The Pennsylvania Chestnut Blight Conference

Chestnut Blight Object Lesson

HARRISBURG

February 20th and 21st, 1912

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA
1912

Group of delegates and guests at the Chestnut Bark Disease Conference, Harrisburg, Penna., February 20-21, 1912.

THE CONFERENCE

Called by the Governor of Pennsylvania to Consider Ways and Means for Preventing the Spread of the Chestnut Tree Bark Disease

THE CAPITOL

Chamber of the House of Representatives

HARRISBURG - PENNSYLVANIA

FEBRUARY 20 and 21, 1912

Stenographic Report of Proceedings of the Conference

Reported by GUILBERT & LEWIS
519 Land Title Building
Philadelphia, Pa.

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA
1912.

FOREWORD.

The following report of the proceedings of the Harrisburg Chestnut Blight Conference is distributed with the compliments and best wishes of the State of Pennsylvania. The numerous papers and the discussions thereon contain many new and valuable ideas. It is believed that the ultimate worth of the Conference will lie in the fact that it brought home to the eastern United States the truth concerning a most serious tree disease, and started discussions and a new trend of thought which must evolve real benefit for the whole people. If the Conference can produce a better understanding and higher appreciation respecting the value of trees, and of one tree in particular, its calling will have been of great public benefit.

The officers chosen by the meeting take this last opportunity of expressing to the Governor, the Chestnut Tree Blight Commission and the Delegates from the States, their sense of high appreciation for the honor conferred upon them in being invited to preside over the deliberations of the Conference. They also have hopes that information may be found in the following pages which will incite greater interest in the earnest work now being undertaken in Pennsylvania and other States to prevent the further spread of this serious and destructive Chestnut Bark Disease.

R A Pearson
New York, *Chairman.*

S. B. Detwiler
Pennsylvania,

F. W. Besley
Maryland,

Secretaries.

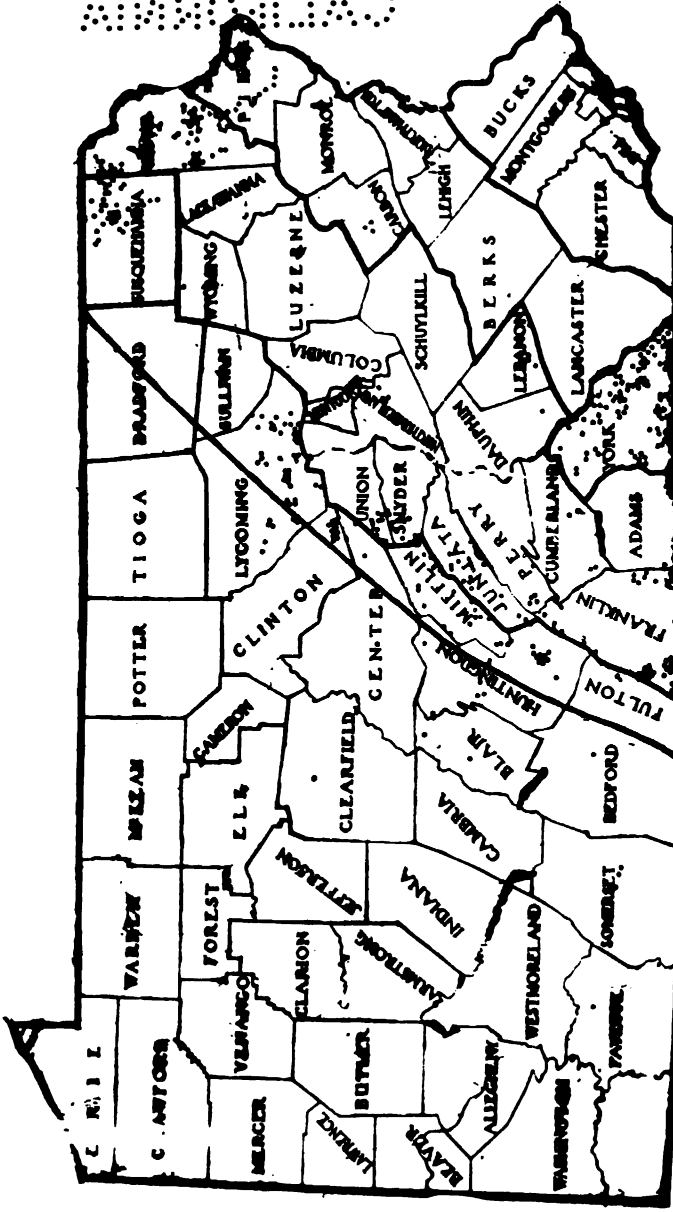
OFFICIAL CALL FOR CONFERENCE.

The Official Invitation for the Chestnut Tree Bark Disease Conference, issued by the Governor of Pennsylvania.

The Governor of Pennsylvania cordially invites you to be present at the Capitol in Harrisburg on the 20th and 21st days of February, A.D. 1912 to participate in a Convention called for the purpose of considering the danger presented by the prevalence and spread of a fungous disease of the wild Chestnut Tree known as the Chestnut Bark Disease and the methods to be pursued in accomplishing its possible control.

Executive Department, Harrisburg.
January 25th 1912.

An early and, if possible, a favorable reply to the Secretary of the Pennsylvania Chestnut Tree Blight Commission, Mr. Harold Peirce, Room 1112, Morris Building, Philadelphia, will be appreciated.



Map of Pennsylvania Showing Infected Zones and Percentage.

1. Bucks, Montgomery, Chester, Delaware and Philadelphia counties, 80 per cent. **2.** Pike, Monroe, Carbon, Northampton, Lehigh, Berks, Lancaster and York counties, 50 per cent. **3.** Wayne, Lackawanna, Wyoming, Luzerne, Columbia, Montour, Northumberland, Union, Snyder, Juniata, Perry, Dauphin, Schuylkill, Lebanon, Cumberland, Franklin and Adams counties, 15 per cent. **4.** From the western boundary of these counties to the quarantine line indicated on the map, the infected trees are estimated at 1 to 5 per cent.

THE PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION.

The call issued by the Governor, in which he urged the importance and necessity for prompt and concerted action in combating the Chestnut Bark Disease, included the following statement:

"In 1911, the Pennsylvania State Legislature passed a bill authorizing the Governor to appoint a Commission of five citizens for the purpose of thoroughly investigating the Chestnut Tree Bark Disease which is rapidly destroying the chestnut trees of the Commonwealth. The Act placed an appropriation of $275,-000 at the disposal of the Commission for the investigation and scientific study of the problem, and more specifically to ascertain the exact extent of the blight, and to devise ways and means through which it might, if possible, be stamped out.

The Commission was appointed in June, 1911, and, after organization, began its work immediately by sending a large force of experts into the field. The reports of these experts together with the results of the work of the pathological staff, will, among other matters, be presented for discussion to a Convention called by the Governor to assemble at Harrisburg, February 20th, 1912.

In order that the other States not yet touched by the blight, but certainly in its line of advance, may realize the seriousness of the situation, the Governor, who is much interested, has called this Convention for a consideration of ways and means, in the hope that the States may be aroused to action and be ready to meet the invasion at their borders. Pennsylvania's problem is now or soon will become the problem of Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Kentucky, West Virginia, Ohio, Indiana and Michigan. Active co-operation of the States is essential. The attendance of a large number of Delegates is respectfully urged."

COMMONWEALTH OF PENNSYLVANIA

PROGRAMME

of

THE CONFERENCE

Called by the Governor of Pennsylvania
to Consider Ways and Means

for

PREVENTING THE SPREAD

of the

CHESTNUT TREE BARK DISEASE

February 20 and 21, 1912

THE CAPITOL

Chamber of the House of Representatives

HARRISBURG - PENNSYLVANIA

An office for registration and information will be opened in one of the ante-rooms of the House of Representatives, and it is earnestly requested that all delegates and guests will promptly register.

PROGRAMME

OPENING SESSION

Tuesday, February 20, 2 o'clock P. M.

ORGANIZATION OF THE CONFERENCE.

1. *Call to Order and Address of Welcome to Delegates and Visiting Friends, by the Honorable John K. Tener, Governor of Pennsylvania.*

   Election of Permanent Chairman for the Conference.

   Election of Two Secretaries.

   Designation of Official Reporters.

   Appointment of a Committee on Resolutions.

2. *Responses to the Governor's Address by Delegates on Behalf of the States Represented.*

3. *"Historical Review and the Pathological Aspects of the Chestnut Bark Disease."*
   A discourse and illustrated lecture by Dr. Haven Metcalf, U. S. Department of Agriculture, Washington, D. C. (Dr. Metcalf's paper will summarize the record of work to date, and present the leading pathological features of this tree disease.)

