge of the life history of this insect would probably very soon have been completed, and which would be a most interesting contribution to science*.

Second.—The Chemist and Physiologist in tree medication had planned to use a new solution for injection into diseased trees, which according to chemical work already done, promises to check the growth of the blight.

Third.—The local intensive work in utilization had just begun, and as stated elsewhere, bids fair to solve largely the difficult problem of utilizing rapidly the diseased chestnut.

Fourth.—The discovery of the blight in China and the possession by the Commission of a large number of seedlings of one of the most important Chinese chestnuts, as well as immune and resistant Japanese stock, opens a field for breeding experiments which would without question have been of the greatest benefit to the owners of chestnut orchards.

Fifth.—Although not demonstrated before, it is now proved that birds and insects carry enormous quantities of spores of the blight fungus, which necessarily changes our viewpoint considerably with respect to the eradication of the disease.

Sixth.—In a number of forest tracts and several orchards, thorough "cutting-out" work and up-to-date surgery treatments have

*Since writing the above, this work has already been finished, as stated in footnote on page 46.

been started by expert employees of the Commission, which are just now beginning to show evidences of the value of this kind of work.

Brief statements of the results of the different lines of work conducted by the Commission follow, credited to the respective parties in charge.

FIELD OPERATIONS.

As heretofore, all field work has been conducted under the immediate direction of the General Superintendent, Mr. S. B. Detwiler. In the following statements some of the principal features of the work to date are pointed out by him, and also suggestions given to timber owners who may wish to clear their woods of blight on their own responsibility. A statement in detail of the effectiveness of sanitation cutting in controlling the blight, by Mr. Detwiler, is appended to this report.

REDUCTION OF FORCE.

A majority of the field agents of the Commission were dismissed in January, 1913, because it was believed that very little work could be done during the inclement months of winter and spring. However, the unusually open winter made it possible for the small field force retained to accomplish more for the time and money expended than at any previous time since our work was organized. An average force of 36 men in the western district and 11 men in the eastern district were in the field from the first of the year to July 25th, 1913, when all field work was discontinued.

BETTER WORK IN WINTER.

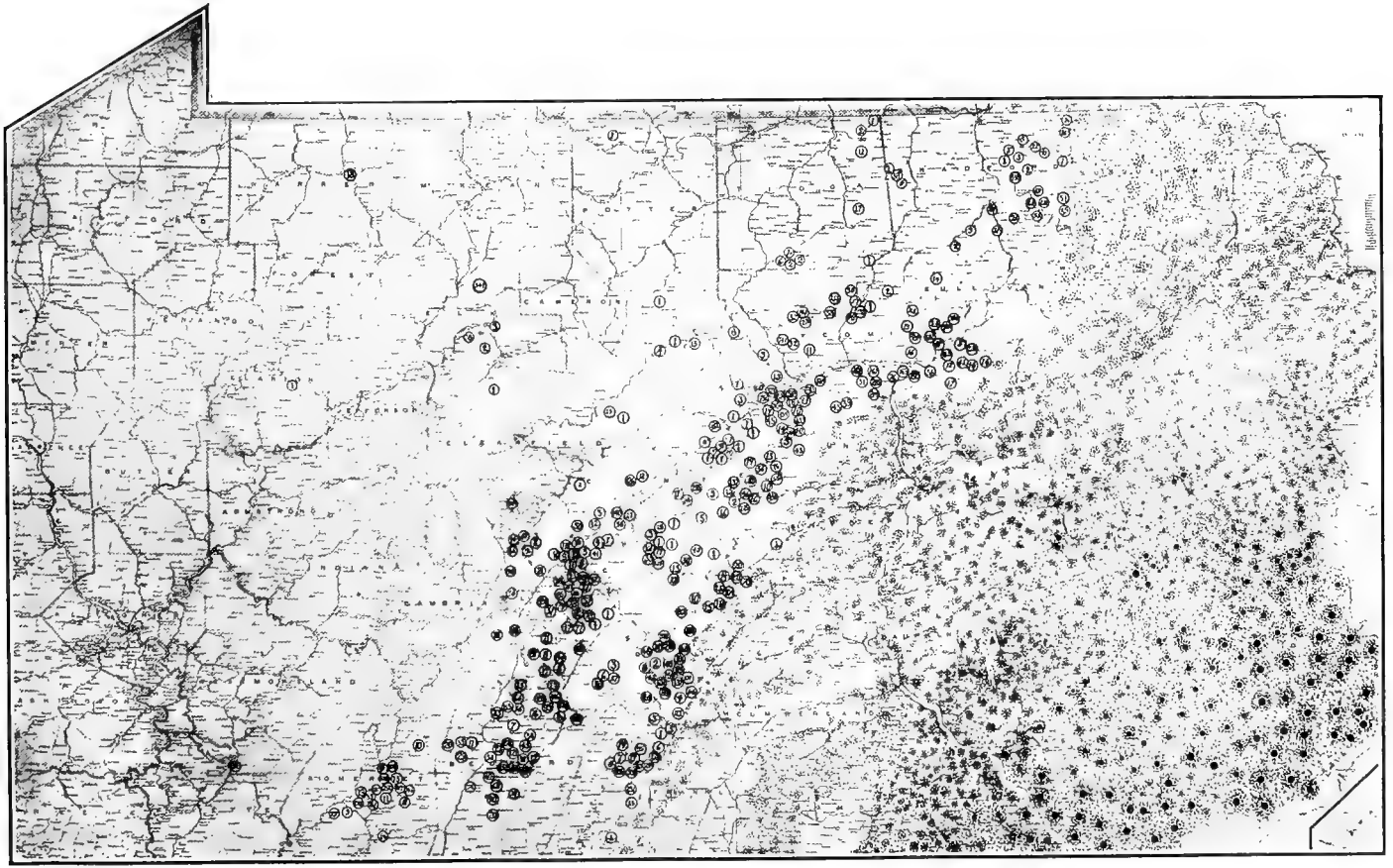
The experience of the past two years has demonstrated that more can be accomplished in locating and destroying the blight after the leaves have fallen than while the trees are in full foliage. Girdled twigs and branches bearing withered leaves are prominent at great distances in winter, and the increased amount of light admitted through the tops of the trees makes it easier to see cankers on the trunks and branches. The proper treatment of the infected trees is no more difficult in winter than in late summer or fall, unless the snow is very deep. In the badly blighted region in the eastern part of the State, field men are able to accomplish better results because most timber owners prefer to cut their timber in the winter, when they can spare the time from their farming operations.

FIELD WORK IN THE WESTERN DISTRICT.

Thorough scouting in 1912 has shown that no blight exists west of a line drawn through central Somerset and Cambria counties, along the extreme eastern border of Cameron County, to the northeast corner of Tioga County. West of this line, nine isolated spot infections were found in six counties, but all of these infections were eradicated as soon as found, and have been under careful surveillance since. These infected spots were located in Fayette, Elk, Warren, Potter, Clarion and Indiana counties, and five out of the nine spots were found to be due to the planting of diseased nursery stock purchased from nurseries in the infected region. In April, 1913, the infection in Indiana County was discovered in a shipment of three chestnut trees purchased from a nursery in New Jersey. These examples show very strikingly the ease with which the blight is widely distributed through the shipment of nursery stock. Persons who have planted nursery grown chestnut trees in regions free from the blight, should watch these trees carefully for the first appearance of the disease, and promptly destroy all infected trees.

Field work in the Western District during the period covered by this report has been confined to Tioga, Clinton, Lycoming, Centre, Huntingdon, Blair, Bedford, and Somerset counties. Tioga, Clinton, Centre, and Blair counties have been scouted and most of the diseased trees removed, but a considerable amount of infection still remains in Lycoming, Huntingdon, Bedford, and Somerset counties. In addition, Fulton and Mifflin counties still have a large amount of infection remaining, since with the small field force it was impossible to continue the work in these counties.

The accompanying map shows the progress of the control work in the Western District, and the location of infected areas. The following tabulation is a statement of the number of infected trees found and cut out in the Western District from the time the work was begun until July 1st, 1913:



Map showing spot infection in the western half of Pennsylvania to July 1, 1913, indicated by circles. Figures inside the circles indicate the number of diseased trees found in each locality.
Inspection in eastern half of the State is generalized from the best information available.

STATEMENT OF CHESTNUT BLIGHT INFECTION IN THE WESTERN DISTRICT.

County.	Number of tracts on which infection was found.	Total number of infected trees found.	Total number of infected trees removed.
Allegheny,	.....	.....	.....
Armstrong,	.....	.....	.....
Bedford,	147	4,027	2,787
Bradford,	91	1,048	829
Blair,	225	1,884	1,680
Beaver,	.....	.....	.....
Butler,	.....	.....	.....
Cameron,	.....	.....	.....
Centre,	142	2,556	1,763
Clinton,	169	3,481	2,704
Clearfield,	9	117	117
Clarion,	1	1	1
Cambria,	9	450	450
Crawford,	.....	.....	.....
Elk,	6	377	377
Erie,	.....	.....	.....
Fayette,	2	11	11
Fulton,	90	1,902	900
Forest,	.....	.....	.....
Greene,	.....	.....	.....
Huntingdon,	233	5,287	4,771
Indiana,	1	1	1
Jefferson,	.....	.....	.....
Lycoming,	259	5,015	4,486
Lawrence,	.....	.....	.....
Mifflin,	95	1,976	1,468
McKean,	.....	.....	.....
Mercer,	.....	.....	.....
Potter,	1	1	1
Somerset,	92	9,110	8,093
Sullivan,	22	207	207
Tioga,	12	43	43
Venango,	.....	.....	.....
Westmoreland,	.....	.....	.....
Washington,	.....	.....	.....
Warren,	3	16	16
Total,	1,609	37,510	30,705

A HARMLESS SAPROPHYTE.

Persons familiar with the appearance of the chestnut blight fungus may easily confuse it with another fungus found in Washington, Greene, and Fayette counties. This fungus *(Endothia radicalis* Schw.), (Denot.) is related to the blight fungus *(Endothia parasitica* (Murr.) (And.), but is found only on dead wood and bark and does not attack living tissues. It has been thoroughly studied by the field pathologist, since at first it was feared that it might have parasitic tendencies. Continued investigation proves beyond doubt that this fungus is a harmless saprophyte which need not be feared. It need not be confused with the parasitic species by those who have the opportunity to compare them.

FIELD WORK IN THE EASTERN DISTRICT.

Field work in the Eastern District has been conducted mainly on the plan outlined in the previous report. Inspections were made on the request of timber owners and advice given as to the best method of procedure in each case. Particular attention was given to assisting owners of blighted chestnut in finding the best markets for the products. On the request of owners desiring to take advantage of the reduced freight rates on blighted chestnut cordwood, inspections were made and necessary certificates issued. Supervision of enforced cutting of all blighted chestnut trees within a half mile of chestnut orchards in which the owners are endeavoring to keep the disease under control, was continued.

As the evidences of the blight become more noticeable and the seriousness of the situation forces attention, owners of chestnut timber in eastern Pennsylvania have shown an increasing interest in the work of controlling the blight, and more requests for assistance were received than could be given individual attention. For the guidance of owners who wished to clean their woods of blight, either by doing the work themselves or having it done by contract, the following suggestions were made by the Office of Utilization. These suggestions are for use in eastern Pennsylvania only, where the blight is general.

SUGGESTIONS FOR TIMBER OWNERS.

1. It is always advisable in cutting blighted chestnut to clean up the ground thoroughly and burn all infected material, for the sake of the future crop and the community as a whole. Even if financial reasons make it impossible to treat the stumps properly, the brush

Cutting out a spot infection among large trees.

and refuse should be burned, and all merchantable material removed from the tract within a reasonable period. Where the percentage of blight is very high, it is advisable to cut all the chestnut trees rather than attempt to remove only the diseased trees.

2. Stumps should not be cut higher than the diameter of the tree, but this may be impracticable in sprout growth timber. A low stump saves the best end of the log, and causes the succeeding generation of sprouts to be firmly rooted.

3. Where practicable, all timber should be peeled. Poles, ties, posts and rails, should be skidded to one or more convenient places. The bark and chips collected at these points should be burned, since this refuse is very frequently the breeding place of the blight fungus.

4. It is advisable to remove all bark from the stumps down to the mineral soil, to prevent the further spread of the disease by its growth on this bark. Unpeeled stumps, even if free from blight at the time the tree is felled, are very apt to become infected, and the disease will then eventually destroy the sprouts at the base. Stumps of trees cut in winter while the bark is "tight" may be left until spring, and peeled when the sap is ascending. Stumps made in summer should be peeled at once.

5. All chestnut refuse, including the brush from the tops, bark from stumps, chips, etc., should be collected and burned at as early a time as may be done with safety from fire. Green tops of trees felled in summer can be burned immediately by close piling over a well-started fire. The danger of infecting the sprouts from the stump is lessened if the fire be made over the stump after peeling. Stumps can be more cheaply sterilized, however, by painting them with creosote, and creosote also appears to be absolutely effective in keeping the stump free from infection, whereas a fire seldom chars the base of the stump sufficiently.

6. Woodsmen, while cutting and removing chestnut, should do as little injury as possible to the remaining trees, whether large or small. When the work is done by contract, trees carelessly broken in felling chestnut should be paid for at their market value. Merchantable chestnut left in the woods, either cut or uncut, when contracts call for the removal of all of the same, should be paid for at its market value.

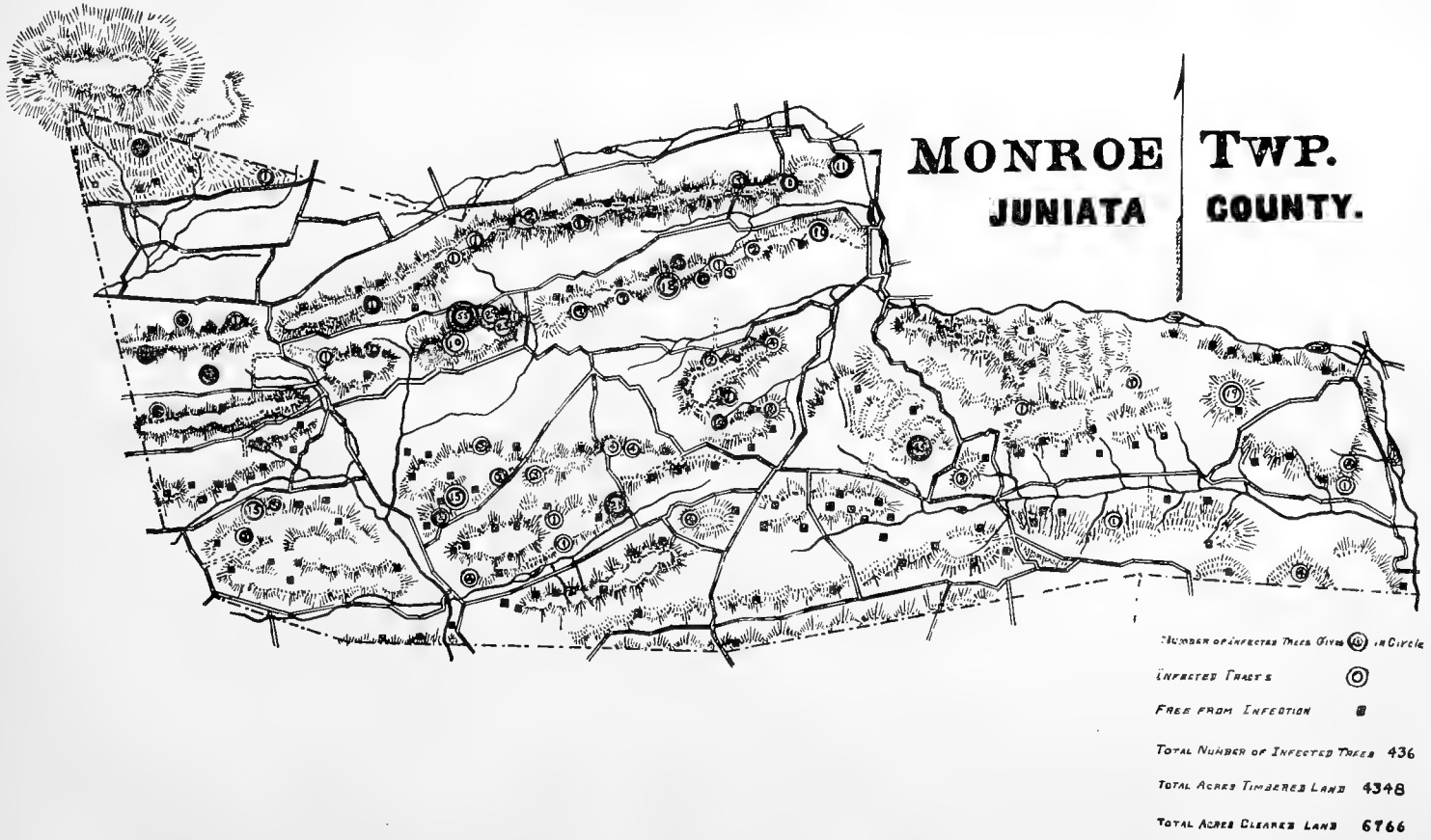
7. Great care should be exercised in burning material so as not to injure other trees, or allow fires to remain unwatched in the woods. Forest fires may result, causing much damage. Burning should not be done when the woods are very dry, or a high wind is blowing.

LOCAL INTENSIVE FIELD WORK.

Early in the spring a more extensive plan of field work in the southeastern portion of the State was adopted. A locality was selected where the blight is beyond control, and immediate utilization necessary to avoid serious financial loss. The boundaries of the area selected were so made that the timber in all of the woodlots in the area could be handled in much the same way as though the woodlots comprised a single tract. A map showing the exact location of all of the woodlots was made, and a field agent detailed to estimate merchantable chestnut in the form of saw logs, poles, ties, posts and cordwood in each woodlot. The local market for these products was then ascertained, to determine whether all timber on the area could be best sold locally on in outside markets. At the same time the field agent interested the owners of the woodlots in the prompt removal and utilization of their chestnut trees before greater loss was occasioned by the blight. Usually the owner of a considerable quantity of blighted trees is anxious to follow this course, but the scarcity of competent woodsmen makes it difficult or impossible. In such cases, the Office of Utilization presented the data obtained by the field agent to operators of portable saw mills, stave mills, pole or tie cutters, as the facts warranted, and as many buyers as possible were interested in locating on the area. So far as there was time to test this plan, it appears that this is the cheapest and most effective way of getting results in the eastern district, since what is desired is to get cutting started on a sane and profitable basis, and this a mere general method of work usually fails to accomplish. Success or failure depends on whether or not buyer and seller can be brought together on a satisfactory basis. The work must be profitable to both owner and dealer. A competent and well-informed field agent can work out a comprehensive plan for disposing of all the merchantable chestnut in a commmunity. Through his knowledge of prices, rates, specifications, sanitation measures, etc., he is the means of saving timber owners from much of the loss occasioned by the blight.

DISEASE INVESTIGATIONS AND NURSERY INSPECTION.

As before reported, the investigation of the blight fungus and the nursery inspection work are under the direction of Dr. F. D. Heald. Mr. P. J. Anderson has given special attention to certain field investigations, including the work at Charter Oak. Statements of some of the principal features of the work here follow:



A Blight Infected District in Juniata County, Pa.

GERMINATION OF SPORES.

Pycnospores of the blight fungus, sometimes called summer spores, germinate much more slowly than the ascospores, or so-called winter spores. The type of growth and size of colonies are different in the early stages of development on culture media.

PRODUCTION OF PYCNOSPORES IN WINTER.

In the case of this fungus the term "summer spores" is very misleading, as these spores are produced at all times of the year, being washed down in large numbers from blight cankers following each winter rain.

BIRDS DISSEMINATE THE FUNGUS.

Careful experiments show that birds act as carriers of spores of the blight fungus. Thirty-six birds belonging to nine different species have been tested. Nineteen were found to carry pycnospores, the maximum number obtained from a single bird, (Downy woodpecker), being 757,074. The highest number was always obtained from birds shot a few days after a rain period.

"SHOOTING" OF ASCOSPORES.

The ascospores are expelled forcibly, but this expulsion depends upon temperature as well as moisture. No expulsion took place in the field from November 26th, 1912, to March 21st, 1913, the temperature during the winter rains being too low. Bark containing ascospore pustules has continued to expel ascospores for over six months, (in the laboratory).

EFFECT OF TEMPERATURE.

Pycnospores are easily killed by heat, (51°C). Ascospores are slightly more resistant, only a few being able to survive 57°C.

RESISTANCE OF PYCNOSPORES.

Pycnospores are easily killed under certain conditions, but can survive in considerable numbers under certain other circumstances. Their length of life in water depends to some extent upon the temperature. Thirty-three per cent. survived in water at 55°C, after

42 days. A large percentage can survive freezing for a considerable period. They are washed down to the ground from blight cankers, during every rain, and have never been found to disappear entirely from the soil during the longest periods between rains. As many as 12 per cent. of those originally present in a soil sample have survived drying for 63 days. The longevity of the pycnospores is greater in the "spore horn" stage than when they are separated by rains and then dried. They have been killed in twenty-four hours by drying in certain tests, while the act of drying alone is generally responsible for the death of 50-60 per cent.

EFFECT OF DRYING ON ASCOSPORES.

Ascospores when shot on to glass slides have been reported as being very resistant to drying. In nature they are generally separated and washed by the rains. Laboratory tests under such conditions indicate that they are very sensitive to dessiccation. Drying alone has been found to kill as many as 94 per cent. in certain tests.

ENTRANCE OF BLIGHT IN GALLS.

A small gall on the chestnut due to a lepidopterous insect (moth) has been found to be one of the places of entrance of the blight fungus. Twenty-eight per cent. of those tested showed young blight infections.

INSECTS AS CARRIERS OF THE DISEASE.

Insects may act as carriers of the spores of the blight fungus. Of a total of 75 tested, many were found to be carrying spores. The maximum number of spores of the blight fungus (336,900), was obtained from a small beetle, *(Leptostylus maculata)*, which has been mentioned as a possible beneficial agent on account of its pustule-eating habits.

OTHER DISEASES OF THE CHESTNUT.

There is another "canker disease" of the chestnut prevalent in the State which is entirely distinct from the blight. It is even more important as a disease of oaks than chestnut, and is known to occur on chestnut oak, red oak, and white oak. A *dieback* of the chestnut is not uncommon. Still another fungus appears to be associated with this trouble. A *tip blight* of the chestnut has also been found, and in connection with it, a third species of fungus.

FIELD INVESTIGATIONS.

A field laboratory has all along been maintained at Charter Oak, and much of the outdoor inoculation work and other experiments have been conducted in that vicinity. Experiments have been conducted here on the rate of growth of blight cankers, details of which are tabulated in another manuscript, submitted for a bulletin. It is sufficient to say here that the retarding influence of the winter season is shown by these experiments. On the other hand, the cankers have continued to spread even in the winter, though the growth is much more rapid in the summer months.

Inoculations have been made both with ascospores and with pycnospores during every month of the last year. No cankers have appeared as yet from winter inoculations.

Other species of trees besides chestnut have been inoculated with the blight fungus in larger numbers than last year, special attention being given to the oaks. As yet there is no evidence that the blight fungus will establish parasitic relation with any other host, although occasionally a canker will be produced.

Careful tree surgery experiments have been conducted at Charter Oak, and to date only three cases are reported in which the canker continued to spread after cutting out and treatment.

NURSERY INSPECTION.

The office records give the following information in regard to each nursery inspection:—date, name and location of nursery, number of trees inspected, number of trees rejected, fungicides used for dipping the stock, name and location of purchaser of stock.

The nurseries from which chestnut stock was shipped during the fall of 1912 and spring of 1913, are as follows:—C. K. Sober, Paxinos, Pa.; Hoopes Bros. & Thomas, West Chester, Pa.; Lovett Nursery, Emilie, Pa.; Rakestraw & Pyle, Kennett Square, Pa.; Morris Nursery, West Chester, Pa.; Cheltenham Nursery, Oak Lane, Pa.; Jos. Moore, Montoursville, Pa.; S. L. Cummings & Co., Dewart, Pa., and Marietta Nursery, Marietta, Pa.

In the fall of 1912, 6,538 trees were inspected. Of these 81 were rejected, and the remainder 6,457, distributed. In the spring of this year 5,305 trees were inspected, of which 195 were rejected and the remainder 5,110 distributed. The trees rejected were either infected with chestnut blight, or showed doubtful incipient infections. In case of doubt the inspectors were instructed to reject the tree. The number of rejected trees, however, is no indication of

the percentage of blight in any nursery, since many diseased trees are removed from the nurseries previous to the time of making shipments, and only those thought to be healthy trees are offered for inspection.

Probably the greater portion of the trees went to purchasers in either Pennsylvania or New York. In case of re-distribution by other dealers, however, the final destination of the stock is not known. According to available records, the trees were sold to purchasers in the following States.—California, Colorado, Connecticut, District of Columbia, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, Nebraska, New Hampshire, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Texas, and Wisconsin.

INSECT INVESTIGATIONS.

The investigations to determine what part, if any, insects take in the transmission of the chestnut blight have been continued under the immediate direction of Prof. A. G. Ruggles. A number of interesting facts have been determined, but several important studies were just well under way when the work was suspended.

The relation of insects to blight dissemination comes under three headings; first, insects that carry the spores of the fungus and actually start new infections at the time; second, insects that carry the spores but do not directly start infections; and third, insects that make wounds in which infection readily takes place through spores carried by some other agency.

INSECTS CAUSING DIRECT INFECTION.

To the present time very little definite data have been obtained on this point, but the longer the subject is studied, the more probable it appears that ordinary insects traveling over a tree, although they may carry hundreds of spores on their bodies, do not directly start new infections.

INSECTS CARRYING SPORES BUT CAUSING NO DIRECT INFECTION.

Ants were allowed to run over cankers showing pycnidial pustules or "spore horns," and also cankers where ascospores were shooting, and then placed in flasks of sterile water and washed

from two to twenty-four hours. Plate cultures made from this material showed in many instances the presence of blight spores on the bodies of the ants. In the same way it was determined that other insects to the number of about twenty species also carry the spores of chestnut blight. The number of spores carried in each instance varied from a very few to the enormous number of 336,900. The particular insect, *(Leptostylus maculata),* carrying the 336,900 spores mentioned, is one of the beetles named in a recent press notice of the U. S. Department of Agriculture, as being very active in eating spores of the blight fungus. Therefore this beetle while destroying spores of the blight is at the same time covering its body with thousands of other chestnut blight spores which it carries from tree to tree, making it probably an injurious insect, instead of a beneficial one in this respect.

INSECTS MAKING WOUNDS IN TREES THUS OPENING THE WAY FOR INFECTION.

This is probably the most serious way in which insects are related to blight dissemination. Among the most serious of wound making insects are the seventeen-year cicadas, tree-hoppers, bark borers, and bast miners. Of these only two have been studied closely,—the cicadas and the bast miners.

CICADA STINGS.

In 1911 there was a brood of seventeen-year cicadas in several counties in the eastern part of Pennsylvania. The relations that these stings bore to blight infection have been studied near Lehighton. Many counts were made on trees and sprouts. While only 4.3 per cent. to 10.4 per cent. of all stings were found to be infected with chestnut blight, from 86 per cent. to 93.8 per cent. of all infections were in stings. This cicada injury was studied where the blight seemed most abundant. In the same tract where blight was less prevalent, other counts were made with less striking results. These observations would seem to show that blight infection is influenced considerably by the number of wounds made, but that infection many times does not take place through a wound although seemingly appropriate openings for catching blight may be present.

THE BAST MINER.

The work of the bast miner was first called to our attention by Mr. S. B. Detwiler. It is believed to be the most important insect causing wounds in the chestnut. Experiments and studies up to the pres-

ent time make it probable that the bast miner is responsible for much blight infection. To understand thoroughly the relationship of this insect to the blight fungus, the life history has to be known. Much time has been spent upon this subject, but unfortunately to date, the work has not been completed.* The injurious period of its life history has been obtained, but the period that would have to do with its suppression, namely the adult period and time of egg laying, has not been discovered.

LARVAL EXIT HOLES AS POINTS OF INFECTION.

Hundreds of sticks of smooth bark trees of chestnut were examined during the past winter and spring to determine the number and nature of the larval exit holes of the bast miner. Every piece a foot long and over two inches in diameter had bast miner burrows present. The lowest number for a linear foot was one burrow while the highest was fifteen. The number of exit holes for a small tree, therefore, would vary from ten to one hundred and fifty. In one acre of chestnut trees the number of these exit holes would be enormous. In the light of what we now know, recent observations show that 50 per cent. of this class of infections originated in bast miner exit holes*

CROTCH INFECTIONS.

Many infections are known to start around crotches, and we speak of them as crotch infections. The eggs of the bast miner are laid near crotches and the newly hatched larvas may make entrance holes sufficiently large to allow spores of blight to enter. Here again the bast miner may be responsible, and if such proves to be a fact, this insect would be the indirect cause of 90 per cent. instead of 50 per cent. of the infection on smooth bark trees. All other insects mentioned as making wounds, with perhaps the exception of the tree hoppers, are local or else the number of wounds is not appreciable; but in the case of the bast miner, the insect is found wherever the chestnut grows.

EXPERIMENTS WITH ANTS.

Ants being found so commonly around blight cankers on chestnut trees, it has been claimed that in some instances they are responsible for as much as 90 per cent. of blight dissemination. To ob-

*Since writing the above, Prof. Ruggles has produced the mature insect in breeding experiments and has thus completed our knowledge of its life history, and finds the insect to be a species new to science.

tain information on this matter, it was decided during the winter to experiment with ants in the greenhouse. Two rooms were set off as an insectary. The inner of these two rooms being thoroughly sterilized, was called the sterile room, and the outer room was called the blighted room. In the latter as much blight material of the kind required as could be obtained was kept and placed on the ant table, where three colonies of ants made their homes. From the table in this room the ants were allowed to run through a glass tube to sterile seedling trees in the sterile room. The ants were of the same species as those suspected of carrying the blight, and were the common mound-builders, *(Formica integra)*, being obtained in the region of Lewisburg, Union County.

The result of the experiment was that with the exception of a few dried leaves on each tree which were chewed or worked on by the ants, the trees in the sterile room are as healthy as when first placed on the table to be run over by the ants. The indication, therefore, is that ants are not responsible for blight infection.

INFECTION IN GALLS.

A more or less cylindrical gall is found on the tips of branches and on sprouts of chestnut, caused by an insect claimed to be a moth. At West Chester and Valley Forge, these galls are very numerous. Out of 161 galls examined by the plant pathologist, forty-five of the 28 per cent. showed the presence of blight, while 49 per cent. showed the presence of another fungus. A gall that shows the presence of chestnut blight in such a large percentage of cases should be given careful study.

CHEMICAL INVESTIGATIONS.

EXCESS OF TANNIN IN DISEASED WOOD.

The principal features of the chemical investigations which have been continued in charge of Mr. Joseph Shrawder, are as follows:

The abnormal tannin content of infected material was the chief subject of interest in the last report. Invariably, infected wood and hypertrophied material continue to show a higher tannin content than sound material from the same sample.

LOSS OF VOLATILE MATTER.

Moisture and other volatile matter proved of interest also. By prolonged heating at temperatures up to 155°C, infected material showed a greater ratio of loss.

CELLULOSE DETERMINATIONS.

A series of cellulose determinations was also made to note the effect of the fungus on wood and bark. A higher percentage of cellulose in sound material leads us to believe that it is being digested with the formation of acids and other soluble matter. It may also be that part of this soluble matter is reported as tannin by the hide powder method. This, with the deficiency of cellulose, may account for the relative high tannin content appearing on analysis.

CHEMICAL CHANGES.

The determination of starch, reducing sugar, and nitrogen shows that decided chemical changes are being produced by the fungus. However, this work was not brought to a satisfactory conclusion owing to the sudden termination of the work of the Commission.

NEW INJECTION MATERIAL FOR TREE MEDICATION.