   Many of the lantern views will be shown for the first time, having been especially made for this occasion.

4. *"Can the Chestnut Bark Disease be Controlled?"*
   By Prof. F. C. Stewart, N. Y. Agricultural Experiment Station, Geneva, N. Y.

5. *"How Further Research May Increase the Efficiency of the Control of the Chestnut Bark Disease."*

   By Prof. W. Howard Rankin, Cornell University, Ithaca, N. Y.

6. *"Recent Notes on the Chestnut Bark Disease."*

   By Prof. H. R. Fulton, Division of Pathology, Pennsylvania State College.

7. *"The Possibility of a Medicinal Remedy for Chestnut Blight."*

   By Dr. Caroline Rumbold, in charge of the Pennsylvania Chestnut Tree Blight Commission's Laboratory.

8. *"Treatment of Individual Trees,"*

   By Prof. J. Franklin Collins, U. S. Department of Agriculture, Washington, D. C.

9. *General Discussion.*

EVENING SESSION

Tuesday, February 20, 8 o'clock, P. M.

1. *"Chestnut Culture."*

   An illustrated lecture by Prof. Nelson F. Davis, of Bucknell University, Lewisburg, Penna. In this lecture Prof. Davis will exhibit the value of the chestnut trees as a source of food (nuts), and outline the progress made in the new American industry, chestnut cultivation.

   The insect enemies of the chestnut, and the methods of controlling them will be shown.

   Many of the views have been especially prepared for the occasion, and will be shown for the first time.

2. *General Discussion.*

MORNING SESSION

Wednesday, February 21, 9 o'clock, A. M.

ERADICATION AND CONTROL OF THE CHESTNUT BARK DISEASE.

1. *"The Pennsylvania Programme."*
   By Samuel B. Detwiler, Executive Officer of the Pennsylvania Chestnut Tree Blight Commission.

2. *Reports by State Foresters,* or other officials of States represented, on the present extent of the bark disease and estimate of the present and possible future loss.

3. *"Chestnut Blight and the Future of our Forests."*
   By Dr. H. P. Baker, Department of Forestry, State College, Penna.

4. *"Chestnut Blight and Constructive Conservation."*
   By Dr. J. Russell Smith, Professor of Industry, University of Pennsylvania, Philadelphia, Pa.

5. *Open Discussion of the Problems Presented.*

AFTERNOON SESSION

Wednesday, February 21, 2 o'clock, P. M.

1. *Presentation of the Report of the Committee on Resolutions.*

2. *General Discussion.*

Adjournment.

In addition to the above stated papers on the advance programme, others were read or formally presented as follows:

1. A paper on the "Botanical History of *Diaporthe parasitica* and Allied or Identical Fungi," by Prof. W. G. Farlow, of Harvard University; read by Prof. G. P. Clinton.

2. A paper on the "Relation of Insects to the Chestnut Bark Disease," by Dr. A. D. Hopkins, of the Bureau of Entomology, U. S. Dept. of Agriculture, Washington, and read by him.

3. A paper entitled "Chestnut Blight and its Possible Remedy," by Mr. W. M. Benson, of the Oak Extract Company, Newport, Perry Co., Pa.

4. A paper entitled "The Field Work of the Chestnut Tree Blight Commission," by Thomas E. Francis, Field Supervisor of the Pennsylvania Chestnut Tree Blight Commission.

5. A paper entitled "A Report on Scout Work on the North Branch of Bald Eagle Mountain, between Sylvan Dell and Williamsport, Lycoming county, Pa.," by Hugh E. Wells, Field Supervisor of the Penna. Chestnut Tree Blight Commission.

Conference for Preventing the Spread of the Chestnut Tree Bark Disease.

OPENING SESSION

Tuesday, February 20, 1912, 2 o'clock, P. M.

CALL TO ORDER AND ADDRESS OF WELCOME TO DELEGATES AND VISITING FRIENDS, BY THE HON. JOHN K. TENER, GOVERNOR OF PENNSYLVANIA.

GOVERNOR TENER: Gentlemen, the meeting will please be in order.

Let me say at the outset, speaking for this Commonwealth and less for myself personally, that we are gratified indeed at the splendid representation here to-day, bearing testimony to the great interest manifested in the work at hand.

I know that many of you have come from afar, many of you at great inconvenience and certainly at expense to yourselves or to the State or Association that you represent, in order that you might meet with us here, in the Capital City of Pennsylvania, to discuss and to consider seriously the objects and the purposes of this meeting.

It is not my purpose to enter into an extended discourse upon the subject of the chestnut tree blight or bark disease, but rather to extend just a word of welcome to you, on behalf of our Commonwealth and our city, and also to suggest what might be proper for your consideration at this time; to go over briefly the extent of this disease in the area it now covers; what it means to us if it spreads farther, and what it has meant to us; the value of our chestnut trees, and a suggestion of what I hope you may be able to arrive at before you leave us. We know that in conventions, we cannot exercise any governmental function; yet we want this to be something more than a "resolve to resolve" meeting, and we hope that something really tangible will result from it. I have noted just a few things which, as I stated before, I would like to have you consider in your deliberations:

This Conference has been called for the purpose of obtaining all possible information concerning the best methods of fighting the destructive fungous disease known as the chestnut tree bark disease or the chestnut tree blight, which was first detected in the neighborhood of New York City about eight years ago, and has since spread to the Northeast as far as Eastern Massachusetts, and to the Southwest as far as Central Pennsylvania, Maryland and Northern Virginia.

This tree disease is virulent in character. To date, no specific remedy to be applied to individual trees is known.

It seems almost unthinkable that a disease of this character should have invaded so large an area and that no means of preventing its spread is yet at hand. Unless this disease be stopped by concerted action among the States, it is certain that within a few years very few living wild chestnut trees will be found in America. It is, therefore, entirely in accord with the American spirit that we make every effort to destroy or check the advance of this blight.

The value of the standing chestnut stock to-day in America is enormous. In Pennsylvania alone, the wild chestnut tree is found native throughout the State, and in its southern counties is the principal remaining forest tree. The value of this tree in the State of Virginia is reliably conceded by competent authority to be not less than thirty-five millions of dollars. I believe that here in Pennsylvania, by a very conservative estimate, placing a valuation of fifty cents upon each tree in our woodlands, which you will admit is a very low estimate, the value of the wild chestnut trees is at least forty millions of dollars.

The best chestnut in the world is still standing in the mountains of North Carolina, West Virginia, Eastern Kentucky and Tennessee. The chestnut stock of the future must necessarily be drawn from these states. To date, the blight has not reached that region, but is steadily tending in that direction. This tree is also of great value in Ohio and the remaining Atlantic Seaboard States, and by reason of the all too prevalent forest destruction going on, the tree can ill be spared; much less its value wasted, as it largely will be, should the remaining chestnut stock be attacked.

The destruction of the wild chestnut trees in New Jersey, in Southeastern New York, Western Connecticut and Massachusetts and Southeastern Pennsylvania is marked to be complete.

The industries depending upon the wild chestnut tree for their support are of large proportions and great value. Every part of the tree is valuable for making tannic acid, used in the tanning industry. Telegraph and telephone companies depend mostly upon this tree for their stock of poles. The railroad companies are largely dependent upon it for their best railroad ties. The nuts are no inconsiderable part of this valuable product. Many thousands of men are employed in the industries depending upon the saving of the wild chestnut tree, and many other thousands of real estate owners will find their land values seriously affected should the tree ultimately be destroyed.

Two great facts to be borne in mind are, *first,* that the plague is with us and it must be reckoned with; and *second* that harmonious action and complete co-operation among all the interests involved, as well as the governments of the various states, can and will be the only means of checking this disease, if it can be checked. We are not so much concerned with its origin as we are with its presence and effects. While its botanical history and pathology are of importance, the real thing is preparedness to repel the invader, using every means known to science and practical experience.

It is, therefore, to be hoped that this aspect of the problem will be thoroughly taken hold of and discussed from every point of view, that concerted action will be immediately inaugurated, and no effort left unemployed that might produce desirable results. The time to act is now, and not after the scientific world has more fully worked out the history and pathology of the disease. Present day practical measures may well be aided by scientific inquiry, but the one by no means must wait upon the other. It was because of Pennsylvania's realization of the importance of this work that the Legislature, at its last session enacted a bill creating a commission and defining the duties of that commission, as well as appropriated an adequate amount to carry on the work. Without reviewing that bill in its full text, it might be said that the proposed Commission was given the direction to seek out and destroy this disease. As Admiral Dewey, you remember, at about the outset of our war with Spain was directed by President McKinley and the Cabinet to seek out the Spanish fleet and destroy it, so it might be said that the only direction given this Commission was to find this dread chestnut bark disease, and destroy it.

That Commission has been organized, and this State is indeed fortunate in being able to command the services of such splendid men, such capable men as Messrs. Sargent, Peirce, Craig, Bodine and Ely, who have gone about their work with the determination to do all that is possible to bring about the desired results.

Were the cause of this disease known, and did we know how to combat it and how to destroy it, a meeting of this kind would be unnecessary; but we do know something of its ravages, how it attacks the trees, and now we are here to consider how we shall blot it out; how we shall arrive at the source of it, if possible, and then blot out the disease completely.

I am prepared now to consider a motion looking to a proper organization of this convention for the carrying out of its work, and for the proper recording of your deliberations to-day.

MR. HAROLD PEIRCE: I would nominate, as permanent chairman of the Conference, Dr. R. A. Pearson, former Commissioner of Agriculture of the State of New York, and as secretaries, Messrs. F. W. Besley, of Maryland, and Samuel B. Detwiler, of Pennsylvania.

THE GOVERNOR: You have heard the motion. The question is upon the election of Mr. R. A. Pearson, former Commissioner of Agriculture of the State of New York, as chairman of this Conference, and Messrs. F. W. Besley, of Maryland and S. B. Detwiler, of Pennsylvania, to serve as secretaries of this Conference.

The motion was put and unanimously carried.

THE GOVERNOR: Mr. Pearson is unanimously elected chairman, and Messrs. Besley and Detwiler are unanimously elected secretaries. I would suggest, gentlemen, for the complete organization for the transaction of your business, that some one be selected or designated to report the proceedings of this convention.

MR. I. C. WILLIAMS: I suggest the name of Mr. Victor G. Marquissee, who is here prepared to report the proceedings of this convention.

THE GOVERNOR: Without objection, the gentleman named in the motion will report the proceedings of this Convention. I now take very great pleasure in presenting to you, and calling to the Chair, the Chairman whom you have elected, Mr. Pearson, of New York . (Applause).

Mr. Pearson took the chair.

THE CHAIRMAN: Governor Tener, Ladies and Gentlemen: I appreciate that it is a great honor to be asked to preside over your deliberations.' I accept the honor, and thank you for it, with appreciation also that it carries with it great responsibilities, for this is an important Conference. It is important because of the great commercial interests involved, and it is also important because of the intricate scientific questions that are involved. That its importance is well recognized could not be better shown than by the fact that the Governor of this great Commonwealth has called this Conference together, that it meets in these splendid quarters, and that this State has taken the lead in providing for practical, efficient work to be done in checking the ravages of the chestnut blight, through the efforts of a special Commission, the competency of the members of which is recognized not only in your State, but in many other States as well, where the work which they have begun has come to be known.

Four months ago we held in the Capital city of New York, a Conference of much smaller proportions than this, but called together to consider the same questions; and at that time we were told that it was the purpose of Governor Tener to call this larger Conference, and we have been looking forward to this time as an epoch-making event.

It has been suggested that we should do nothing to counteract the ravages of the chestnut tree disease, because we are not fully informed as to how to proceed. That is un-American. It is not the spirit of the Keystone State, nor the Empire State, nor the New England States, nor the many other great States that are represented here, to sit down and do nothing, when catastrophies are upon us. It has been suggested that we should wait patiently until the scientists have succeeded in working out these questions in all their minutiae; that thus we may be able to accomplish our results more quickly. But that is not the way that great questions are solved. If we had waited until the application of steam should be thoroughly understood, we would be still waiting for our great trains and steamboats, which are the marvel of the age. (Applause).

We know some things about this curse, and we are here to exchange ideas; to tell, on the one hand, what we have learned through our scientific studies, and, on the other hand, what we have learned through our practical work; and thus we believe that at the close of this Conference, we will all go away from here, wiser and better prepared to carry forward the great work in which we are interested.

Now we are here for business. The Governor has given us the keynote for the meeting. I should not take your time further in making remarks, but let me say to you that, so far as in me lies, these meetings will be expedited; they will begin on time; the programme will go forward without unnecessary delays; and I only ask that the Chair may have the sympathy and the cordial co-operation of the many delegates who are attending the meetings, to the end that when we close, we may all feel that it was well that we came together. Unless other arrangements are made, the Chair will understand the usual rules of procedure will govern our deliberations, and he will follow those rules to the best of his ability, being always willing to be corrected or to be overruled by those who are participating in the Conference.

The Chair will now recognize Mr. Samuel T. Bodine, of the Chestnut Tree Blight Commission.

MR. BODINE: In order that the deliberations of this Conference may be properly summed up, Mr. Chairman, I move that a Committee on Resolutions be appointed by the Chairman of this Conference, of which he shall be a member ex-officio, which Committee shall be representative of the various States interested in the wild chestnut, and represented at this Conference.

The motion was seconded.

MR. S. M. ENTERLINE, of Pottsville, Pa: I would further add, Mr. Chairman, that these proceedings should be reported and printed, if that be possible, and forwarded to the delegates, as far as the supply of reports may reach.

THE CHAIRMAN: That question may come up properly a little later. The motion now before you is on the appointment of a Committee on Resolutions.

The motion was put and unanimously carried.

THE CHAIRMAN: The Chair will be pleased to receive, if the opportunity offers, suggestions from members as to their desires in this or any other matter.

The programme now calls for brief responses to the Governor's address, and it has been suggested that the best manner of procedure will be to call the roll of States which are represented here, asking one person from each State to make a response; and, in order that we may get through the list promptly, unless directed otherwise, the Chair will have to ask each State to limit its response to three minutes. It may be that some of the first names on the list are not prepared to respond at once. In that case we will pass them over and return to the names a little later.

Alabama. (No response).

Connecticut.

DR. GEORGE P. CLINTON, New Haven, Conn., Expt. Station: Mr. Chairman: I hold a commission from the Governor of Connecticut to represent that State, with two other delegates, at this Convention. In Connecticut we have studied this disease somewhat longer than you have here in Pennsylvania, and we have it in a very serious manner. I am not officially on the programme, but I have prepared some of my ideas and views on this subject which I wish, at the proper time, to present to this Convention. I have also a paper by Professor Farlow, from Harvard University, who has studied the history of this fungus, that I wish at the proper time to present to the Convention for their consideration. I take it that we want in this Convention, to know everything that is known concerning the chestnut blight and from that to deduce our conclusions. In that respect I am prepared to present all that I know and my views on the subject, in order that the truth, if such is known at present, may come out.

THE CHAIRMAN: The District of Columbia. This includes the Federal Department of Agriculture. Is Professor Collins in the room?

PROFESSOR J. FRANKLIN COLLINS, Department of Agriculture, Washington, D. C.: I am not prepared to make any remarks for the District of Columbia. I come from another direction. I have no remarks to make particularly.

THE CHAIRMAN: We will give you an opportunity later, Professor Collins.

The Dominion of Canada. (No response).

Delaware.

Dr. WESLEY WEBB: Mr. Chairman, Delaware sends a delegate up here to learn the situation. Delaware itself is pretty thoroughly infested with this disease. Every chestnut growth and every forest has diseased trees in it. The only way to destroy the disease in Delaware, in my opinion, is to destroy every chestnut tree and clean it up. I doubt if any measures short of that would be successful; but still, something may be learned here that will modify that opinion.

THE CHAIRMAN: Georgia. (No response).

Illinois. (No response).

Indiana. (No response).

Maryland.

MR. J. B. S. NORTON: Mr. Chairman, I had supposed that Professor Patterson would speak for our State, as he is interested from the forestry standpoint, and I am interested in the Experiment Station from the nursery standpoint. We will have a problem to meet in our State in controlling this disease, and I am sure we are very actively interested in this work, because we are in the same condition as a few other States. We have a large part of our area already infested, and a considerable part of it that is free, so it makes it a more active and important question to us than to sections where the territory is entirely covered with the disease.

THE CHAIRMAN: Massachusetts.