Some preliminary work was also started in a search for a suitable injection—material to be used in the tree-medication experiments. It is evident from the chemical investigation that a suitable injection-material must not coagulate the excessive tannin and other colloids in the wood and bark, and that it must be able to penetrate cutin in suberin in order to diffuse properly through the infected area. A brief investigation of a modified chlorine solution showed that it fulfilled these requirements in many respects, but its value in treating trees has not been determined.

TREE MEDICATION.

The experiments in tree medication, in charge of Dr. Caroline Rumbold, have been for some time conducted in a large chestnut orchard located near Martic Forge, Lancaster County. The following is a brief statement of recent work:

PLOTS UNDER EXPERIMENT.

In 1912 three plots were selected for experiment. Each contained about fifty trees varying in age from seedlings to eighteen years old. This year two new plots were added to the three of 1912. Some tree surgery work was done, and the trees sprayed with lime-sulphur.

OBSERVATIONS OF THE WORK OF 1912.

Last year fifty-four trees were injected; 15 with salts of the heavier metals; 5 with formaldehyde; 12 with stains; 22 with alkalies, and the remainder with water. An attempt was made to inject two trees with canker extract, but the solution would not go into the trees.

On June 7, 1913, results of observations on these trees injected last year were made as follows:

To date, the injections of the salts of the heavier metals, (copper, zinc, barium), appear not to have killed the trees, although they mutilated them. Those injected with the copper salts suffered the most. Inoculations made on these trees after they were injected have taken, and the cankers forming are larger than those on the check trees. Of the five trees injected with the formaldehyde, two are alive, but mutilated. Inoculations on these trees have formed cankers larger than those on the check trees. Most of the trees injected with stains have been cut down, for observation. None were killed, however, by the injection. The trees injected with water are in good condition with the exception of one tree infected with a canker, which is now girdled. The only unusual sign about the tree is the large amount of suckers at its base.

FAVORABLE EFFECTS OF ALKALIES.

The trees injected with alkalies are all in good condition at present. An encouraging feature of the experiment with alkalies is that a number of inoculations on these trees did not take, and on those which have taken cankers have formed smaller than those on the check trees. These trees were cut into in April in order to count the number of inoculations that took, and in a number of cases these cuts have formed callus.

INJECTIONS IN 1913.

The past spring, 69 trees have been treated—21 with colloids, 18 with alkalies, 18 with acids, 17 with benzenes, one with methyl alcohol, and two with methylene blue, while five are water checks. The method of injection used this year is the same as in 1912.

EFFECTS OF THIS YEAR'S INJECTIONS.

The trees have not reacted to the injections this year as quickly as last summer. The slowness of reaction may be due to the season of the year, the cool weather, and the large amount of rain since injections began. As was to be expected, the trees have reacted to the injections differently. Potassium chromate and bi-chromate caused the fastest and most severe reactions. Reactions of the trees to the chemicals are generally shown by discoloring, drying, or falling leaves. Sometimes the trunk shows the path the solution followed by sunken areas, or long cracks in the bark, extending up the tree. So far no results can be given as to the effect of this year's injections, either on the trees themselves or on the canker growth. The full effect of the present injections probably cannot be seen until next year.

TREE SURGERY.

INDIVIDUAL TREE EXAMINATIONS.

The tree surgery work was continued in charge of Mr. Roy G. Pierce. A brief statement of the work here follows:—

Numerous requests for examinations of individual trees have been received continuously up to the time of closing our work. These requests have come from owners of individual lawn trees, owners of cultivated orchard trees, and owners of wood lots or small forest properties. When desired the owners or the gardeners were instructed how to take care of the trees. This is the most satisfactory way of handling this kind of work, since frequent examinations during the growing season are necessary to keep the chestnut blight under control. The owner, if well informed, may notice a diseased twig or branch at any time and remove it before the infection has spread any further. On request, the names of reputable tree surgeons have been given the owners.

ADVICE IN FOREST MANAGEMENT.

Frequently where there have been a large number of infected chestnut trees in the forest, as on Mount Penn and on the Neversink Mountain at Reading, or at Galen Hall, Wernersville, Berks

Tree surgery. Operator has gouged outer rim of canker, leaving mycelium of chestnut blight in center. Other cuts shown on tree were made at an earlier period.

County, the owners have not been so desirous of prolonging the life of the chestnut trees as of maintaining a grove or woodlot of trees of different kinds. In such cases the first principles of forestry have been recommended, namely, requiring the removal of trees that were becoming badly diseased, thus giving place to other tree species coming up beneath, such as hickories and oaks, instead of advising any tree surgery.

CONTACT WITH THE PEOPLE.

In thus meeting the people themselves, it has been possible to inform them much more thoroughly on the real cause of the blight than can be done through the medium of bulletins or newspaper articles. Many still think that the chestnut blight is caused by an insect or a mysterious something that kills the trees by descending on them as a vapor. To these people, however, "seeing is believing."

EXPERIMENTS.

Experiments have been started at different points:—(1) On methods of cutting out cankers; (2) With substances used as sterilizing agents and as water-proofing; (3) On the charring of cankers for various periods of one to five minutes; and (4) On the uses of various fungicides and water-proofings for painting over the cankers.

EXPERIMENTS WITH LIME-SULPHUR.

The use of the lime-sulphur spray to prevent infection has been experimentally tried at several places on orchard chestnut trees. One of the most important of these experiments is one that was started in Chester County in an orchard of 200 chestnut trees, 41 trees being used for the experiment, the trees ranging in height from 15 to 35 feet, and about twenty-five years of age. At the time of closing the work of the Commission, these experiments have not yet been continued for one year, therefore no definite results have been obtained, nor can any definite conclusion be drawn.

ALLEGED CURES FOR THE BLIGHT.

Besides the trials of different treatments at Emilie, Bucks county, mentioned elsewhere, three residents of Pennsylvania, who claim they have cures for the chestnut blight, have been permitted to demonstrate the efficacy of their cures at other points. Two of these "cures" are already failing at the present time.

LOCATION OF CANKERS.

An observation which may be of importance is that blight cankers are very seldom found to have started on the underside of branches.

VALUE OF TREE SURGERY WORK.

The work of tree surgery thus far has shown that it is possible to save chestnut trees that are diseased with the chestnut blight. This can only be done, however, by the most careful tree surgery, followed by frequent examinations for new infections and the spread of the old ones. Young, smooth bark trees are more easily saved than old thick bark trees, because it is much easier to discover the blight on the former than on the latter.

OTHER TREE SURGERY WORK.

In addition to the tree surgery work under the immediate direction of Mr. Pierce, other competent employees of the Commission have done similar work at Emilie, Charter Oak, and in a large orchard at Paxinos, the results of which up to this date are considered as largely successful.

The accompanying figures, No. I and No. II, will illustrate certain phases of the tree surgery work.

GEOGRAPHIC WORK.

WEATHER CONDITIONS.

A brief statement of some additional work by the Geographer, Dr. F. P. Gulliver, follows:—

Since the last report very few definite facts have been obtained as to the relation of rainfall to the spread of the blight, but nothing has yet been learned which would contradict the opinion previously stated that blight dissemination increases much more rapidly during rainy periods.

RELATION OF SOILS TO BLIGHT OCCURRENCE.

Considerable time has been given recently to a study of the character of the soils in different localities in the State where there is

more or less chestnut blight, to determine whether there is any real relation between the nature of the soil, and the amount of the disease in any locality.

LOCATION OF OBSERVATIONS.

After a careful survey of the State, it was decided to conduct this study in—(1), Chester Valley; (2), The Kutztown Valley, Berks County, and (3), Center County. To date, there has been time only to make observations in the first two localities. In the Chester Valley these studies have been much facilitated because of the constant occurrence of limestone toward the base of the mountains, and of shales toward the top. Usually, more chestnut blight was found near the tops of the mountains, and less, as one descends towards the valley.

RESULTS OF OBSERVATIONS.

The results of these observations on the relation of limestone or other alkaline soils to blight distribution, are as follows, which are simply, however, what appear to be the facts obtained from studies to date, and are not put forth as absolute conclusions.

(1)—In every series of tracts taken from limestone to overlying shale soils, the percentage of blight is least at a comparatively short distance (50 to 200 ft.), from the edge of the limestone.

(2)—Tracts on soils derived from limestone which show the highest percentage of blight seem to be those where the soil has become acid from underground drainage, and consequent leaching out of the alkalies.

(3)—Chestnut trees on soils derived from other alkaline rocks show less blight than is found in the trees on shale soils with limestone underneath.

(4)—Where the rocks have been faulted, and an older crystalline rock has been brought up to the level of the later formed limestone, there does not appear to be any less blight on the crystalline rock near the limestone.

RELATION OF ALTITUDE TO BLIGHT DISTRIBUTION.

On about 200 tracts examined, there does not seem to be any relation between the percentage of blight and the elevation above sea level.

UTILIZATION.

At the time of the last report, the work of "Utilization" was in charge of Professor J. P. Wentling. He continued to direct this work until March 1, 1913, when his leave of absence expired, and he resigned to resume his duties in the Forest School of the University of Minnesota. From that date, Mr. W. M. Kirby acted in charge of the office work, while Mr. J. R. Wilson was made directly responsible for the field operations. Until a suitable specialist could be obtained, the General Superintendent, Mr. S. B. Detwiler, has had general direction temporarily, of all the utilization work.

PRELIMINARY WORK.

For sometime, naturally, a great deal of information had to be obtained as to timber owners, purchasers of chestnut products. portable saw mills, demands for various kinds of products, etc., besides working out a general plan of active procedure. This had been largely done by Professor Wentling, before leaving, and he had already pointed out the importance of the portable mill operator, the necessity of experiments in deterioration of blighted chestnut, and of making tests of certain chestnut products through reputable manufacturers, and also the desirability of a trial of intensive local utilization in a few localities, and showed that it was desirable to keep in close touch with the important lumber associations.

CONCLUSIONS OF UTILIZATION CONFERENCE AT TRENTON.

At a Utilization Conference between various State and National officials held at Trenton, New Jersey, certain conclusions were arrived at as to special lines of work in utilization. Among these, it was recommended that the individual States take up local market studies.

LOCAL INTENSIVE UTILIZATION.

In accordance with the conclusions of the Utilization Conference above mentioned, and in line with the suggestion of the Forester of this Commission previously in charge of Utilization, it was decided to try such local work at one or two points in this State, the work being under direction of the General Superintendent. The first place selected was in the vicinity of West Chester, Chester county.

The local market for various chestnut products was thoroughly exploited to determine what amount could be taken care of in local consumption, and afterwards it was determined so far as possible, how much of the surplus could be disposed of at more distant markets. The results of the work have been very interesting, and bid fair to solve largely the entire problem of utilization.

RESULTS OF THE LOCAL WORK.

In the short time that has been given to this work, up to the date of closing, remarkable progress has been made, as the following statement shows:—

(1)—Careful estimates of timber were made of 14 tracts, in the vicinity, ranging in size from 2 to 26 acres each.

(2)—Various satisfactory interviews were obtained with the timber owners, and in this connection, it was found that there has been much change in the sentiment of owners, favorable to a rapid disposal of blighted chestnut.

(3)—All local timber operators were interviewed.

(4)—It was found that the owners themselves could use a large amount of their own timber for fencing.

(5)—Lists of buyers of chestnut products were obtained at West Chester, Downingtown and vicinity, and along the Pennsylvania Railroad main line.

(6)—After getting the confidence of timber owners, they were quite willing to place the disposal of their chestnut wholly in the hands of Commission employees.

(7)—One thousand ties were sold to a street railway company, and orders were expected for 5,000 more.

(8)—Arrangements were made for installing a saw mill in the area.

(9)—At the time of closing the work, efforts were being made to obtain 20,000 poles for a firm in New Jersey.

DIFFICULTY OF OBTAINING LABOR.

In the particular local work above referred to, the difficulty of obtaining labor was encountered, as in all other cases of work of this kind. Here again, however, the Commission employes were able to aid timber owners and operators greatly by obtaining hands from a distance, until finally eight different timber owners were on the waiting list to use wood-cutters who had been imported through our efforts.

WORK IN OTHER LOCALITIES.

No doubt results similar to those mentioned above could be obtained in the same way in other localities. Such work was successful in Lebanon County, to the extent of being able to locate ten different portable saw mills in active work in that county inside of one month.

DETERIORATION EXPERIMENTS.

An experiment, probably the first of its kind, has been installed by this Commission in co-operation with the United States Forest Service, at Mt. Gretna, Lebanon County, Pennsylvania, to determine accurately the effect of the chestnut blight on the quality of chestnut wood products, and upon the durability of such products. Chestnut telephone poles, some diseased and some from healthy wood, have been set. Thirty standard railroad ties, partly diseased, and partly not, were placed in a siding of the Cornwall & Lebanon Railroad. A fence was made with mortised posts and rails, some of them from diseased trees, and others from healthy trees. To determine the direct effect of blight lesions in telephone poles, cross arms were placed through these lesions; also some fence posts were set with lesions at the ground line. The complete results of this experiment will not be possible for several years, but it was expected to take records at regular intervals each year.

CHESTNUT EXTRACT CHIPS FOR PAPER PULP.

Spent extract chips from blighted chestnut wood which had been run through the leaches of a tannin extract company, were sent to the U. S. Forest Products Laboratory at Madison, Wisconsin, where experiments are being carried on to determine whether or not these chips can be used in the manufacture of paper pulp.

TESTS IN CO-OPERATION WITH MANUFACTURERS.

In connection with the above mentioned experiment, an attempt has been made to make similar tests in a practical way through co-operation with manufacturers. A small shipment of chestnut chips was made to a company in New York State, to test its value for the manufacture of plaster board. A similar shipment was made to a company in Ohio which manufacturers special machinery for reducing wood, the idea being to test these chips for the production of paper pulp.

BLIGHTED WOOD NOT INJURED.

Careful studies to date have shown decidedly that blighted chestnut is injured very slightly, if at all, for use as lumber. The blight lesions extend to only a fraction of an inch below the bark, and even this portion is taken off in the slabs. To illustrate this fact, small hand samples of blighted chestnut in board shape, have been prepared and distributed to different chestnut users throughout the State.

KINDLING AND FUEL TESTS.

There has always been considerable prejudice against the use of chestnut for fuel, and investigations have shown that most likely this prejudice is to a large extent unwarranted. It was intended therefore, at the time of closing our work, to make practical tests of chestnut for kindling, in comparison with the common kindling woods now in the market.

MOVEMENT OF CORDWOOD.

The movement of cordwood under the special reduced tariff has made an excellent beginning. Several hundred cords have already been shipped, and a number of parties were preparing to ship large amounts when our inspection work ceased. The discontinuance of this inspection work will be a financial disadvantage to many timber owners, who were expecting to take advantage of the special tariff, unless some arrangement can be made to continue such inspection under other auspices.

CO-OPERATION WITH THE U. S. FOREST SERVICE.

A list of pole and tie dealers has been furnished by the U. S. Forest Service. This list is being combined with a corresponding list of wood-cutters prepared by this Commission, the whole to be made out in duplicate, which will be of great use for future workers in utilization in this State.

DEMONSTRATION WORK.

The demonstration and lecture work has continued in charge of Mr. Keller E. Rockey.

LECTURES.

The subjects of lectures include every matter of interest concerning the chestnut blight. At intervals, parties engaged in other lines of operation of the Commission have lectured on topics relating to the particular work they were doing. The most of the lectures were given under the supervision of the State Farmers' Institute management. The lecturers were as a rule, supervisors of the territory in which the lecture was given, and were, therefore, fully able to give the audience news of the latest local developments, and much valuable information.

Besides farmers' institute lectures, addresses were made at several normal schools, before county fruit growers' associations, at the meeting of the Northern Nut Growers' Association, and also at various meetings of botanical societies, civic clubs, and in colleges and schools.

CHESTNUT BLIGHT EXHIBITS.

Exhibits of specimens and illustrations showing in various ways the operations of this Commission have been installed in the Carnegie Museum, at Pittsburgh, and in the State Museum, in Harrisburg. An unusually large exhibit has been started for the Commercial Museum, Philadelphia, and it was planned to make an exhibit at the Everhart Museum, at Scranton. An excellent display showing the work of the Commission was made in connection with the State Forestry Exposition, at Horticultural Hall, Philadelphia, in May. Much interest was shown in this exhibit by people from all over the State. Many minor exhibits have been made in connection with farmers' meetings at various places.

DISTRIBUTION OF SPECIMENS.

Several hundred small boxes of specimens of disinfected bark showing the chestnut blight were sent to various addresses all over the State, to be placed on exhibition in high schools and other public places. Photographs accompanied this material to add to its interest and practical value.

FIELD DEMONSTRATION.

Very often in connection with the lectures, particularly at farmers' institutes, the lecturers demonstrated the actual field work of the Commission in neighboring forest tracts, explaining the nature of the disease, the manner of removal, sanitation, and methods of tree surgery.

View of a chestnut orchard, 25 years old. A spraying experiment is being conducted with these trees.

CO-OPERATION OF THE PRESS.

In connection with the vast amount of active labor performed in field work, pathological research work, chemical and insect investigations, etc., in the effort to control the chestnut tree blight, the press of Pennsylvania proved a most valuable ally in constantly acquainting timber owners and the public in general with the symptoms and characteristics of this comparatively new, but extremely destructive tree pest.

The native chestnut tree is properly regarded as the best forest tree remaining in a large quantity in Pennsylvania. The presence of the deadly chestnut tree bark disease throughout eastern and central Pennsylvania counties, and the actual and immediate necessity for a concerted and active warfare against this parasitic disease in order to prevent the threatened total extermination of the chestnut tree in the Keystone State, naturally awakened the editorial fraternity and other advocates of forest conservation to the great importance of aiding in the fight to control and eradicate the disease.

It is admitted by scientific authorities that had the necessary work towards stamping out the blight been inaugurated by other states at the proper period, Pennsylvania's extraordinarily heavy loss could have been confined to a minimum. It is believed however, that the Commonwealth has already sustained a loss through the partial destruction of chestnut, aggregating a total of $70,000,000, of which enormous amount Eastern Pennsylvania timber owners suffered the heaviest burden. The probervial "ounce of prevention" was sadly ignored, and hence, the deplorable conditions that rapidly followed this costly neglect of duty. Although the Keystone State has ceased its activities in its efforts to save this invaluable species of trees from destruction, the National Department of Agriculture and a dozen other states are continuing the work with renewed energy, confidently believing that the interests of timber owners and the public in general deserved such recognition and protection. Many taxpayers who were compelled to wage warfare against the spread of the blight at their personal expense report gratifying results, thus again demonstrating that by prompt action and thorough work, the parasite might have been controlled and these extraordinary heavy financial losses averted.

Oliver D. Schock, Assistant Superintendent, was in charge of this important publicity department. Grateful acknowledgments are due to the newspaper editors for their continued and liberal co-operation. It is equally gratifying to know that there was but little, if any unfavorable criticism by the press of the entire State of the methods pursued by the Commission in combating the blight.

Report of

Samuel B. Detwiler

General Superintendent Pennsylvania Chestnut
Tree Blight Commission

OBSERVATIONS ON SANITATION CUTTING IN CONTROLLING THE CHESTNUT BLIGHT IN PENNSYLVANIA.

By SAMUEL B. DETWILER,
GENERAL SUPERINTENDENT OF THE PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION.

INTRODUCTION.

In view of the continued rapid spread of the chestnut blight, and the great damage sustained through this relentless parasite, it is important at the present time to have more complete information on the possibility of controlling its spread. It is now an established fact that the disease exists in China, and that it was probably introduced into America from the Orient. This disposes of the theory that the blight is caused by a native fungus, originally a saprophyte or weak parasite, which gained vigor, or appeared to gain vigor because of the decadence of the native chestnut trees from the effects of drouth and winter injury. It is evident that it would be difficult, if not impossible, to control a native fungus of wide dissemination, with predisposing factors in its favor. But even the most severe critics have acknowledged that foreign origin of the parasite affords "at least some basis for the fight for control."*

HOW THE BLIGHT SPREADS.

The pathological investigations of the Commission have shown that wind, water (rain), and birds are the principal agencies in disseminating the blight. A single spore thread may produce from 100,000,000 to 200,000,000 pycnospores, and even a small canker produces dozens of spore threads in a season. A single perithecium has been observed to eject ascospores almost continuously for a period of 26 days, at the rate of 4.7 spores per second. Insects assist by making wounds through which the spores of the fungus enter the bark, and also, to some extent, by distributing the spores locally. The ejection of ascospores into the air following rain, and the washing of pycnospores down the trunks and into the soil during rain, appear to be the principal agencies in spreading the disease. Birds have been proved to carry spores in great numbers, and undoubtedly are responsible for a certain proportion of infections, at least, of advance infections.

*Clinton, G. P. Science 36: pp. 907-914, Dec. 27, 1912.

The planting of diseased nursery stock in regions free from the blight appears to be one of the principal agencies in spreading the disease to great distances. The disease was probably introduced into this country on nursery stock, and in the early years, nursery stock apparently played the most important role in getting the disease quickly and firmly established. This point is well illustrated by a shipment of three chestnut trees sent from a New Jersey nursery into Western Pennsylvania in 1912. Through a misunderstanding, these trees were not held at the State line for inspection, but were carried direct to their destination. When the inspection was made, the disease was found at two places on one of the trees, although the nurserymen claimed to have carefully examined the trees before shipment. At Warren, Warren county, Pennsylvania, 11 out of a shipment of 12 nursery trees purchased in 1910 were found affected with the blight in 1912. In Elk County, 34 diseased nursery trees were found in a young chestnut orchard, and the disease had already reached adjoining native chestnut trees. In Somerset County, there is evidence to support the belief that an infected area covering about one-third of the county spread originally from diseased scions grafted on native trees. There are many similar occurrences outside of Pennsylvania.

All observers have noted that the blight advances by attacking widely separated trees far ahead of the generally infected territory. In Pennsylvania, the main spread of the blight has been from the southeastern corner of the State. During rains and immediately following, when the spores are being ejected, the wind is usually from the south or east, thus tending to carry the spores north and west. At least, it is a matter of common observation that the southern and eastern edges of woodlots very frequently show the first infections.

In order to learn more about the spread of the blight, two areas in the region of general infection, one in the Mahoning Valley in Carbon County, and the other in the vicinity of Topton Mountain, in Berks county, were studied in the spring of 1913 by Mr. J. Wesley Sitler, a field agent of the Chestnut Tree Blight Commission.

STUDY OF BLIGHT CONDITIONS IN THE MAHONING VALLEY.

In the Mahoning Valley, all timber tracts on an area about 7 miles square were mapped on a large scale topographic sheet, (Fig. 1). In round numbers this investigation covered about 50 square miles of land which varied widely as to elevation and geological formation. Spot infections of blight were accurately located on

of gullies; or, where a ridge slope forms a terrace-like flat. How-

Sketch map showing blight centers and percentage of infection in a portion of the Mahoning Valley, Carbon and Schuylkill Counties, Pennsylvania.

By J. Wesley Sitler.

June, 1913.

formation. Spot infections of blight were accurately located on

the map, and each spot was studied in detail as to the percentage of surrounding infection, slope, exposure, soil, character of the stand of timber, and surface features. Originally chestnut oak and yellow pine occupied the steeper upper slopes, while the more gentle and fertile lower slopes were covered with a stand consisting of 50 to 70 per cent. chestnut, with a mixture of red oak, maple, and white pine. Very little chestnut grew in the valleys where the forest consisted of heavy stands of white oak, white pine, red oak, and maple. All of the flat bottom land and much of that along the lower slopes has been cleared for farming, so that part of the area studied consisted of woodlots with trees varying in size from small coppice to 20 inches in diameter. The area is traversed by several ridges extending northeast and southwest, and the poor rocky soil of these ridges, particularly north of the Mahoning Valley, is covered with young coppice of oak and chestnut, or with scrub oak brush. Forest fires frequently burn over the ridges and the young growth is therefore in poor condition.

At present no tract can be found on the area studied that is entirely free from blight, but the chestnut trees south of Mahoning Valley are diseased more than the stand north of the valley. The southern slopes of the ridges, also the south and east portions of exposed woodlots, are more seriously infected than the northern exposures. There are thousands of cicada wounds in twigs of all species growing in these woods. These wounds were made during the invasion of 1911. It is very common on chestnut to find such wounds infected, and the cicada has thus undoubtedly aided in the general distribution of the blight throughout this region.

Every tract of chestnut timber showing the presence of blight, when carefully examined, shows that the disease appears in spots. By careful observation, the source of infection for the entire spot can be traced to one or more badly infected trees which evidently bore the original infection of that particular area. Such a tree or group of trees is commonly referred to as an infection center, because from such centers the disease advances in all directions. The age of these centers can be determined quite accurately from the appearance of the original infection, by the concentric rings of cankers and by the age of water sprouts and shoots at base of cankers. Generally, the older the infection, the further it has spread from the center.

Many of these infection centers have been carefully worked over, but nothing definite can be said as to characteristic elevation, soil conditions, exposure, or character of woods. Probably 90 per cent. of these centers are found in the shallow depressions at the heads of gullies; or, where a ridge slope forms a terrace-like flat. How-

ever, it is evident from a large number of observations, that such centers develop under any surface conditions favorable to the growth of chestnut. They are found on well drained gravel slopes, dry knolls, steep rock slopes, and in low fertile flats.

The spread of the blight seems more rapid in young coppice growth of nearly pure chestnut, than in a chestnut stand of large trees. In old stands the percentage of infected trees decreases abruptly from the infection center outward. Often, a distance of twenty rods will take one from an area of 40-50 per cent. infection to a zone of one-fourth per cent. and beyond that no infection may be found. In coppice growth the decrease is more gradual and a zone showing less than 8-10 per cent. infection can seldom be found on a tract with an infection center. The abundance of bast miner galleries in the bark of young smooth-barked chestnuts probably explains the wide and even distribution of the blight in such stands.

The importance of wind as an agent in disseminating blight cannot be positively stated, but from observations made in this locality there seems more evidence favoring wind distribution than any other factor. The result of a large number of comparative observations show that:—

1. A large number of infections are in wounds made by cicadas and are usually uniformly distributed around a blight center.

2. New infections are generally scattered through areas of young shoots growing up after fire.

3. Freshly cut stumps with their new sprouts show a high per cent. of infection even where the surrounding woodland is little affected.

4. Trees standing in exposed places, such as isolated trees in fields, and trees along southern edges of timber tracts, show a high per cent. of infection.

Very little can be said about birds as carriers of blight. Numerous scattered spots of infection show signs of having been started by bird distribution. However, the observations gave little reliable evidence on this point. Many spots have a large, dead-topped tree standing near the center. Often these trees have been infected on the lower branches, longer than any of the surrounding trees. The dead, snaggy tops show no evidence of death from blight. There is reason to believe that birds were attracted by the open snag and carried the spores which later started the infections in the lower branches.

This locality furnishes numerous opportunities for comparing the percentage of infected trees on the north and south slopes. The stand of chestnut is similar on the two slopes. The results of detailed examinations show that there is more blight on the south

slopes. Also, many of the woodlots show a higher per cent. of infection on the southern borders. To strengthen these observations several miles of the Blue Ridge, (lying north of the Mahoning Valley, and not included in the area studied), were also worked over, (Fig. 2.) This ridge is higher than any other within the limits of area studied, and shows the typical high percentage of blight on the south slopes, up to the summit. Immediately across the summit, northward, the number of blighted trees decreases. However, at the base of the north slope in almost pure chestnut, it increases but does not average more than 60 per cent. of the amount of infection at the base along the south side. There is a general decrease in the amount of infection on each successive ridge to the north.

There are distinct differences in the moisture conditions in this region. The stream valleys often have a clay loam soil too heavy and moist to support chestnut. We find all variations in soil and moisture from these valleys to the dry, rugged ridges where chestnut oak and scrub oak form most of the stand. The amount of infection apparently does not depend on soil moisture, as is shown by the percentages on the infection map. Tracts lying in the valleys show similar percentages of infection to those on higher ground. The theory that chestnut trees growing on or near limestone soils are resistant to blight is not supported by these observations. A belt of limestone borders Lizard Creek Valley on the south, and the per cent. of infection is as high in that region as elsewhere. Infection centers have been found near limestone quarries, where the roots of the chestnut penetrated to bed rock.

INFECTION POINTERS.

1. Each successive ridge shows a decrease in the number of old infections, from the Blue Ridge northward.

2. There is more blight along the south slopes than on the adjacent north slopes.

3. Recently cut stumps with their sprouts show a high per cent. of infection even where adjacent tracts are clear of blight.

4. Centers of infection are found under all conditions. Slope, exposure, drainage, rock formation, and fertility of the soil seem to have no relation to origin of infections.

5. A large number of infections one and two years old began in wounds made by cicadas in 1911.

6. Wind appears to be the most important factor in the dissemination of the blight. Birds may be factors as carriers of the original infecting spores, but cannot be blamed for the local distribution of the blight around an infection center. This distribu-

tion is very uniform, which presumably would not be the case had birds been the principal carriers of the disease. In young coppice growth much wounded by cicadas, the wounds on the twigs are the chief points of entrance for the disease. Results of accurate counting show that on certain tracts 80 to 90 per cent. of new infections began in such wounds made by the 17-year cicadas during their invasion of 1911. Many new infections are at and near the bases of young sprouts, and there is little cause to believe that these were due to birds, since they are usually about the same age and at points that birds are not likely to frequent. Also, this condition exists on exposed north slopes little visited by birds. The most plausible explanation seems to lie in the hypothesis of wind dissemination. This explains the numerous infections starting in cicada stings; also the rapid spread over a tract of young sprouts; the common occurrence of new infections on trees standing alone, in exposed places. The greater quantity of infection on south slopes appears to be due to the fact that the prevailing winds are southerly and easterly during the periods when ascospores are extruded in greatest numbers.

STUDY OF BLIGHT CONDITIONS ON TOPTON MOUNTAIN, BERKS COUNTY.

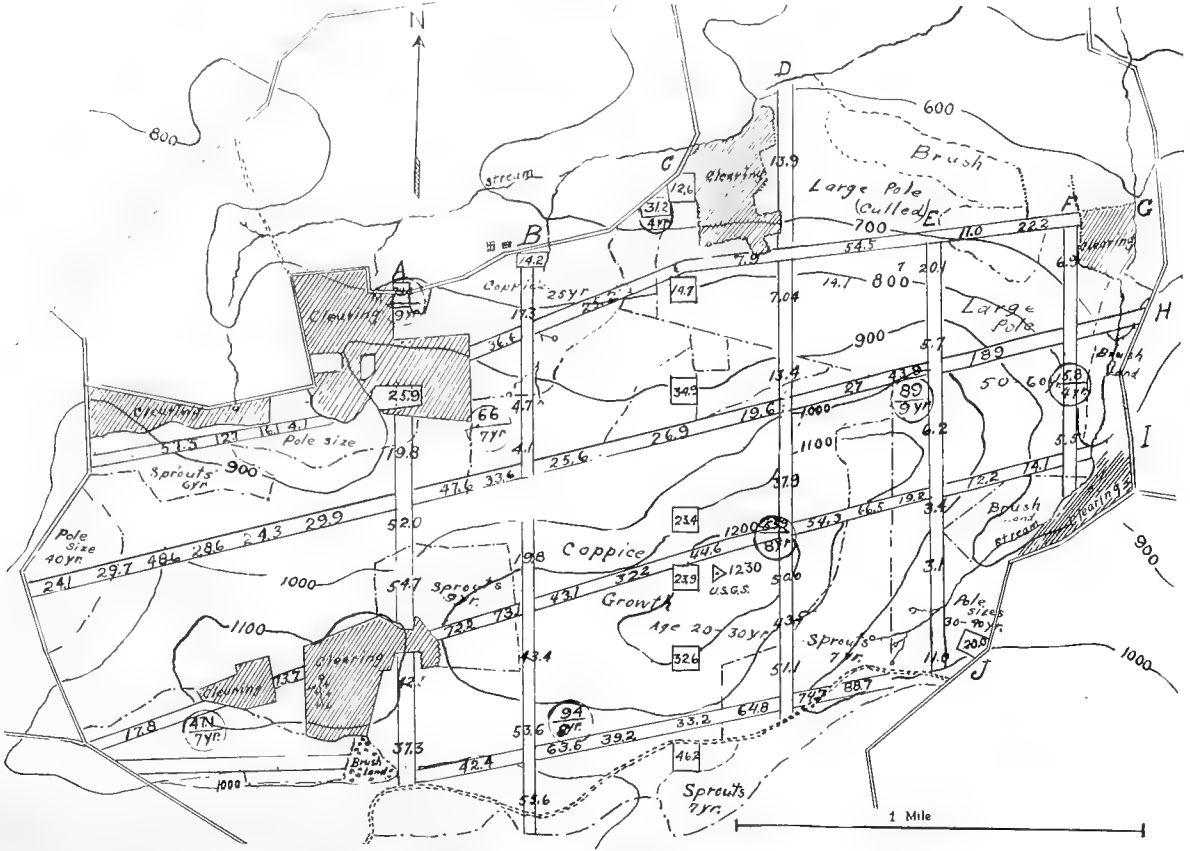
The highest point of this mountain rises about 600 feet above the base, the summit being 1,230 feet above sea level. The long axis of the ridge runs about 15 degrees north of east, the east end of the ridge terminating abruptly. The area studied comprises about 2,000 acres, about 600 of which are cleared, and the balance bears a dense stand of timber which is mainly coppice growth between 10 and 25 years old. On the summit, and the upper and middle slopes, chestnut is the predominating species, forming 80 to 90 per cent. of the stand. Below this is a zone in which chestnut and chestnut oak constitute the stand in about equal proportions. At the base of the mountain there is a narrow, irregular belt of tulip, butternut, red oak, and ash, with a very low per cent. of chestnut.