PROFESSOR F. W. RANE, State Forester: Mr. Chairman, I was sent out here by Governor Foss. I had an opportunity to have a conference with the Governor shortly before coming. We had hoped to bring along some of our large timber owners, but, at the last moment, it was impossible to make arrangements. The Governor said it would be impossible for him to be here, but urged me to extend his compliments to you by all means. In Massachusetts we are just beginning to realize that the chestnut bark disease is a very serious menace to us. During the past year we have had a man from the Department of Agriculture with us for three months, and I have had all my assistants in the State Forestry Department out in the field hunting it down. We find that it is scattered pretty much over the State. Our simple remedies we send out by men that are with us, and we are always ready to assist anybody in any part of the State with any suggestions possible in regard to it; but I do not care to talk about that at the present time. I am here to learn everything possible, and am glad to be here, I assure you.

THE CHAIRMAN: New Jersey.

DR. MELVILLE T. COOK: Mr. Chairman, in the State of New Jersey I find, although I have been there but a short time, that those who have looked into the situation most carefully are inclined to believe that, so far as the State is concerned, the situation is practically hopeless. Almost every chestnut growth in the State is infected at the present time. We expect, of course, to do some work in combating the chestnut blight, because we will not give up until the chestnut timber is entirely destroyed. While the majority of those who have been making a study of the conditions over the State look upon the situation as hopeless, yet we can say that there has some good come out of evil, because at the present time the people are wike-awake to the importance of the careful study of plant diseases. At the present time there is no difficulty, whatever, in getting the people to listen to any advice that looks toward the protection of the natural interests of the State. So the State of New Jersey greets the Convention here to-day with honest hopes that something may be accomplished which will advance the public interest and welfare.

THE CHAIRMAN: New York.

GEORGE G. ATWOOD: Mr. Chairman, the State of New York appreciated very highly the honor extended by the invitation of the Governor to be here to-day, so as many as possible of the delegation accepted with pleasure. We are here to-day to learn something in order to perfect a plan that has been brewing in New York State. New York State has a large chestnut area to save. We have a small section of the State where the chestnuts are practically gone. Arrangements are being perfected for carrying on the work under the advice of the botanists of our stations, and we hope soon to have a forest plant pathologist, working either with the Department of Agriculture or with the Conservation Commission. The Governor of the State is very much interested in this proposition. We are waiting for some definite plan, which will be taken hold of as quickly as it can be devised, and as thoroughly as the necessities of the case require.

THE CHAIRMAN: North Carolina. (No response).
Ohio.

DR. AUGUSTINE D. SELBY: Mr. Chairman, Ohio is very much interested in this Conference, because Ohio lies in the western part of the Appalachian chestnut belt, and, as State Pathologist, the problems of the chestnut bark disease would become our laboratory and field problems. As yet we are not aware that the disease exists in Ohio, although it may be so; but we are perfectly aware that our success is indissolubly bound up with the success of Pennsylvania and the states to the east of it. If Pennsylvania, either by reason of a natural change in conditions by which the parasite of this chestnut bark disease becomes less virulent, or by the trees becoming more resistant, is not able to save a portion of its chestnut growth, then Ohio will not be. If, on the other hand, Pennsylvania and West Virginia, as well as New York, are able to save their trees from the wrecking of this disease, then Ohio will realize the advantages of such a Conference and such work. I assure you that whatever efforts are made by this Conference, or whatever conclusions are reached by this Conference and whatever efforts are made by other States, these will be supplemented with vigor in our own area. Personally, of course, we are without experience in the disease. For ourselves, we feel that we have in the chestnut bark disease one of those occasional and epoch-making parasites which has arisen from the unknown and wrought incredible damages; that it will continue its aggressiveness through a long period may or may not prove to be true. If it prove to be true, then our difficulties are very, very great. If the conditions prove more favorable, our forests may be preserved.

THE CHAIRMAN: Rhode Island.

JESSE B. MOWRY, State Forester: Mr. Chairman, in behalf of the State of Rhode Island and the other delegates representing that State, I desire to acknowledge the very cordial welcome extended to us by the Governor of Pennsylvania. Last summer a systematic inspection of the State of Rhode Island was made, under direction of Professor Collins, and this disease was found to exist in the chestnut-growing portions of the State. We are very glad to be here, to learn what we can about it, and to profit by the pioneer work which the State of Pennsylvania is doing in behalf not only of its own Commonwealth, but in the interest of all the other States which grow the wild chestnut tree.

THE CHAIRMAN: Tennessee. (No response).

Vermont. (No response).

Virginia.

MR. GEORGE B. KEEZELL: Mr. Chairman, on behalf of the General Assembly of Virginia, I desire to return thanks to the Executive of this great Commonwealth for the invitation to be present on this occasion, and to take part in these deliberations. So far as Virginia is concerned, we are at this time perhaps fortunate in the fact that, if we have this dread disease with us, we have so far had very little complaint of it. We are not here to give any experience of our own which may be helpful to others, but to learn from others what may be of benefit to the whole

Commonwealth of Virginia. As was suggested by the Governor in his remarks, a great deal of the wealth of the Commonwealth of Virginia is in our chestnut timber interests. Within the last decade her chestnut timber has been the source of a great deal of income to Virginia, and of a great deal of wealth. Its more recent use, for tannic acid, has brought into great value the waste places of the State, and timber heretofore regarded as not very valuable has become one of the most valuable assets of the Commonwealth. Naturally, we are very much interested in anything that goes toward the preservation of this valuable timber, and at this time we are especially grateful for the invitation to be here, because our General Assembly is now in session, and bills have already been introduced looking toward appropriations to combat this disease; and we are particularly anxious to get all the information we can here, in order that we may go back and give our legislators the necessary facts. I have no doubt provisions will be made by the Commonwealth to fight the ravages of this disease.

THE CHAIRMAN: West Virginia.

DR. N. J. GIDDINGS: Mr. Chairman and Ladies and Gentlemen: I can assure you that the people who are most interested in West Virginia appreciate the opportunity which this Commonwealth has offered for meeting here and considering matters in regard to the chestnut bark disease. The chestnut in West Virginia is a very important tree. Just recently I learned of shipments from one station amounting to one hundred and fifty-five thousand pounds of chestnuts,—the wild nuts,— during last fall, and there may be other shipments that run as high, or higher.

The annual cut of chestnut in West Virginia for the last two years has been about one hundred and eighteen million feet, and has neither increased or decreased; but the disease is present in the State. To what extent, we do not know. We are in hopes to have at least one or two men in the field this spring to learn more in regard to the conditions in the State, and we hope to be in a position, after getting the details which we may from this Conference, to go back and undertake the work in a much better manner than we otherwise could.

THE CHAIRMAN: For the Dominion of Canada, the Chair will call on Dr. H. T. Gussow, of Ottawa, the Dominion Botanist.

DR. GUSSOW: Mr. Chairman: On behalf of the Department of Agriculture of the Dominion of Canada, I am here to thank you for your very great courtesy in asking us to participate in this very important meeting. I may say that, as far as we are concerned in Canada, we have not this dreaded disease at the present time, and we have been very anxious to avoid the importation of it across the border, by passing stringent legislative measures prohibiting the importation of chestnuts of any kind, nursery stock or even chestnut wood, or anything else connected with chestnuts. I find that this will probably be the only means to restrict the disease to the States in which it is found at the present moment, and I can only extend to you, neighbors of the United States, my best wishes to succeed in combating, or at least, restricting this very serious disease.

THE CHAIRMAN: Are there other States represented who have been passed over? Are there any States we have not heard from?

MR. J. W. FISHER, of Tennessee: Mr. Chairman, we are very greatly interested in this subject, because we have such a marvelous growth of chestnut in Tennessee. It is receiving very considerable attention at the present time from the axemen, for lumber and tannic acid. It has a vital connection with our water sources, because it covers the area so completely that if it were destroyed, it would vitally affect vast water powers and irrigation. We are therefore, extremely interested that you, in your deliberations, should find some means of checking this disease, that we may have our forests preserved to us. I shall take a great deal of pleasure in reporting whatever I can to our Governor, Hon. Benjamin Hooper, whom I have known for years and who comes from our town, so I think I am in an attitude to bring the attention of the State to this matter, and I shall be extremely glad to do so.

THE CHAIRMAN: Are there still other States represented, who have not been heard from? A number of delegates are expected in later in the day. You will all agree with the Chair when he suggests that it is very much like having the play of Hamlet with Hamlet left out, when we fail to hear from the great State of Pennsylvania; but, as usual, this State asserts her modesty, and has insisted on being excused for the present. The Chair will assure you that later we will hear from the State of Pennsylvania, and from more than one person.