Strips four rods wide were run north and south across the mountain, and also in an east and west direction over the top and along the sides. Observations were made of all the chestnut trees on each strip acre. In this way the tract was gridironed, and a fairly comprehensive idea obtained of the relative amount of blight in the various portions of it. (Fig. 3).

The infection nowhere runs less than 3 per cent., and it was impossible to find an acre with less than this amount of blight on it.

Sketch map of Topton Mountain, Berks County, Pennsylvania, giving a comparison of percentages of blighted chestnut.

By J. Wesley Sitler, July, 1913.
Scale 2.75 inches—1 mile.



6/6-yr blight center, upper figure is per cent. of infection on an area within 50 feet radius or more of the center. Lower figure is the approximate age of the original infection.
24.3 per cent. of infection on one strip acre.

On most of the ridge the percentage of diseased chestnut runs from 17 to 30 per cent., although there are spots where it is much higher. The centers of infection are not confined to any characteristic slope or environment. Generally, the blight has spread over larger areas on the summit and south slope than on the north slope. The centers along the south slope and summit show more trees killed by the blight than those of any other part of the mountain. This is doubtless due to a more rapid spread of the blight in these situations. Scattered dead trees are less common along the north slope than elsewhere; however, several centers containing a dozen or more large trees entirely killed are found on the north slope.

The blight is so uniformly distributed between the centers that it was difficult to determine the facts relative to the dissemination of the disease by wind. However, most of the infected areas show a wider zone of distribution east and north of the infection center, giving the areas of thick infection an egg-shaped outline, with the oldest infections nearest to the western boundary. No definite information was obtained on this tract concerning the part played by birds as disseminators of the disease.

The south slope of the ridge is more dry and barren than the north slope. The only springs found there are near the eastern end of the ridge, and a few small springs are scattered along the lower portions of the south slope, but these are below the zone of chestnut growth. The north slope is a more gradual incline, and there are numerous shallow dips resembling miniature gullies. Some of these are moist enough to support alder bushes and several species of moisture loving ferns; also trees of the lowland types, such as tulip and maple, are quite common in these depressions. Most of these dips contain springs, but not all of them; however, there are numerous small springs scattered all along the north slope of the ridge. Most of these are well down toward the base, but several are well up toward the summit. So far as could be ascertained, no relation exists between the thickly infected areas and moisture conditions.

The data collected lead to the belief that the infection is distributed without any regard to elevation. For instance, along the base of the north slope high percentages of infection are found. Similarly, an increase in the percentage of blight is found half-way toward the summit. While the summit seems to support more infection than any other portion of the mountain, there is no reason to suppose that this is due to elevation. The stand here is almost pure young chestnut coppice, and the conditions appear to be more favorable to the rapid spread of the disease in such stands. The

base of the south slope supports coppice growth similar to that found at the summit, and here the per cent. of infection compares very closely with that along the summit.

RESULT OF OBSERVATIONS.

No definite cause for the areas of high and low per cent. of infection was determined. The highest percentages of infection are found on the summit and on the south slope of the ridge. Also this portion of the area supports more old infection than any other part of the mountain. In part, this may be due to the higher percentage of chestnut on the summit and south slope, and to the fact that most of it is young coppice. Such stands appear very susceptible to the disease. The theory that varying chemical elements, derived from the rock strata, affect the amount of infection is not supported by any evidence gathered in this work, for on the three general rock formations of this tract, as well as along the edge of the adjacent limestone, high and low per cents. of infection seem equally common. No evidence sheds any light upon the belief that the distribution of disease is along any definite compass direction. If there is any proof at all toward this end, it lies in the fact that infections on the south are more uniformly distributed than on the north. It is probably true that the advance infections came from the south and crossed the mountain northward, but areas of thick infection are not confined to any character of topography, slope, or elevation.

The accompanying maps give in detail the percentages of blight found in the Mahoning Valley and Topton Mountain areas.

RATE OF INCREASE OF BLIGHT IN EASTERN PENNSYLVANIA.

The southeastern corner of the State has a higher percentage of infection than any other portion of the State. The rapid increase of the blight is well shown in this section by the record of 1,637 trees on tracts in the vicinity of Philadelphia, which were examined for blight in October and November, 1910, December, 1912, and August, 1913. In 1910, 31 per cent. of these trees were infected with the blight, and 29 per cent. were doubtful. In 1912, 79 per cent. were infected, and in 1913, 88 per cent. If we include the 29 per cent. doubtful trees with the 31 per cent. certainly infected in 1910, the total becomes 60 per cent. This makes the annual increase in infection approximate 10 per cent. per annum. In this connection it is interesting to note that on the du Pont estate at Kennett

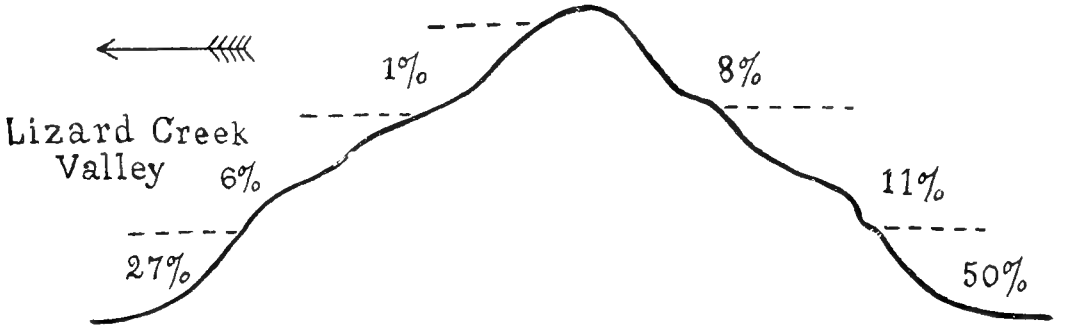


Figure 2.
Cross section of the Blue Ridge Mountain, showing altitudinal distribution of the chestnut blight on north and south slopes

Square, Pa., where tree surgery methods, supplemented by spraying with Bordeaux mixture, have been in use for the past two years, the progress of the blight has been materially delayed. Mr. R. E. Wheeler, forester for the estate, believes that these methods will save the trees under treatment for at least five years more, and probably for a much longer time.

Tree surgery without spraying has had little effect in delaying the progress of the blight after it attacks a tree. In a large orchard of Paragon chestnuts, in Northumberland County, in a block of 9,612 trees, 4 to 15 years old, thoroughly examined in the winter of 1911-12, 194 infected trees were found, (2 per cent. infection), 103 of which were so badly diseased that they were cut out and burned, and 91 trees were treated by surgical methods. In the winter of 1912-1913, this same block was again carefully gone over, and 1,064 infected trees were found, (11.2 per cent. infection), 325 of which were marked for removal, and the balance for surgical treatment. The rate of increase in this case was over 500 per cent.

INFECTION CENTERS ON THE ADVANCE LINE.

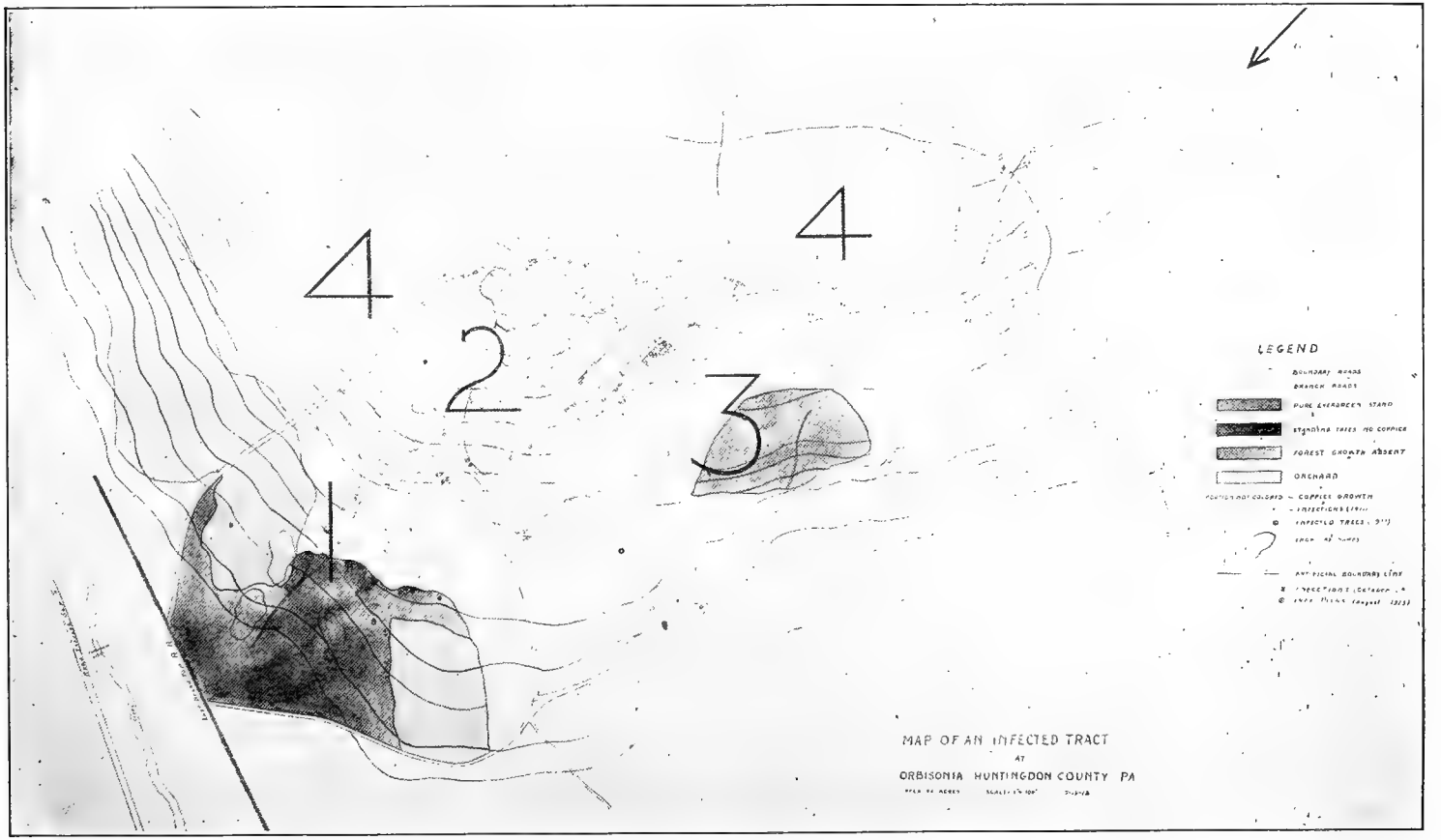
In applying sanitation measures for the control of the blight, it is not practicable to use tree surgery methods and spraying, (except possibly in orchards), but only to cut out bodily every infected tree and to sterilize the stumps. When the blight is generally distributed through a region, as is the case in southeastern Pennsylvania, it is manifestly impossible to eradicate the disease by sanitation methods without also practically eradicating the host. A detailed study of spot infections as they occur on the western advance line of the disease is therefore of more interest than the conditions which exist in the generally infected territory.

On the advance line, as in the eastern part of the State, there is no rule for the location of an infection center, nor is there any rule as to the part of the tree which is attacked first by the disease. It is true, however, that on the western advance line more infections occur on isolated trees and on the edges of timber tracts than elsewhere, and that the majority of infections first appear in the tops of trees. Likewise, in its spread from tree to tree around a center, the blight shows no general rule, except that the trees immediately adjoining a primary infected tree are most apt to show the first secondary infection. The following tabulation gives the details of 175 infected trees in a spot infection of 271 trees, located at Orbisonia, Huntingdon County, Pennsylvania, studied in 1911 by Mr. R. C. Walton.

TABLE I.

DETAILS OF INFECTION AT ORBISONIA, PA.

		Number.
Origin of tree,	Coppice,	136
	Seedling,	39
Slope,	Gentle to medium steep,	5
	Gentle to steep,	24
	Gentle,	6
	Steep,	79
	Very steep,	0
	Medium steep,	61
Aspect,	North,	108
	Northeast,	16
	Northwest,	41
	North to northwest,	7
	North to northeast,	3
Location,	Lower slope,	23
	Middle slope,	152
	Along road,	76
	Near road,	28
	Away from road,	71
Moisture,	Dry,	28
	Damp,	37
	Dry to damp,	69
	Medium dry,	13
	Medium damp,	20
	Windy, dry,	8
Density of forest,	Dense,	72
	Medium dense,	97
	Rather open,	6
Infection on benches,		36
Orientation of lesions,	North,	34
	East,	29
	South,	14
	West,	21
	Northeast,	29
	Southeast,	10
	Northwest,	9
	Southwest,	5



Blight Infected District at Orbisonia, Huntingdon County, Pa.

The most important practical point in the study of spot infections, however, is the location of the secondary diseased trees with reference to the original center of infection. Where a careful study has been made, it has always been apparent that the disease spreads from an original center of one or two trees to trees in the immediate vicinity, as illustrated in the accompanying diagram, which is an example of a typical small spot infection, (Fig. 4).

PROCEDURE IN ERADICATING SPOT INFECTIONS.

SCOUTING.

The principal obstacle met in applying sanitation methods for the control of the chestnut blight is the high cost of locating spot infections. The cause of this lies in the great extent of territory which must be covered, and difficulty in securing competent and reliable scouts at reasonable salaries. Experience has proved, however, that thorough scouting can be done at a moderate cost under efficient supervision. Rapidity and efficiency in scouting vary with the size and density of the stand, the proportion of chestnut, the topography and location of the tract, and the prevalence of blight. The records of the Chestnut Tree Blight Commission show that between October 3 and June 30, 1913, it required 11,651 days of labor to scout 738,881 acres of timber, notify timber owners of infections found, and supervise the work of removal. This is at the rate of 63.41 acres per man per day, with the average of 2.07 infections found, and 1.49 infections removed per man per day. The average day, (not including time consumed in going to and returning from work), consisted of 8.2 hours spent in the field, .4 hour lost on account of rain, and .4 hour lost on account of sickness and leave. With thoroughly experienced and practical men under competent crew leaders, an average of 100 acres or more per day can be covered, unless the spot infections are very large and numerous. In thick infection, one man can make thorough tree to tree examinations of from 2 to 5 acres, depending on the character of the timber. However, on the basis of past experience, it appears to be more practical and economical to locate the boundaries of the spot infection, and eliminate all of the chestnut trees within and immediately adjoining the spot infection, instead of eradicating

only the diseased trees. This plan reduces the amount of tree to tree inspection required, and one man should be able to scout at least 50 acres per day, even when spot infections are numerous. It has been found that a crew of two or more men can accomplish more and obtain better results than in the case of men scouting alone, except in a country where the woodlots are very small and scattered.