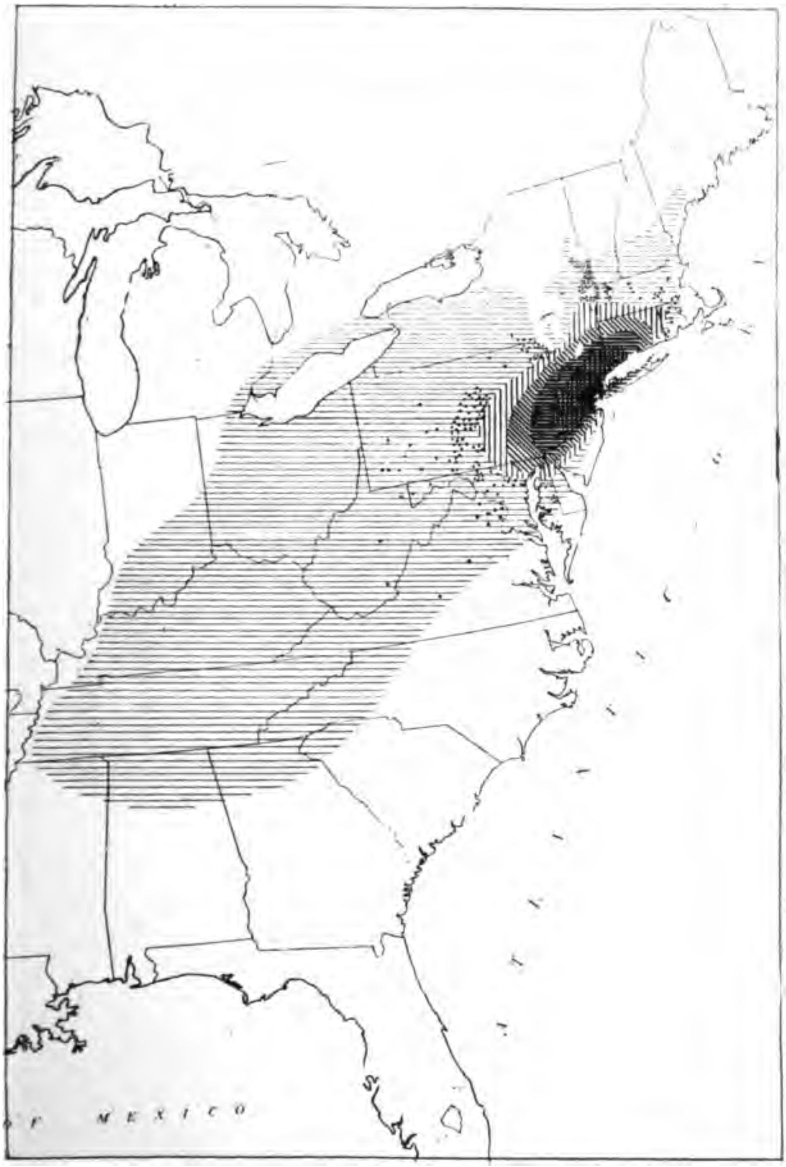
Unless it is otherwise decided by motion and vote, the Chair will request that all resolutions be handed in at the desk, without taking the time of the Conference to read them, to be referred directly to the Committee on Resolutions. This, however, may be overruled if the delegates desire to take the matter into their own hands.

I am informed that provision has been made for registration at one of the ante-rooms outside of the entrance to this chamber, and each one is earnestly requested to register his name, home address, official position, and his temporary Harrisburg address.

The program now calls for an address upon the "Historical Review and the Pathological Aspects of the Chestnut Bark Disease," by Dr. Haven Metcalf, of the United States Department of Agriculture. It is with the greatest regret that we have learned of the serious illness of Dr. Metcalf, which makes it impossible for him to be present at this time. Fortunately, however, we have with us Professor J. Franklin Collins, the Assistant Pathologist in the Federal Department of Agriculture, and Professor Collins has kindly consented to address us at this time.

ADDRESS OF PROFESSOR J. FRANKLIN COLLINS, OF THE DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Mr. Chairman, Ladies and Gentlemen: It is with very great regret, for many reasons, as you can imagine, that I have to take Dr. Metcalf's place here. I came here rather unprepared to take his place. The accident to Dr. Metcalf occurred on Saturday night, and I had the chance to see him only a little while on



No. 35. Distribution of the chestnut bark disease. Horizontal lines indicate approximate distribution of uninfected chestnut; dots indicate isolated infected spots; the heavier lines in various directions indicate varying degrees of infection culminating in an area about New York City in which all chestnut trees are dead.

No. 1. Branch of a chestnut tree showing a disease lesion on smooth bark.

No. 2. Portion of a branch of chestnut tree, exhibiting a lesion started around dead stub, the pustules being especially prominent.

No. 4. Surface section of chestnut bark, with pustules in the crevices.
Lower illustration shows pustule greatly enlarged, from which three spore threads have been produced.

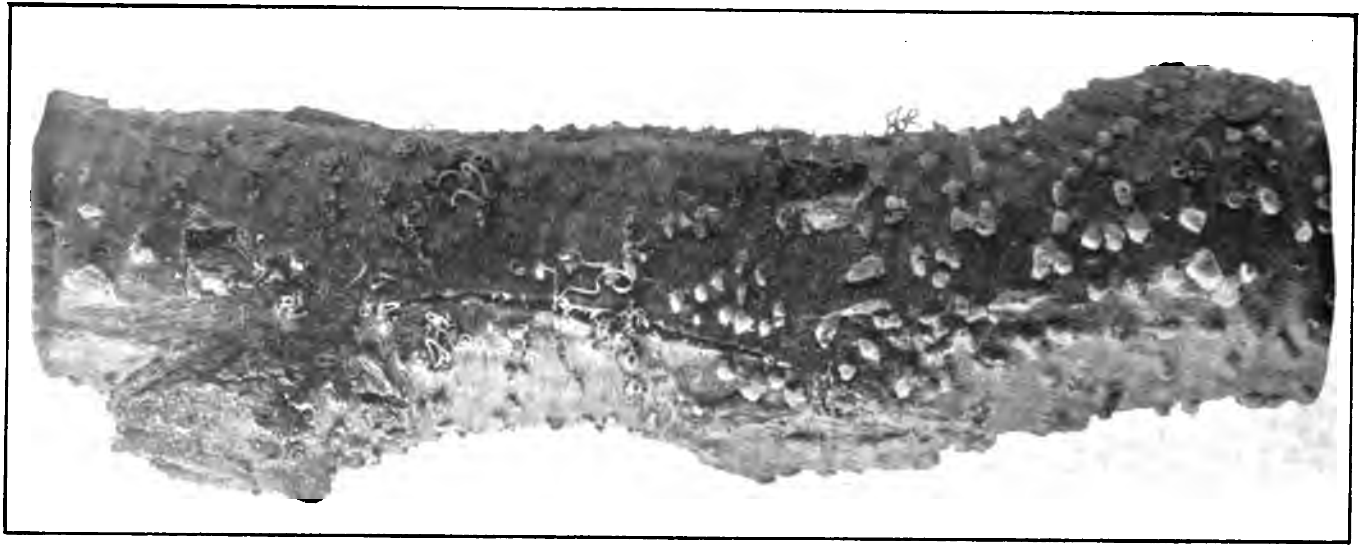
Sunday. I have come here without many of his ideas. However, he has some slides which are to be shown, and perhaps I can tell you something about those, and so add to their interest.

Before the slides are shown, I want, very briefly, to give a short sketch of the history of this disease. It will be very brief, and of a general nature only. The history of the disease has already been published in quite a number of cases, so I will touch only upon the main points.

Our attention was first called to this disease, I believe, in the fall of 1904 by Dr. Merkel, of the Bronx Zoological Park, in New York city. He noticed that chestnut trees were dying in greater numbers than seemed to be warranted by any previous knowledge of the dying of chestnuts. He looked the matter carefully over, as I understand it, and decided that there was a definite disease there, and later turned the material over to Dr. Murrill, of the New York Botanical Gardens. Dr. Murrill studied this disease and later published his findings upon it, naming the fungus which caused the trouble, *Diaporthe parasitica,* a new species of the genus. At that time, I believe, Dr. Murrill stated that it was a very serious disease, and sent out a warning to that effect. If I am misquoting him, I hope he will correct me, for he is in this room to-day. It was not until 1907, three years after the discovery of this disease, that a laboratory was established in Washington for the study of tree diseases. Since that time—almost immediately and since then—certain investigations, both in the laboratory and in the field, have been carried on in Washington. I do not propose to say anything about these studies at the present time. My point here is to give you a general idea of the disease, what it looks like, how it affects a tree, and things of that sort,—a general discussion of the topic. This review will be, will necessarily have to be, primarily an explanation of the views which will be thrown on the screen. I may elaborate at points, but, as I say, I am not primed as Dr. Metcalf would have been had he been able to be here. I think perhaps we may as well proceed to the views at once.