In scouting, rapid and thorough work depends upon the experience and capability of the crew leader. The size of the crew depends on the character of the timber to be scouted and the ability of the crew leader to handle men. Except in a very heavily timbered area, three men constituting a crew will usually accomplish more than a larger crew. There is an added advantage in a small crew in that two or three men can find accommodations near to their work where a larger number of men cannot, and must consequently spend more time on the road to and from work. In large tracts of woodland, the best plan is to establish a camp as headquarters for several crews. A camp is too expensive for a small crew, but for a number of men it is economical, and has the advantage of keeping the men close to their work.

The tracts must be scouted systematically. The best plan is to go back and forth parallel to the backbone of the ridges, each man inspecting a strip 50 to 100 feet wide. In large bodies of timber four or five men can work together advantageously, each man being separated by the distance best adapted to viewing all the trees in the strip between himself and the men on either side of him. The man on the outside marks the edge of the strip either by breaking branches on the underbrush of species other than chestnut, or by marking tree trunks with yellow lumber crayon. Unless eradicated as found, diseased trees are located by pacing to the strip boundary at right angles and marking a tree on the line with crayon to indicate the location of the diseased tree. If a cutting-out crew closely follows the scouting crew, there is less waste of time and effort than where the scouting crew attempts to eradicate the infections as found, unless infections are very few and limited to single trees. With the cutting-out crew following the scouting crew, there is the additional advantage that they may locate diseased trees missed by the first crew.

The greatest aid to efficient scouting is a pair of good field glasses. They often make it unnecessary to climb doubtful trees, and are of further usefulness in the hands of an experienced scout, because they enable him to locate many diseased trees from a high point of land or from tree tops. In such cases compass sights are taken on the diseased trees, and an assistant is dispatched to locate them.

Thorough scouting for the blight is necessary.

Such scouting, however, cannot entirely take the place of more detailed examination.

It has also been demonstrated that more and better work in scouting can be done in the fall and winter, after the leaves have fallen. In August and September the majority of new infections become plainly visible on isolated trees, but in dense woods the foliage makes it difficult to locate small infections. After the leaves have fallen, however, more light is admitted, and a scout can see for comparatively long distances through the bare tops, even in dense woods. The dead leaves on girdled branches are conspicuous throughout the winter and early spring, and where cankers have not yet girdled the parts, the increased light makes them much more prominent than in summer. Winter scouting has the disadvantage of fewer hours of daylight and occasional loss of a day or two on acount of snow storms that tend to hide the cankers on the trunk and branches. If the snow becomes very deep it is not easy to examine the bases of the trees sufficiently, and the snow also greatly interferes with the proper treatment of the blighted trees.

In the work done by the Commission, the law required that the owner of diseased trees be notified to remove them within 20 days. A map or written description giving the location of the diseased trees on the tract, was also required by law. On private land the scouts kept field notes on the location of all diseased trees, blazed each tree to the wood and marked a serial number on it with black lumber crayon; on the side opposite from the blaze, a yellow manila tag was attached to the tree. These tags bore a printed notification that the tree to which one was attached must be cut in 20 days, with directions for treatment and a warning against starting forest fires; they also bore the serial number of the tree, the name of the scout, and the date when attached. In this way the trees were easily identified later when approached from any direction, and by means of the "location sheet" giving the direction and distance of each diseased tree from some fixed point, it was not difficult to find the trees. The "location sheet" was made out in duplicate, one copy being handed to the owner of the tract, with a written request to remove the trees within the 20 days granted by law. The duplicate copy was sent to the field office, the scout retaining his note book. Some system of this sort is necessary when the cutting out is not done by the scouting force, but it is cumbersome and very expensive. Frequently, it required more time to fulfill the requirement of the law than would have been necessary to treat properly the diseased trees on a tract. Much time was consumed also in very detailed inspection of the trees around a blight center, so

that apparently healthy trees would not be cut, since the law provided that healthy trees ordered to be cut, must be paid for. Not only was this very detailed scouting a waste of time in the light of recent investigations, but it resulted in decreased efficiency of control because so many of the trees permitted to remain, in reality were infected. Although no disease could be found on them at the time, the disease developed fully after the spot was treated, necessitating several re-examinations before all infections could be removed.

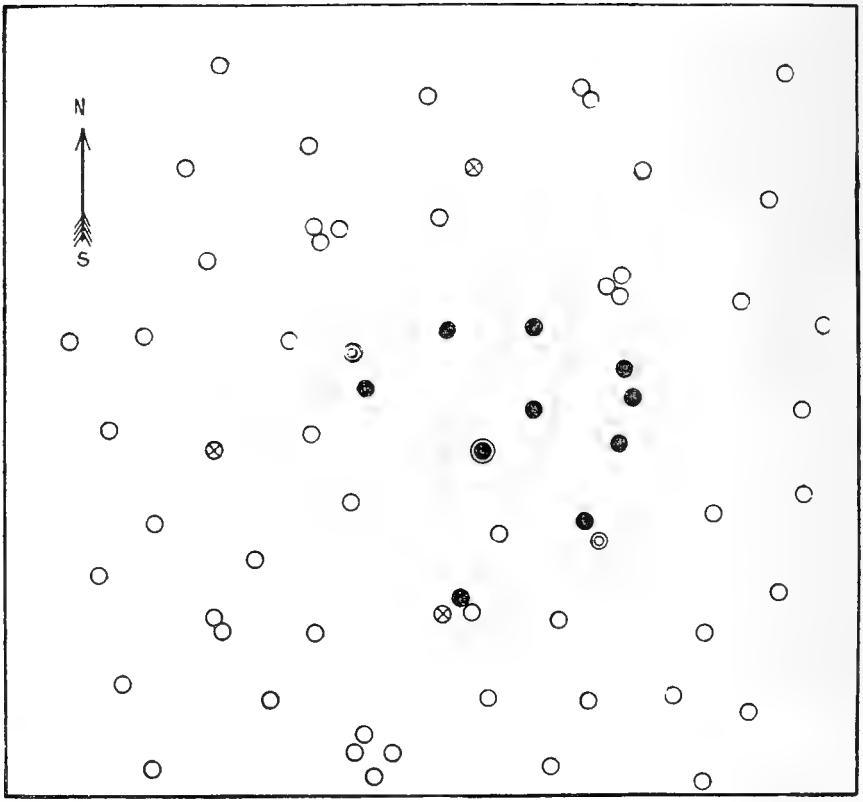
METHOD OF ERADICATING A SPOT INFECTION.

There are many points to be observed in removing diseased trees in spot infections, if the disease is to be permanently wiped out. The main point to keep in mind is the fact that the fungus propagates itself more readily as a saprophyte than as a parasite, so that unpeeled logs, strips of healthy bark and chips from diseased trees or nearby healthy ones, if left in the woods, are almost certain to become infected. The principal object is to do the work in a thoroughly sanitary manner at a reasonable cost. An experienced man acquired "tricks of the trade" that enabled him to do the work much more thoroughly and in less time than an inexperienced hand can do even a poor job. Great care was necessary in supervising the work of removal carried on by the individual owners, since each spot infection practically meant training a new man to do the work, and unless an experienced man was constantly on the spot, the work would seldom be done properly. On State forest reserves and in cases of forced removals, the work was done by employees of the Commission, and it was found that it was done at less cost and much more effectively than was usually the case elsewhere.

The removal of an infected tree is best done as follows: First: Where the ground beneath the tree is covered with a dense growth of brush, this growth should be cleared away so that the chips and branches may be easily picked up. Small chestnut or chinquapin trees or sprouts should be cut flush with the surface of the ground and the tops burned.

The stump should be made as low as possible. The bark should be first removed from the lower 3 or 4 feet of the trunk to an inch or more below the surface of the soil. If felled by sawing, peeling may be done after the tree has been cut down. During the fall and winter the bark is difficult to remove, and if the stumps are cut low, it is easier and cheaper to split off the sap wood and attached bark with an axe. In any case the stump and all exposed roots must be cleared of every particle of bark, and all bark removed must be carefully collected and burned.

Peeling blight infected trees in a spot infection.



Original infected tree, cut and burned December, 1911.

Secondary infected trees, cut and burned December, 1911.

Secondary infected trees, December, 1912.

Secondary infected trees, August, 1913.

Healthy trees, 6 to 12 inches in diameter.

Scale—

Figure 4.

Typical small spot infection, near Dry Run, Franklin County, Pa., showing original center and secondary infected trees. If all chestnut trees within 35 feet of the nearest diseased tree cut in 1911 had been removed at the time of the first cutting, and all stumps properly sterilized, it would have prevented the appearance of the new infections of 1912 and 1913.

After the tree is felled, all portions above the stump which show mycelium or pustules of the blight must be peeled of bark or the entire piece cut out. This diseased material, the brush from the tops, the bark, and portions of the felled chestnut trees which are not peeled and which it is not intended to utilize must be burned.

After the stump is peeled, if fire can be made over it without injuring the surrounding trees, and without danger of forest fires, the brush and refuse is best piled over the stump and burned. The fire must entirely consume or deeply char all of the material; no uncharred ends of branches and small twigs can be allowed to remain without grave chances of reinfection. If it is impossible to make the fire over the stump without injuring the surrounding trees, the sides and top of the stump and exposed roots should be thoroughly coated with creosote.

Portions of infected trees which show no evidence of the blight should not be permitted to lie unpeeled in the woods over twenty days, but may be safely handled and shipped with the bark on, if shipped as soon as cut. If the logs from the diseased trees are not removed from the woods within twenty days from the time the trees are felled, they should be peeled and the bark burned, or else the entire trees burned. Wood from diseased trees to be used where exposed to the weather must be peeled, or the fruiting bodies are almost sure to appear on the dead bark and become a source of infection. Fire wood, if kept under dry cover, need not be peeled.

One of the most important time saving items is to peel the lower portion of the tree before felling, and it is still more important to cut the stumps as low as possible. Bark remaining between buttresses and deep crevices of stumps can be removed very readily by chipping down from a position directly over the low stump, which is not possible in the case of high stumps. A rake and a large coal-burner's basket included among the tools used in burning, are very useful in cleaning the chips from the ground. Before starting the fire, all the leaves and debris for a considerable distance around the place where the material is to be burned should be raked into a pile on which the fire is started. The bark and small particles of wood are raked together as soon as the brush is piled, instead of waiting until all the tops are burned. In this way, no large quantity of leaves and fine rakings are left until the end to smoulder for a great length of time before burning, and thus increase the danger of forest fire.

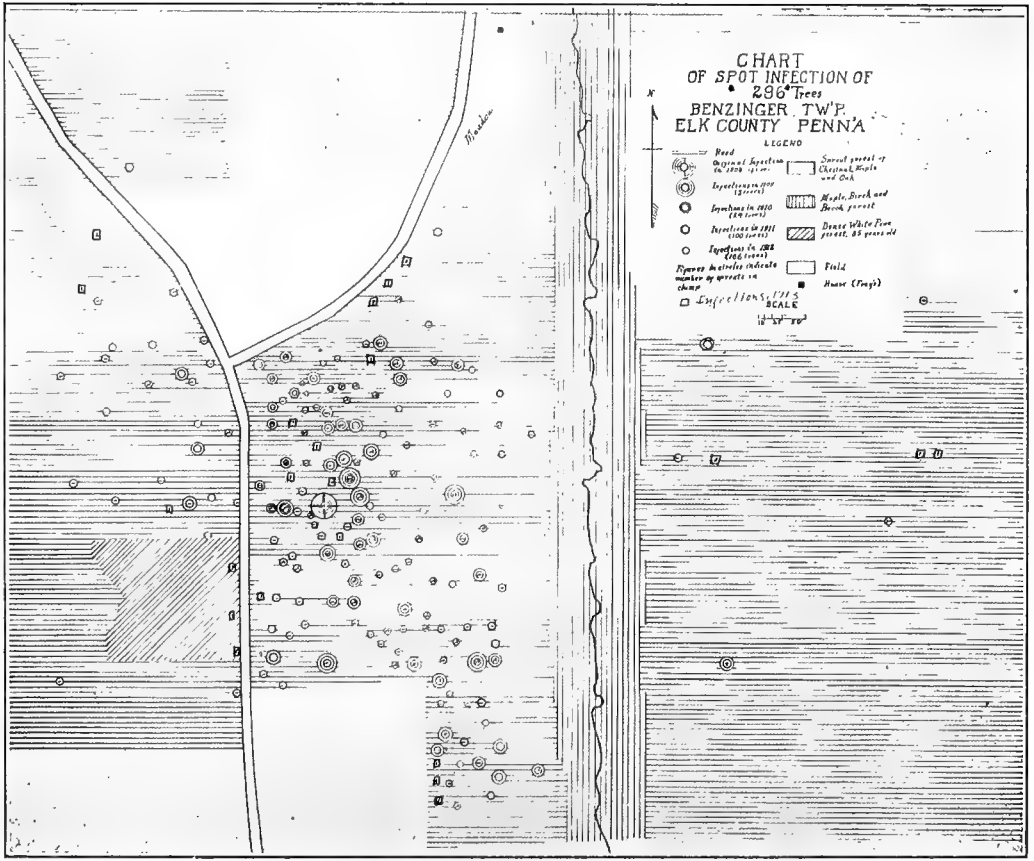
All possible care should be taken to prevent injury to surrounding chestnut trees and sprouts in felling the infected trees. Observation has shown that nearby trees are too frequently injured through carelessness, and the wounds are very apt to be a point of reinfec-

tion. Experience has also shown that unbarked stumps of blighted trees and green tops which are permitted to lie for a month or two on the ground are almost certain to become infected. The spores germinate on the sappy surface of the stump, and the mycelium grows downward through the cambium, and in the course of a year or two reaches the sprouts which come up around the base of the stump. In the case of the tops and particles of bark and wood, the decaying bark appears to be a very favorable seed-bed for the development of the spores that reach any portion of this material. It must be impressed on the workmen that the stumps must be peeled *clean,* and every particle of the diseased tree must be either burned or utilized in such manner that no opportunity is given for the saprophytic growth of the fungus.

It has been found that painting the thoroughly peeled stumps with creosote is effective in keeping the stumps free from the pycnidia of the blight fungus, but is not so desirable as hard burning over the stumps. In an experimental cutting at Wildwood Park, Harrisburg, 55 per cent. of burned stumps later showed blight, while only 23 per cent. of the creosoted stumps showed any signs of it. However, it is possible that in the future, many of the creosoted stumps will become diseased.

The results of an extensive experiment at Anderson Station, Mifflin County, are given below. This experiment deals with the efficiency of burning over stumps as compared with creosoting stumps. The stumps in Table II were peeled at various times during January, February, and March, 1913, and cold creosote applied with a brush. The cost of creosote and labor of application was approximately one-fifth of a cent for each six-inch stump, cut low. The data given below are the result of an inspection of these stumps made December 12, 1913.

Center of spot infection at St. Mary's, Elk County, Pa. This tree was infected at least four years prior to the time the picture was taken.



A Spot Infection in Elk County, Pa.

TABLE II.

RESULTS OF CREOSOTING PEELED STUMPS.

Number.	Number of vigorous sprouts.	Average height of vigorous sprouts (feet).	Number of diseased sprouts.	Point of disease on sprouts.	Diseased bark on stump.	Pycnidia on wood of stump (creosoted portion).
1,	14	5	.....	.....	Yes	.....
2,	8	5	1	Base	Yes	.....
3,	8	5	.....	.....	.....	.....
4,	6	6	.....	.....	.....	.....
5,	4	4	.....	.....	.....	.....
6,	4	5	.....	.....	.....	.....
7,	5	6	.....	.....	.....	.....
8,	3	3	.....	.....	.....	.....
9,	12	5	1	Base	Yes	.....
10,	7	7	.....	.....	.....	.....
11,	4	6	.....	.....	.....	.....
12,	3	5	.....	.....	.....	.....
13,	1	3	.....	.....	.....	.....
14,	6	6	.....	.....	.....	.....
15,	2	5	.....	.....	.....	.....
16,	5	3	.....	.....	.....	.....
17,	2	4	.....	.....	.....	.....
18,	6	5	.....	.....	Yes	.....
19,	2	4	.....	.....	.....	.....
20,	4	3	.....	.....	.....	.....
21,	4	6	.....	.....	.....	.....
22,	6	7	.....	.....	.....	.....
23,	10	7	.....	.....	Yes	Yes
24,	3	5	2	Base	Yes	.....
25,	1	4	.....	.....	.....	.....
26,	3	4	1	Base	Yes	.....
27,	8	5	.....	.....	.....	.....
Average, ...	5.2	5.2	0.035 of sprouts 0.148 of stumps	.....	.....	.....

No pycnidia were found on wood of peeled stumps after creosoting, except in one case, where a large area of inner bark adhered to the stump at time of creosoting, and later raised up, exposing an untreated wood surface. The inner side of this bark and the uncreosoted area of wood were covered with pycnidia. Creosote painted on thick bark at the base of stumps or on an exposed root does not appear to hinder the growth of the fungus. Hence, since stumps can be peeled but a very short distance below the soil, especially in winter, it is believed that creosoted stumps are more apt to have infected sprouts after a few years than burned stumps. The danger point is at the ground line, and exposed roots and the crotches at the collar between roots are especially liable to have areas of bark that are missed in peeling. If this bark becomes affected, it brings the disease very close to the young sprouts that spring up around the stumps, and sooner or later causes infection.

The stumps in Table III were burned in December, 1912. The data given below are the result of an inspection made December 12, 1913.

TABLE III.

RESULTS OF BURNING OVER PEELED STUMPS.

Number.	Number of vigorous sprouts.	Average height of vigorous sprouts (feet).	Number of diseased sprouts.	Point of disease on sprouts.	Diseased bark on stump.	Pycnidia on wood of stump.
1,	4	3	0	.....	.....	.....
2,	8	6	3	Base	Yes	.....
3,	2	2	0	.....	Yes	.....
4,	4	4	0	.....	.....	.....
5,	6	6	1	Base	Yes	Yes
6,	7	4	0	.....	.....	Yes
7,	3	3	0	.....	.....	.....
8,	2	4	0	.....	.....	.....
9,	5	4	0	.....	.....	.....
10,	0	0	0	.....	.....	.....
11,	3	4	0	.....	.....	.....
12,	4	3	0	.....	.....	.....
13,	1	1	0	.....	.....	.....
14,	4	3	0	.....	.....	.....
15,	4	7	0	.....	.....	.....
16,	3	6	0	.....	.....	.....
17,	4	4	1	Base	Yes	Yes
18,	4	4	0	.....	.....	.....
19,	4	5	0	.....	.....	.....
20,	1	6	0	.....	.....	.....
21,	3	5	0	.....	.....	.....
22,	2	3	0	.....	.....	.....
23,	4	4	0	.....	.....	.....
24,	2	2	0	.....	.....	.....
25,	5	5	0	.....	.....	.....
26,	0	0	0	.....	.....	.....
27,	2	4	1	Base	Yes	.....
28,	6	4	0	.....	.....	.....
29,	6	6	2	Base	Yes	Yes
Average,	3.5	4.5	*0.078 †0.17			

One very heavily burned stump, cut close to ground, had an area of diseased bark at crotch between roots, and a diseased sprout (No. 27). The least charring was always in crotches between roots at or near the soil line. Heavily burned stumps have weak sprouts or none, as a rule, about one stump out of twenty having no sprouts. Creosoted stumps usually have more and stronger sprouts than burned stumps.

Creosoting is cheaper than burning over the stump, on account of the labor saved. While it is apparently effective where the peeling and creosoting are well done, burning is safer, although more expensive. A gallon of creosote costs about 15 cents and will treat from 50 to 100 medium sized (10″—15″) stumps, varying with the height of the stump and the temperature of the air and

Heavily burned stump showing very few sprouts; also shows remnants of improperly burned tops, bearing growth of blight fungus, (on right).

Improper piling and burning of parts of an infected tree. The brush from the tops must be piled, and the edges of the pile pushed on the fire from time to time.

creosote. The creosote may be profitably used where other trees will be injured by fire or where there is great danger of starting forest fires. Other methods of treating the stump have been tried, such as spraying the stumps with crude oil or kerosene and then burning them, after peeling. The stumps have also been buried under a mound of soil through which the sprouts had to penetrate. These treatments are less efficient and more expensive than creosote and cannot be recommended.

COST OF ERADICATION.

The cost of eradication will vary greatly according to the conditions. If an average of 50 acres is scouted per day per man, at a labor charge of $2.50 per day to include the cost of supervision, the cost of scouting an acre is 5 cents. In a region of much blight, the cost of efficient scouting will run four or five times this amount unless the plan is adopted of determining only the edges of a spot infection, and then cutting out all of the chestnut trees inside of the area regardless of whether or not they show visible signs of the blight. This seems to be the most sensible plan, since the results of reinspection show that it is the trees inside of the edges of the spot infection which in almost every case show reinfection. It will save money not only in scouting, but in future control. On the Pennypacker forest reserve in Perry County where the infections were thickly scattered, the cost of scouting and removal in 1911 and 1912 on 1,620 acres was 73 cents per acre, or 52 cents per diseased tree, and this is probably the lowest figure for which the work can be done. The most expensive part of the work is the peeling of the stumps, and here a great deal can be saved by following the proper methods. In a large spot infection, the cost can be reduced considerably because of the concentration of the work. A spot infection of 822 trees, ranging up to 18 inches in diameter on the stump (average 6 inches) was cut out at a cost of $70.50 or 8.58 cents per tree. This included peeling not only the stumps, but all merchantable portions of the trees, burning the brush, sterilizing the stumps, and cleaning up thoroughly. This cost, however, does not include scouting, which in this case can be figured at 2 cents per tree. The total area of this spot was about three acres, so that the total cost of scouting and eradication was approximately $29.00 per acre. In all but very small spot infections, enough material is produced to pay for doing the work.

In Mifflin County, three men treated 2,341 clumps of six-year-old chestnut sprouts at an average cost of 20.3 cents per clump. Each man averaged 15 clumps per day; cutting, peeling, cleaning

up and burning were very carefully done at a cost of 16.3 cents per clump. Scouting, creosoting, and loss of time from bad weather cost an additional 4 cents per clump. The average acre contained 205 clumps of chestnut sprouts, with an average of 5 five-inch sprouts per clump; 29 clumps per acre or 14 per cent. were diseased. The cost of thorough sanitation thus amounted to $5.89 per acre. The average daily wage was $2.40, including the cost of board and supervision.

EFFICIENCY OF THE CUTTING-OUT METHOD OF CONTROL.

To determine the efficiency of sanitation in controlling the disease, a careful reinspection of 67 spot infections which had been treated a year or more previous to the examination, was made in the fall of 1913. The results of these investigations are shown in the following tabulation:

TABLE IV.

RESULTS OBTAINED, IN ONE YEAR, IN CUTTING OUT 20 ADVANCE SPOT INFECTIONS OF CHESTNUT BLIGHT.

Tract number.	County.	First Inspection	Number of infected trees removed.	Second Inspection.	Number of infected trees.	Number of treated stumps with infected sprouts.	Probable age of oldest infection.	Distance of furthest infection from center (yards).
1	Blair,	April, 1913,*	1	Feb., 1914,	1	0	1913	10
2	Clearfield,	Nov., 1912,*	1	Jan., 1914,	0	0	.....	.....
3	Tioga,	Dec., 1912,*	1	Jan., 1914,	0	0	.....	.....
4	Tioga,	Sept., 1912,*	1	Jan., 1914,	0	0	.....	.....
5	Tioga,	Nov., 1912,*	1	Jan., 1914,	0	0	.....	.....
6	Tioga,	Sept., 1912,*	1	Jan., 1914,	0	0	.....	.....
7	Bradford,	Jan., 1913,*	1	Jan., 1914,	0	0	.....	.....
8	Bradford,	Jan., 1913,*	1	Jan., 1914,	0	0	.....	.....
9	Bradford,	Jan., 1913,†	1	Jan., 1914,	0	0	.....	.....
10	Bradford,	Jan., 1913,*	1	Jan. 1914,	0	0	.....	.....
11	Blair,	Dec., 1912,*	2	Aug., 1913,	0	0	.....	.....
12	Cambria,	Jan., 1913,*	3	Jan., 1914,	0	0	.....	.....
13	Tioga,	Jan., 1913,*	3	Aug., 1913,	0	0	.....	.....
14	Tioga,	Dec., 1912,*	4	Jan., 1914,	4	0	1913	30
15	Huntingdon,	Jan., 1913,*	6	Jan., 1914,	5	0	1912	70
16	Blair,	Feb., 1913,§	7	Aug., 1913,	10	0	1912	50
17	Blair,	Jan., 1913,*	8	Aug., 1913,	1	0	1913	.....
18	Blair,	Jan., 1913,†	22	Aug., 1913,	4	0	1912	50
19	Blair,	Jan., 1913,*	26	Aug., 1913,	3	0	1912	.....
20	Huntingdon,	March, 1913,*	30	Jan., 1914,	7	0	1912	5
	Averages,	.....	6.15	.....	1.75	0	.....	35.8

*Sanitation well done—stumps well peeled, well burned or creosoted, and refuse burned.
†Sanitation fairly well done, but stumps not thoroughly peeled or burned.
§Sanitation poorly done—no burning done, and stumps poorly peeled in some cases.

TABLE V.

Results Obtained, in Two Years, in Cutting Out 35 Advanced Spot Infections of Chestnut Blight.

Tract number.	County.	First Inspection.	Number of infected trees removed.	Second Inspection.	Number of infected trees removed.	Number of treated stumps with infected sprouts.	Third Inspection.	Number of infected trees.	Number of treated stumps with infected sprouts.	Probable age of oldest infection.	Distance of furthest infection from center (yards.)
1	Blair,	August, 1912,*	1	December, 1912,	0	0	February, 1914,	0	0	.....	.....
2	Blair,	August, 1912,*	1	December, 1912,	0	0	February, 1914,	0	0	.....	.....
3	Blair,	June, 1912,*	1	December, 1912,	0	0	February, 1914,	1	0	1913	12
4	Blair,	July, 1912,*	1	December, 1912,	0	0	February, 1914,	0	0	.....	.....
5	Huntingdon,	April, 1912,*	1	December, 1912,	0	0	January, 1914,	0	0	.....	.....
6	Huntingdon,	November, 1912*	1	March, 1913,	0	0	August, 1913,	0	0	.....	.....
7	Warren,	October, 1912,*	1	April, 1913,	0	0	December, 1913,	0	0	.....	.....
8	Huntingdon,	January, 1912,‡	2	November, 1912,*	0	0	August, 1913,	7	0	1912	20
9	Elk,	July, 1912,*	2	May, 1913,*	2	0	January, 1914,	0	0	.....	.....
10	Elk,	June, 1912,*	3	April, 1913,*	3	0	January, 1914,	3	0	1912	13
11	Clearfield,	June, 1912,‡	3	December, 1912,‡	1	0	December, 1913,	4	2	1912	37
12	Blair,	August, 1912,*	3	December, 1912,	0	0	February, 1914,	0	0	.....	.....
13	Blair,	July, 1912,*	3	April, 1913,†	3	0	February, 1914,	1	0	1913	6
14	Blair,	April, 1912,†	4	December, 1912,	0	0	February, 1914,	1	0	1913	4
15	Blair,	May, 1912,*	4	March, 1913,*	4	0	February, 1914,	2	1	1913	3
16	Blair,	June, 1912,*	4	March, 1913,*	7	0	February, 1914,	3	0	1913	10
17	Warren,	July, 1912,*	4	April, 1913,	0	0	December, 1913,	0	0	.....	.....
18	Blair,	July, 1912,*	5	December, 1912,	0	0	February, 1914,	3	0	1913	20
19	Blair,	June, 1912,†	6	March, 1913,†	1	0	February, 1914,	1	0	1911	300
20	Blair,	July, 1912,*	6	December, 1912,	0	0	February, 1914,	0	0	.....	.....
21	Blair,	July, 1912,†	6	December, 1912,	0	0	February, 1914,	1	0	1913	10
22	Huntingdon,	April, 1912,‡	6	May, 1913,†	5	0	January, 1914,	1	1	1912	0
23	Blair,	July, 1912,*	7	April, 1913,†	1	0	February, 1914,	0	0	.....	.....
24	Blair,	April, 1912,†	7	March, 1913,‡	2	0	February, 1914,	1	0	1913	0
25	Blair,	August, 1912,*	7	March, 1913,‡	3	0	February, 1914,	1	3	1913	5
26	Clearfield,	July, 1912,*	7	December, 1912,*	2	0	December, 1913,	10	0	1912	15
27	Clearfield,	September, 1912,*	7	December, 1912,	0	0	December, 1913,	0	0	.....	.....
28	Clearfield,	June, 1912,†	9	December, 1912,‡	8	0	December, 1913,	5	2	1912	7
29	Warren,	October, 1912,*	11	April, 1913.	0	0	December, 1913,	0	0	.....	.....
30	Blair,	July, 1912,*	11	March, 1913,‡	5	0	February, 1914,	7	5	1913	.....

TABLE V.

Results Obtained in Two Years, in Cutting Out 35 Advanced Spot Infections of Chestnut Blight.—Continued.

Tract number.	County.	First Inspection.	Number of infected trees removed.	Second Inspection.		Number of treated stumps with infected sprouts.	Third Inspection.	Number of infected trees.	Number of treated stumps with infected sprouts.	Probable age of oldest infection.	Distance of furthest infection from center (yards.)
31	Blair,	June, 1912,†	15	April, 1913,‡	10	1	February, 1914,	6	2	1913	35
32	Blair,	July, 1912,*	17	April, 1913,‡	9	0	February, 1914,	9	9	1912	200
33	Clearfield,	September, 1912,†	19	December, 1912,‡	11	1	December, 1913,	8	1	1913	50
34	Blair,	August, 1912,*	25	March, 1913,*	3	0	February, 1914,	3	0	1913	5
35	Blair,	August, 1912,‡	27	March, 1913,‡	9	0	February, 1914,	4	9	1913	35
	Averages,		6.8		2.5	.06		2.3	1.0	.....	37.5

*Sanitation well done—stumps well peeled, well burned or creosoted, and refuse burned.
†Sanitation fairly well done, but stumps not thoroughly peeled or burned.
‡Sanitation poorly done—no burning done, and stumps poorly peeled in some cases.

TABLE VI.

RESULTS OBTAINED IN CUTTING OUT 8 LARGE SPOT INFECTIONS OF CHESTNUT BLIGHT.

Tract number.	County.	First Inspection.	Number of infected trees removed.	Second Inspection.	Number of infected trees removed.	Number of infected stumps with infected sprouts.	Third Inspection.	Number of infected trees.	Number of treated stumps with infected sprouts.	Age of oldest infection.
1	Elk,	August, 1912,†	34	May, 1913,†	4	0	January, 1914,	2	2	1912
2	Clearfield,	September, 1912,‡	36	December, 1912,‡	12	0	January, 1914,	36	0	1912
3	Blair,	November, 1912,‡	93	August, 1913,	14	0				1912
4	Huntingdon,	March, 1913,‡	100	January, 1914,	46	0				1912
5	Huntingdon,	March, 1912,‡	271	November, 1912,†	82	0	August, 1913,	88	6	1910
6	Elk,	November, 1912,*	296	April, 1913,*	23	0	December, 1913,	51	0	1911
7	Cambria,	November, 1912,*	480	June, 1913,*	5	0	August, 1913,	9	0	1913
8	Huntingdon,	October, 1912,†	822	June, 1913,‡	24	0	August, 1913,	91	0	1912
	Averages,		266.5		26.2	0		46.2	1.3	

*Sanitation well done—stumps well peeled, well burned or creosoted, and refuse burned.
†Sanitation fairly well done, but stumps not thoroughly peeled or burned.
‡Sanitation poorly done—no burning done, and stumps poorly peeled in some cases.

NOTES OF RE-INSPECTION.