Slide No. 1. This, to begin with, shows a diseased spot, as we will find it on the smooth bark of a branch of a chestnut tree, a branch which is perhaps anywhere from three to six inches in diameter. The disease is a fungous disease, and starts its growth from a very miscroscopic, one-celled body, which we know as a spore. By some means the spore reaches a place in the bark of the chestnut, where conditions are favorable for its growth. Its growth is not essentially different from that of the spores of other fungi. It consists mainly, or principally, of a threadlike growth coming from the spore. This threadlike growth branches, and finally we have a great mass of threadlike filaments. In the case of the chestnut disease, the spore may gain entrance at some point, say here, or some little break here, possibly (indicating on slide), and perhaps occasionally without any break at all in the bark. The growth in the bark continues to increase in size, that is, the general area of the growth, and sooner or later, the same as in practically all plants, we have a fruiting stage of this fungus. This view shows some of these fruiting stages, as we ordinarily see them on the chestnut. Some of the stages, which are not quite so common, will be shown a little later; but I want to call your attention to the fact that, from this point to the point away over there (indicating) we have an area of disease. As a rule the bark in the smooth-barked limbs is somewhat sunken, where the limbs are two or more inches in diameter. Where they are below that diameter, the diseased area may be an enlargement rather than a depression in the bark. These little yellowish spots which you see all over here, many of them, are smaller than the head of a pin. They are of various colors, but usually some tint of yellowish brown or orange, or sometimes they weather to a darker color. Those pustules are what we know as the fruiting pustules of this fungus. These pustules, during the growing season, in the summer as a rule, produce a certain type of spore, and later in the season, or at a later stage in the age of the disease, at least another type of spore. For convenience we will speak of the first type as the summer spores and those of the later stage as the winter spores.

No. 2. This shows a similar branch with a lesion, which has started evidently from around this old dead stub, and this has spread until we get the diseased area from this point, from here probably, (indicating) up to the top of the picture. Now during the summer, or rather after a rainy spell which is followed by a dry spell, perhaps two days or one day or three days after the rain has ceased, we shall find that these pustules, or fruiting



No. 5. Pustules on the bark; some showing spore-threads; (magnified).

spots, have pushed out a little mass, a threadlike mass, in much the same way as you would press out the paste from a collapsible tube by pinching the tube. As a result we get, perhaps, from one of these pustules, anywhere from one to fifteen or twenty structures of that sort, (indicating) which are, of course, here greatly magnified. This represents the pustule at the base, this yellow area; and this is one of the threadlike masses which has been forced out by the swelling of the mucilaginous matter in the pustule.

No. 3. Each one of those masses shown at the right hand side of the view is composed of many hundreds of thousands of spores, no larger than bacteria. One of these spores may, so far as we know, under favorable conditions, reproduce this fungus and consequently reproduce the disease, if it starts growth in the proper place.

No. 4. This shows simply a somewhat larger view of one of those pustules, from which three of those spore threads have been produced. At the upper part of this picture we have a surface view of the chestnut bark in which we find the pustules gathered in the crevices. This is rather characteristic on chestnut bark that is of a sufficient age to be cracked. Only on smooth chestnut bark, as a rule, do we find these pustules all over the bark. In the cracked bark we find them primarily, if not entirely, in the crevices.

No. 5. There we have a section of a small branch that shows some of these pustules, and above some of these threads as they appear on the bark of the chestnut. I have nothing special to say about that view, except that, so far as the color is concerned, we are apt to get it just that color, but quite as often somewhat darker, with a little orange or reddish tint to the pustule.

No. 6. Now if we take one of those areas of disease on smooth bark and cut into it, if we shave the top of the bark off with a sharp knife,—suppose we take just such a case as we have at the left here (in fact this is made from the same branch) and shave it so as to show what is beneath,—we get a discolored area, a rather characteristic area, which is not shown as well in this view as it will be in another; but remember that this view at the right represents such a branch as that at the left, with the surface of the bark removed with the knife.

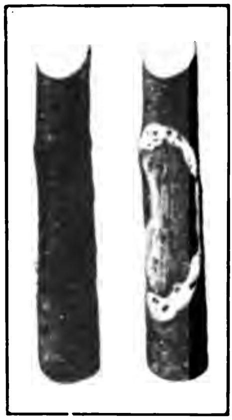
No. 7. Here is a view which represents a branch, from which the surface of the bark has been shaved in the same manner as in the last view, but here we have the characteristic fanlike mottling, which we often get in the bark beneath the surface. Some times the effect which you see here is produced immediately beneath the surface of the bark, at other times down in the middle of the bark, and at other times you have to get in pretty well towards the wood in order to find this characteristic marking, depending largely upon whether there is a perfect epidermis, or perfect skin, over the bark, or whether there is a corky layer; but it is not entirely gauged by those characters. This line (indicating) representing the line of discoloration; the infection started at this point and radiated in all directions from the common starting point. Of course, if we shaved off the other side of that branch, we should have expected to find about the same condition of affairs there; but here we have shown only the half circle of the more or less circular area of the disease.

No. 8. Here are two branches of a chestnut tree, an orchard tree as I recall it. These branches are about four or five inches in diameter. This represents a very common appearance on chestnut in the smooth-bark stage. Of course, this has begun to crack more or less from age. That is not an exceptional case by any means, as all who have seen the disease will readily realize.

No. 9. This represents another case of a diseased portion, in which the disease started about at this point (indicating). One of these cracks probably represents the position of the starting point of the disease, and it has radiated in all directions, tending to form the circular mass which is shown here, running down there and across the bottom and of course off of the view entirely at the right. That is a grafted tree, by the way, and the enlarged portion at the middle of the tree represents the graft line.

No. 10. This is merely a section of a little older piece of bark, where we get the pustules of a darker color, that is, more of the brownish tinge, as we often do in weathered bark. This, as I said a moment ago, is found in material which has withstood the weather for some time.

No. 11. This is another view which shows merely some of the older pustules. This is intended more to represent the winter stage of the fungus. I do not think, however, that you will be



No. 6. Sections of smooth-barked chestnut twigs showing disease lesions. Surface of bark removed from right-hand specimen, showing discolored and diseased areas.

No. 7. Characteristic fan-like mottling revealed by shaving the bark of a diseased branch.

No. 8. A large area of disease pustules on a smooth-barked orchard tree.—*Photograph by Prof. Collins.*

No. 9. Bark removed from over a canker, showing the cracks at the centre and the fan-shaped spread of the yellowish fungous mycelium; also, at the lower edge, the circular margin of the disease.—*Photograph by Prof. Collins.*

able to make out the individual little spots which go to make up one of these common masses. The winter stage of this disease produces its spores down in the bark; that is, down beneath the surface of the bark, and so also does the summer spore stage, except that in the summer spore stage they are extruded in the form of these threads, while the winter spores are not extruded in the same way, although they are extruded later.

No. 12. This view represents a diseased spot on an orchard tree. The diseased spot is less than three years old, but more than two years old, according to the records which were kept. This shows, at the upper part of the picture, how the bark soon loosens and later falls from the tree and the branches, until finally we have simply the bare trunk or a bare branch left. Sometimes this bark breaks away in less than two years, to much the extent that is shown there.

No. 13. Here is a small twig of a chestnut. A little while ago I mentioned the fact that, in the smaller twigs, we sometimes had an enlargement when the disease was present, rather than a depression. Here at the left we get the normal size of the twig, and then, running out this way towards the apex of the branch, we see where the disease started, and we have this considerable swelling. This is quite characteristic, under certain conditions, of twigs which are less than a half inch in diameter. It sometimes occurs in larger branches, but as a rule we get it quite commonly in this type of branch.

No. 14. In the older trees, where the bark has become deeply furrowed, I said that we found the diseased pustules almost entirely in the cracks or crevices of the bark. This represents the surface,—greatly magnified, of course, and beyond what you might imagine,—and some of the furrows. We get the yellowish-orange pustules in the crevices there, and in various places, whereas the other parts, the raised places, show no pustules at all.