Over 60 spot infections located on the western advance line were examined between August, 1913, and February, 1914. The spots were located in 7 counties on the extreme western advance line of the disease, and also some distance back of this line. The cutting out had been done by practically as many owners as there were spots, under supervision of various field men, so that the conditions were averaged in every way. The point which was brought out most prominently by the re-examination was the fact that where the stumps were well peeled and thoroughly charred and where the tops and refuse were well cleaned up and burned, and the merchantable material promptly removed from the vicinity of the spot infection, there was no reinfection of the stumps or sprouts of the treated trees. Where the work was carelessly done, there was more or less reinfection. However, there were exceptions in both cases. In some cases where the work was done only fairly well or even poorly, there was less infection than might naturally be expected. In some other cases where the work was done as well as it can be expected under field conditions, there was a considerable reinfection. This variation is probably explained by other factors which undoubtedly enter into the effectiveness of sanitation cutting. Probably the age of the original infection center is one factor governing the number of new infections which appear after the first cutting out. If the original infection is still so young that there is a comparatively small canker, or if the condition of the growth has been unfavorable for the production of ascospores, a small amount of new infection may be expected, since the wind apparently distributes most of the infection to the surrounding trees. On the other hand, if the diseased area of bark at the center of an infection is large and has produced a great number of perithecia, and the climatic conditions have been favorable for the ejection of ascospores, a large number of incipient infections are very apt to be left in the surrounding trees at the time of the first removal cutting.

Just how long after cutting it takes these incipient infections to develop so that they can be detected in scouting depends on a number of conditions, such as the location of the diseased area on the tree and the height above ground where infection occurs, size of the tree, season of the year and climatic conditions following the occurrence of infection, location of the spot infection relative to topography, etc. Probably the most important factor governing the number of new infections after a removal cutting is the character and quality of the man who scouted the area. Certain

Healthy sprouts growing around a burned stump.

men have much better scouting ability than others, and in some of the spots examined, at least, this factor alone is sufficient to account largely for the conditions found on reinspection. However, even the best scout cannot detect small twig infections in the tops of tall trees before they have girdled the twigs, and it is frequently very easy to miss well developed cankers either at the base of large trees when no fruiting bodies have been produced, or on the upper trunks of tall trees before the tops have been girdled.

It was very noticeable that new infections appearing in a spot where the original infection had been properly removed were almost always within a short distance of the original infection. Probably half of the new infections found, even after the second inspection, were on trees that grew on the same stump or in the same tree group as an original infected tree, and 90 per cent. of the newly infected trees were so close that their tops interlocked or were directly exposed to the tops of the previously infected trees. The accompanying diagram illustrates the characteristic manner in which new infection appears. In several cases the farthest infection as noted in the tabulated data was an old infection which was missed at the time of the first inspection, and which really constituted a separated spot infection.

Blight spots in northern Pennsylvania seem to be smaller, more widely scattered, and to spread less rapidly from the center than spots in the southern part of the State. One reason for this may be that there is, as a rule, a much lower percentage of chestnut in the forest and the chestnut appears to be sounder and in better health than much of the chestnut in the southern part of the State. Further south along the advance line, greater injury is noticed on young trees from the bast miner; damage from ice storms and hail storms also appears to be greater. Another possible factor is that the climate is warmer, and favorable to the copious formation and ejection of ascospores over a longer period than in the northern part of the State. Another possible factor is differences in topography which favor the carrying of spores long distances along regular "air lanes." This may be the explanation for long chains of spot infections which occur along the lower edges of timber of the long, forested ridges, and on benches half way up mountain sides. This is put forth merely as a suggestion and not as a fact, although there is some evidence to warrant a hypothesis of this kind.

The results of the investigation show clearly that the chestnut trees immediately within and adjoining a spot infection (say 25 feet beyond the outermost infected trees), should be cut out and the stumps sterilized whether the trees appear to be infected at the time the cutting is done, or not (Fig. 4). The investigation

proves that these trees in the majority of cases will become infected later on, and it means extra expense and less effective control to wait until the infection appears. In very small spot infections or even those of considerable size, it is believed that such treatment will avoid a recurrence of the blight in the majority of cases. However, to cut out these apparently healthy trees is not sufficient; the sanitation work must be done as thoroughly as if the trees were diseased. Even though the merchantable portions are taken out of the woods and the tops burned, the unpeeled stumps are very apt to become infected, especially if nearby diseased trees have been ejecting ascospores. Four treated spot infections were examined which proved this very conclusively. The following facts relative to these spots are interesting:—

Spot 1. Five infected trees in Huntingdon County were treated in April, 1912, by digging up the trees, stumps and all, and burning them in an open field. In March, 1913, the spot was re-examined and three infected trees found. The stumps were peeled and the tops burned, but not over the stumps. At the same time all of the chestnut trees on a half acre surrounding the spot that were large enough for fence posts were cut out, the tops burned and the rest of the trees removed. The stumps were left unpeeled and in January, 1914, 6 new infections were found on small saplings that remained after the cutting, and all but 4 out of 75 stumps from which the bark was not peeled showed pycnidia on the cut surface of the wood or bark, pustules in the dead bark on the side of the stump, and usually, mycelium growing downward toward the base of the stump through the live bark.

Spot No. 2. Seven infected trees cut March, 1913; stumps well peeled but not burned over. In January, 1914, 9 new infections were found on adjoining trees and 50 new infections were found on the stumps of healthy trees cut in close proximity to the spot in March, 1913. These stumps were not peeled and the pustules appeared in the bark on the side of the stump, and in many cases showed mycelium running through the live bark of the lower part of the stump.

Spot No. 3. Seven trees cut June, 1912; stumps peeled and well burned. March, 1913, 7 infections were cut out, the stumps poorly peeled and not burned. At this time 17 healthy trees were cut within a radius of 30 yards and the bark was not peeled from the stumps. In January, 1914, no new infections had appeared on any of the surrounding trees, but 8 of the stumps were infected.

Spot No. 4. One infection cut July, 1912. Stumps peeled and burned. In April, 1913, 16 new infections were found on stumps cut at the time the original infection was removed and immediately

Healthy sprouts in spot infection where blight was cut out by sanitary methods

Properly burned stump; stump on the left cut too high.

surrounding the infected trees. These stumps were located as follows: One stump 3 yards west of center; 3 stumps northwest of center (farthest 35 yards); 3 stumps north of center (farthest 20 yards); 5 stumps northeast of center (farthest 12 yards); 2 stumps east of center (farthest 3 yards); 2 stumps southeast of center (farthest 8 yards); these stumps were peeled and not burned over. In February, 1914, 4 additional infected stumps were found, the farthest being 12 yards from the center.

East of the advance line sanitation has proved effective in hindering the progress of the disease, but not in eradicating it. Inspections made of a tract of blighted chestnut at Haverford, Pa., cut in 1910 and the stumps peeled, but not burned, showed both in 1912 and 1913, that only about 20 per cent. of the stumps and sprouts were reinfected. On a nearby tract where the trees were cut at the same time and stumps left unpeeled, the reinfection was approximately 80 per cent. At Hummelstown, Pa., on several acres of diseased chestnut, cut in the winter in 1911-12, a portion of the stumps were peeled and lightly burned. In the spring of 1913, 80 per cent. of the peeled stumps and 90 per cent. of the unpeeled stumps were reinfected. The reasons for the high per cent. of reinfection was the fact that the peeled stumps were not well burned, and the nearness of disease on trees in the adjoining woods and on the adjoining unpeeled stumps. This is shown by the location of the infection on the sprouts as follows:

TABLE VII.

INFECTION ON SPROUTS AROUND STUMPS OF BLIGHTED TREES CUT AT HUMMELSTOWN, PA.

PEELED STUMPS.

Stump Number.	Number of sprouts.	Infected Sprouts.		
		Infected on crotches.	Infected in insect galls.	Basal infection.
1,	42	5	11	0
2,	28	0	0	0
3,	35	4	7	0
4,	20	4	1	0
5,	11	0	3	0
6,	12	2	0	0
7,	50	0	2	0
8,	10	0	2	0
9,	15	1	3	1
10,	28	0	0	0
Average,	26.1	1.2	2.9	0.1

UNPEELED STUMPS.

1,	15	4	3	0
2,	24	0	4	1
3,	30	1	0	1
4,	10	0	2	1
5,	2	0	0	0
6,	46	0	4	0
7,	54	1	3	0
8,	55	1	1	0
9,	23	0	1	0
10,	40	1	3	0
Average,	29.9	.8	2.1	.3

The investigation at Hummelstown shows that there is little or no difference in the number and vigor of the sprouts produced by peeled and unpeeled stumps. In many cases, the sprouts reached a height of six feet or more in a single year's growth. The sprouts from peeled stumps frequently spring from the roots, 2 to 4 inches from the stump, and push through three inches or more of soil. This will undoubtedly aid in keeping them free from disease, and the new growth will be better rooted than ordinary stump sprouts.

Peeled stump uncovered after burial. Showing piece of diseased bark buried with stump. On this bark the fungus was still alive.

RECOMMENDATIONS.

It has been shown that with the less effective methods of cutting out spot infections used in the beginning of its work by the Pennsylvania Chestnut Tree Blight Commission, the amount of blight has been substantially reduced. It is reasonable to suppose that much more efficient results will be obtained by using the methods which have been developed by experience, and which are recommended in this report:

(1) Cutting out all chestnut trees inside the limits of a spot infection, also immediately beyond, regardless of whether or not they all show visible signs of the blight.

(2) Great care in peeling the stumps and in burning or removing from the woods all felled portions of the treated trees.

(3) Thorough disinfection of the peeled stumps, preferably by burning.

(4) A force of well-trained and experienced men to do both the scouting and sanitation cutting.

REGULATING SHIPMENTS OF CHESTNUT NURSERY STOCK.

The Commission issued the appended official regulations for the better protection of buyers of chestnut nursery stock, and to aid in the effort to prevent the spread of the chestnut tree bark disease. So far as could be learned, the railway and other transportation companies generally complied with these instructions, recognizing their meaning and importance, knowing that diseased nursery stock was a serious menace.

REGULATIONS RESPECTING CHESTNUT NURSERY STOCK; ADOPTED BY THE CHESTNUT TREE BLIGHT COMMISSION, MARCH 4, 1913.

Whereas, It is found necessary to make certain regulations in order to provide efficient and practical means for the prevention, control, and eradication of the chestnut tree blight; therefore, in pursuance of the powers conferred by Act of Assembly, it is resolved by this Commission that the following regulations be adopted,

and as occasion may arise, such other and further regulations, and the altering or amending of the same, as it may seem necessary.

Regulation No. 1. Railroad companies, express companies, and other common carriers must not accept for shipment, until further notice, any chestnut nursery stock which does not bear the official inspection tags of this Commission. Chestnut nursery stock shipped from without the State and intended for delivery within the State not being accompanied by an official inspection tag issued by the proper authorities of the State or Country wherein such shipment originated, certifying apparent freedom from chestnut blight, must be held at a convenient place within the State, and this Commission immediately notified. Every such shipment must be retained in its original package, unopened, and must not be delivered to the consignee until after an examination shall have been made by an inspector representing this Commission, and then not until the inspector shall have attached thereto the official inspector's tag of this Commission.

The official inspection tag of the Commission bears the official seal of the Pennsylvania Chestnut Tree Blight Commission, and reads as follows:

COMMONWEALTH OF PENNSYLVANIA

The Commission for the Investigation and Control of the Chestnut Tree Blight Disease in Pennsylvania.

CERTIFICATE OF INSPECTION

This is to Certify that the chestnut nursery stock to which this certificate is attached, under my supervision, was carefully examined, and at the time of shipment was found to be apparently free from any infection by blight caused by the fungus *Diaporthe parasitica.*

Dated .....191.....at .....Pa.

.....Inspector.

For the Chestnut Tree Blight Commission.

Each bundle, bale, or package of chestnut nursery stock shall bear the above tag, and in addition each tree shall have attached thereto a numbered and signed tag of which the following is a copy:

Large sprouts growing around creosoted chestnut stumps.

COMMONWEALTH OF PENNSYLVANIA

The Commission For the Investigation and Control of the Chestnut Tree Blight Disease in Pennsylvania.

Certificate of Single Tree Inspection.

Tree Number.....

This is to Certify that the chestnut tree to which this tag is attached, under my supervision, was carefully examined, and at the time of shipment was found to be apparently free from any infection by blight caused by the fungus *Diaporthe parasitica.*

Dated .....191.....at .....Pa.

.....Inspector.

Regulation No. 2. No chestnut tree nursery stock shall be removed from any nursery or other place where the same may be growing, for the purpose of sale or shipment until said trees shall first have been inspected by this Commission and the official inspection tag attached thereto. "Removed" is here construed to mean the final tying up into an original package, transporting from the premises where grown, or offering same to a common carrier for shipment.

Regulation No. 3. All chestnut tree nursery stock intended for sale or shipment must first be dipped into an approved fungicide prior to delivery or shipment. The official inspection tag will not be attached to stock unless first so treated.

Regulation No. 4. All chestnut tree nursery stock found to be infected with the chestnut bark fungus must be immediately destroyed. This regulation applies to diseased stock found at the time of inspection for shipment, and also to inspections in the nursery before stock is marketed.

Regulation No. 5. Nurserymen and common carriers, who, after receiving notice of the above regulations, negligently or willfully fail to refuse to be governed thereby, will, without further notice, subject their chestnut stock and shipments to quarantine, which will be maintained by this Commission.

All correspondence relative to nursery inspection should be addressed to Dr. F. D. Heald, Pathologist, Zoology Building, University of Pennsylvania, Philadelphia, Pa.

THE AMENDED CHESTNUT TREE BARK DISEASE ACT.

The work of the Chestnut Blight Commission was suspended not because of the lack of a desire to proceed, or lack of opportunity to render most valuable services, but for reasons stated in the letter at the beginning of this report. While the legislation recognized the

need of continuing active work of this character by providing for a continuation of the Commission, it did not see its way clear to have the work advance with that vigor which the Commission believed necessary in order to achieve the most marked success.

The original Act of Assembly approved June 14, 1911, provided that the Commission should continue operations for a period of three years from the date of the approval of the Act. This period would have expired by limitation, June 14, 1914. To continue the Act in force, and to provide for a Commission to take up the work at any time, should it be thought in the future desirable to do so, the original Act of Assembly was amended by extending the term of the original Commission to a period of five years from the date of their appointment, and to continue thereafter for so long, as in the judgment of the Governor, it might be necessary to have work done in accordance with the terms of the law. This makes the Commission a continuing one to be revived at the pleasure of the Governor. Section one, of foregoing Act, as amended* by the 1913 Legislature, reads as follows:

"Section 1. *Be it enacted, etc.,* That a commission, to consist of five members, to be appointed and commissioned by the Governor for a period of five years from the date of their appointment, and to continue thereafter for such period as, in the judgment of the Governor, may be necessary to enable them to complete the work to be done under 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. Provided further, That if the fungus causing the aforesaid disease be found to attack other species of trees, such trees shall be deemed to come within the purview of this act."

*See P. L. 1913, p. 313.

Peeled chestnut stump buried, showing sprouts.

Bibliography

of the

Chestnut Bark Disease

By R. KENT BEATTIE, FOREST PATHOLOGIST,
U. S. Department of Agriculture.

A BIBLIOGRAPHY OF THE CHESTNUT BARK DISEASE.*

Prepared for the Pennsylvania Chestnut Tree Blight Commission.

By R. KENT BEATTIE, *Forest Pathologist*,
BUREAU OF PLANT INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE.

DECEMBER 31, 1913.

The rapid rise and spread of the Chestnut Bark Disease since its introduction into the United States from the Orient, probably in the nineties, has called it to the attention both of scientific men and the general public. The result of this almost universal notice in the eastern states has been the production of numerous articles written from many different standpoints.

It has been the effort in this bibliography to cite all the writings of a scientific or semi-scientific nature, with the aim of making a good working bibliography of the disease. Since it is manifestly impossible for any such bibliography to be complete, the author will be glad to have called to his attention any omissions or any corrections in the citations here given.

Because of their importance in the chestnut bark disease problem, references to *Endothia radicalis* and *Endothia gyrosa* as well as those to *Endothia parasitica* have been included in this bibliography.

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