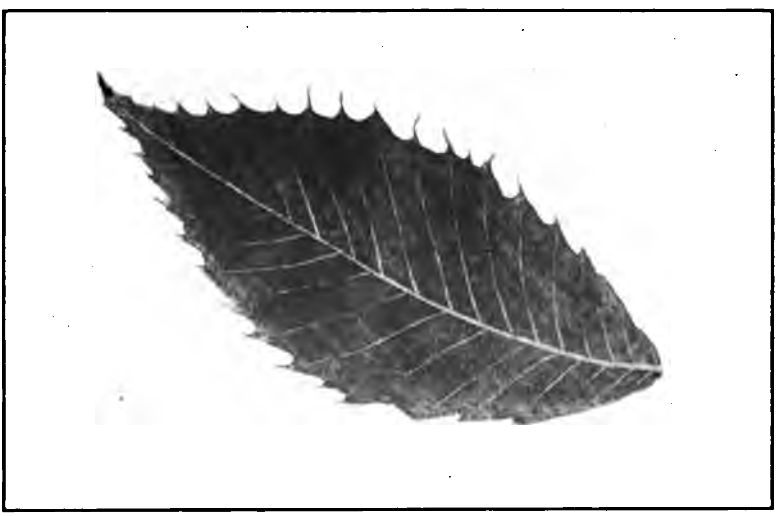
No. 15. So much for the disease as it appears on the branches. Now when the disease appears on a branch, or on the trunk of a tree, it starts from the common point and radiates in all directions, forming the more or less circular area of disease. Of course, on the trunk of a tree it goes up the trunk from the common point, down the trunk, and around the trunk. When these portions of the disease which go around the trunk meet on the other side, we have a branch or a trunk which we speak of as girdled. Now a girdled branch, or a girdled twig, or a girdled trunk, means the early death of all parts of the tree beyond the girdled area. If it is a twig, it means the death of the twig beyond the girdled area. If it is the trunk, it means the death of the whole tree at once, or soon after the girdling is completed; not immediately, as a rule. Now I want to call your attention to some of the obvious effects of this girdling upon the foliage of the tree. When you are looking for this disease during the season of foliage, it can be detected oftentimes at a great distance. I have myself detected diseased trees more than a mile away, or trees supposed to be diseased, by the characteristics which I want to call your attention to now. To be sure, you must bear in mind that the coloration of the leaves to which I am going to call your attention can at times be brought about by other things than this disease; but we have in the coloration of the leaves, as we generally say, the "danger signal" which suggests where to look for the disease; for, if the disease has been going on very long, for a few months, or weeks even, in certain places, we shall get some of these discolored leaves as the result of the girdling of some one or more of the twigs or branches. I have shown here a somewhat normal chestnut leaf. It is a little broader than the normal leaf; this is intended to represent not, perhaps, a perfectly typical chestnut leaf, because we have on the margin a little paler green than in the portion in the centre. The pale green in the margin of every leaf at times, is one of the first symptoms of discoloration. It becomes a little pale. First of all, perhaps, the leaf wilts a little, if you notice it carefully, and if this paleness of the leaves is extended over the leaves of a whole branch, the effect as a whole is quite noticeable.

No. 16. Here is a greenhouse plant which has been inoculated with the disease. At the left we find some of the normal chestnut leaves; at the right a branch which had been inoculated and has been girdled way down here. (Indicating). Now I do not know about that particular specimen, but, if we were looking for the disease on such a specimen as that, we should never look up here for it, that is, not primarily. What is causing the trouble

No. 10. Bark showing pustules of a dark color or of a brownish tint, due to longer exposure to weather.—*Photograph by Prof. Collins.*

No. 12. Diseased chestnut tree showing shredded bark after two or three years infection.—*Photograph by Prof. Collins.*

No. 13. Small twig of chestnut with enlargement due to disease. At the left side the normal size of the twig is shown.



No. 15. Normal chestnut leaf. A pale green in the margin is one of the first symptoms of discoloration and disease.

with that stem is down here somewhere, down below all these dead leaves. That applies to looking for the disease on the tree, or on the sprouts or suckers which may come up from the base of a tree.

No. 17. In very young nursery stock, or the young sprouts which come up from a tree, or the vigorous growth on a tree, on the twigs at least, we often get this type of the disease at its very beginning. This is often more brilliantly colored than shown in this view. It is very conspicuous indeed, particularly on nursery stock. Although the view does not show any fruiting pustules at all, by cutting into that area we get the characteristic mottled mycelium or vegetative stage of the fungus beneath the bark.

No. 18. Now we have a branch which shows the withered and yellowish leaves. This yellow color follows along after the pale green color. It is not a pure yellow, as a rule, although sometimes it has been quite strikingly of a pure yellow color. You will notice that the leaves wither after awhile; that is, they crumple up after a time and that crumpling is shown, to a certain extent, in this view; and also the yellow color.

No. 19. A little later we have the deeper color. This shows the browner coloration around the margin of the leaves. At the left we have two leaves which show merely the beginning of the discoloration. At the right the leaf is somewhat crumpled, bent, and discolored.

No. 20. This is a stage much the same as that of the little branch which was shown three views back, this showing a larger view of the same thing.

No. 21. Finally the leaf assumes a somewhat brownish tint, which is shown here. The leaves in this condition are often more crumpled and curled up than shown here. These two leaves have been flattened out somewhat so as to show the color.

No. 22. Now to take some of the woodland views, to show how the disease looks in the landscape. Here is a large tree which, owing to lack of special instruction as to the coloring of it, lacks one or two features which it ought to have. For instance, this branch up here, and that whole branch (indicating), ought to have shown the yellow brown color. The coloring, however, was not noticed in time to give instructions in regard to it. This view, however, is shown primarily to represent the type of tree which is so valuable in the large estates in the various States. This particular tree had a circumference, above the settee which is there, of more than nineteen feet. The view was taken three years ago. That tree now has only two or three of the green branches left and the whole top of the tree is cut off. I am sorry I do not have the other views to go with this, but through some slip somewhere they were not forwarded to be shown.

No. 23. Now we have a view in which the disease has a start up in this corner, and the discoloration of the leaves, or the masses of leaves, is here shown. Now a discoloration of this sort, particularly when it comes to a little later stage and has a more brilliant color, is quite conspicuous in the landscape. This view does not do credit by any means to the point which is intended to be brought out here.

No. 24. Here is a view taken on Long Island, which shows the effect on the tree; a tree which has been nearly killed by the disease, showing the practically defoliated type of tree. Here is another type, (indicating), which has become badly diseased, and we have a bunch of sprouts appearing at this point, also here, and also basal sprouts coming up. These sprouts are rather characteristic; perhaps I should not say characteristic, but they are commonly found connected with this disease, and are supposed to be more or less characteristic of the disease, but the sprouts can be produced by other means than as a result of the disease.

No. 25. Another tree, also on Long Island, in which all but two of the lower limbs on the left hand side have been killed by girdling from the disease, and now we have remaining only those two, or perhaps three, lower left hand limbs.

No. 26. This is a tree showing the sprout growth which I alluded to in one of the last pictures, to even better advantage. Notice the sprouts which come up around the base, and the sprouts which come from the trunk at various places up in the crown.

No. 27. There you have another type of the same thing, a more pronounced example, in which the sprouts are confined almost entirely to the trunk of the tree and everything is dead or dying, except perhaps one or two branches.

No. 28. This view is shown in order to call to your attention this particular tree (indicating), which shows four good lesions

No. 16. A green-house chestnut tree in pot, three months after artificial inoculation with summer spores. *Photograph by Brewer.*

No. 17. Early effect of the disease upon young chestnut sprouts and nursery stock.

No. 18. Characteristic withered and yellowish leaves on chestnut twig infected with the disease.

of the disease, diseased spots, on the trunk of the tree. That is the way the tree looks when this disease attacks the trunk. That tree is practically dead. The lower part, represented by the lower half of that picture, shows some life.

No. 29. In the course of two or three years we find that the bark begins to peel from the trunks of the trees. At the left we have a tree which has only recently been killed, that is, within a year or so perhaps, and the next one to it is one which is a little older, and the bark has begun to peel off. The one which is so prominent is probably the first in the group which was attacked and killed, and the bark has practically disappeared from the tree, so far as this view shows.

No. 30. Now to consider the more general appearance of the woodland, here is a view taken in Forest Park, Brooklyn, along the Boulevard. This is one of the main boulevards through the Park, and any of you will have no difficulty in picking out the chestnuts. They are the most conspicuous objects. Not one of the green trees you see there is a chestnut.

No. 31. Here is another view taken, I think, at Port Jefferson on Long Island. It may have been a New Jersey view; I am a little uncertain as to just where it was taken. That shows the young growth coming up and becoming diseased, and shows the effect along the hedgerow that we get from this disease.

No. 32. This is one of the most southern stations which we know for the disease. This view was taken in South-western Virginia, in Bedford county. The more prominent trees there have lost the bark entirely. Those trees, I understand, have been cut out and no longer exist.

No. 33. If you want to see what the chestnut disease can do in a very nearly pure stand of chestnuts, there is a view which will show it. That was taken in Forest Park on Long Island. Any of you who have been in Forest Park will probably recognize that view.

No. 34. The next view, I think, is another view of a little different portion of the same Park. These trees at the right are not chestnuts at all. This one up here, I believe, is a chestnut and there are some oaks there at the left.

No. 35. I want to call your attention to the distribution of the chestnut, and, to do so, I want to call your attention to this map.

This map represents the eastern portion of the United States and the horizontal lines represent the approximate general distribution of the chestnut tree. It may not be exact. I think most any of you who live at or near the border line represented here would have some suggestions to offer, but the map has been compiled from as reliable general sources as we could obtain. Thus we have the chestnut from northern Mississippi, through northern Alabama and Georgia, northwestern South Carolina, western North Carolina, up through this region and up into the northwestern edge of Androscoggin county in Maine. In New Hampshire and Vermont there are only a few chestnuts present, as compared with the region farther south. Down through here (pointing to the southern Alleghanies), we have our great chestnut stand, particularly on the western slope of the mountains. In the State of Connecticut a bulletin which was published within a few years stated that probably more than fifty per cent. of the forest trees in Connecticut were chestnuts. That was on very good authority, and I do not hesitate to quote it. In Rhode Island the chestnut is of a little less importance, but probably pretty nearly half of the trees in Rhode Island are chestnuts. The proportion further south I am not so well informed about, but we have the bulk of the heavy chestnut timber south of the Potomac River. The black area on the map represents the places where practically all the chestnuts are now dead, and the various forms of lines which are shown on the map represent varying degrees of infection, until we come down to the line right here. (Indicating). These vertical lines represent the approximate limits of what you might call somewhat general infection. The black spots which are shown there represent the outlying spots of infection, so far as we knew them in December. Here is the line through Pennsylvania. The eastern part of Pennsylvania is pretty well infected with the disease, and the work now being done in this region, (indicating), will be told about a little later by someone who is better informed than I am.

In closing this address, I want to read just a few words and, if we can have the lights now, I will finish in about two or three minutes.

Having seen what this disease is and what it is doing, we now come to the question which, I take it, we are gathered here to

No. 19. Leaves of the chestnut exhibiting discolorations and curling of leaves caused by the disease.

No. 20. Curled and discolored leaves of the chestnut at an advanced stage of the disease.

No. 21. Leaves of the chestnut, showing brownish tint from effect of girdling by the disease.

No. 22. Types of ornamental chestnut trees killed by thousands. Note the small, diseased branches. Scene near Philadelphia, Pa.—*Photograph by Prof. Collins.*

answer as best we can: What are we going to do about it? That is the question. Three conditions lie open before us, as we see it:

First: Do nothing; lie down and let the disease spread as far as it will, and destroy as much property as it can. It must be acknowledged that there is ample precedent for this course, as well as ample scientific support. Beyond question, this is the easiest thing to do.

Second: Conduct scientific investigations of the disease, but make no attempt to control the disease until these investigations yield conclusive results. Such a course would unquestionably yield results which would be valuable in future epidemics of disease, but it would not save the chestnut trees at this time. The President of the Carnegie Institution, in a recent address, enunciated the principle that the results of scientific research must be stated in decades, not in years. We must investigate the disease as thoroughly as possible, but investigation alone, without application, will not save the trees.

Third: Investigate as thoroughly as possible, devote as much money as possible to research on the fundamental problems relating to the disease, but, at the same time, put into force immediately whatever measures against the disease appear to be most promising, recognizing clearly that there is not time first to prove absolute efficiency. I am informed that, as an immediate result of the recent burning of the Equitable Building in New York city, a special commission was appointed to devise better methods of fighting fires in the congested business section of New York. The appointment of the commission was necessary and will unquestionably yield excellent future results; but I notice that the New York Fire Department, went ahead and did its best to put out the Equitable Building fire, without waiting for the reports of any commissions. It appears to me that we are in much the same situation. The fire is burning too fast for us to wait for the reports of experiments which will take from two to ten years time to carry out. We must go ahead, using the best methods that we have, and leave the results to the future. (Applause).

THE CHAIRMAN: I am sure everyone will agree that this talk has been both instructive and interesting, and we are particularly indebted to Professor Collins for stepping in at the eleventh hour, as he has done, and favoring us so generously.

PROFESSOR SELBY: Mr. Chairman, would it not be proper for us to send, on behalf of this Convention, at this time, an expression of our sympathy with Dr. Metcalf in his serious accident? I move you that such an expression be sent by the Convention.

Seconded by Mr. I. C. Williams.

THE CHAIRMAN: Such a motion naturally would go at once to the Resolutions Committee, but the Chair is glad to make an exception in this case. Professor Selby moves that this Conference send a message of sympathy to Dr. Metcalf, with hopes for his speedy recovery.

The motion was put and unanimously carried.

THE CHAIRMAN: The Chair will appoint Professor Selby a Committee of One to prepare and forward the message.

The next on the program is a paper entitled "Can the Chestnut Bark Disease be Controlled?" by Professor F. C. Stewart, of the New York Agricultural Experiment Station.

CAN THE CHESTNUT BARK DISEASE BE CONTROLLED?

By PROF. F. C. STEWART, *New York Agricultural Experiment Station.*

Mr. Chairman and Ladies and Gentlemen: My views are so much at variance with what I conceive to be the sentiment of this Conference that I hesitated somewhat to present them. I feel like one throwing water on a fire which his friends are diligently striving to kindle. But a sense of my duty to the public and, also, myself, impels me to proceed.

I assume that you are all familiar with the method of control which has been recommended, namely, the one which has been outlined by Dr. Metcalf and Prof. Collins in Farmers' Bulletin No. 467, so I shall not take time to explain it. If you are not familiar with it, you will become familiar with it before the close of this meeting.

No. 23. Very early stage; infection of twigs in top of trees, at upper right-hand side. Lancaster county, Penna.—*Photograph by Prof. Collins.*

No. 24. Type of diseased chestnut tree on Long Island, New York, showing characteristic sprouts.—*Photograph by Prof. Collins.*

No. 25. Tree nearly dead from the disease. Only the two lower left-hand branches remain alive. Scene near Cold Spring, New York.—*Photograph by Prof. Collins.*

No. 26. Chestnut trees on Long Island, New York, showing the effect of the girdling of the tree by the chestnut bark disease.—*Photograph by Prof. Collins.*

No. 27. A chestnut tree on Long Island, New York, with sprouts at various points on the trunk.—*Photograph by Prof. Collins.*

No. 28. The chestnut tree in the centre of the picture shows four well-developed lesions.—*Photograph by Prof. Collins.*

No. 29. Typical group of dead chestnut trees. Note dead suckers on the trunks. From left to right:—the first trunk shows the disease less than one year old, (nothnig evident in this photograph); the second, an infection of from two to three years old; the third four or more years old; and the fourth about three years old. Scene near Brooklyn, New York.—*Photograph by Prof. Collins.*

No. 30. Dead chestnut trees along a boulevard near Richmond Hill, New York. Note healthy condition of trees of other species.—*Photograph by Prof. Collins.*

No. 31. Dead and dying sprout growth. Note healthy condition of trees of other species. Scene at Port Jefferson, New York. *Photograph by Prof. Collins.*

No. 32. The most southern point of infection—a group of diseased chestnut trees at Fontella, Bedford county, Virginia.—*Photograph by Prof. Collins.*

No. 33. Complete destruction of chestnut trees in a nearly pure stand. Many of the trunks have lost their bark. View in Forest Park, near Brooklyn, New York.—*Photograph by Prof. Collins.*

No. 34. Complete destruction of chestnut trees in a nearly pure stand. Many of the trunks have lost their bark. Scene in Forest Park, near Brooklyn, New York.—*Photograph by Prof. Collins.*

It is my opinion that we are rushing into this enormously expensive campaign against the chestnut bark disease without considering as carefully as we should the chances of success. The first question to consider is, can the disease be controlled by Metcalf's and Collins' method,[1] of destroying advance infections and establishing an "immune zone?" This is a technical question of fundamental importance. It is a question to be answered by expert mycologists and plant pathologists. I have observed that the leading advocates of the method avoid, as far as possible, discussion of its probable effectiveness. In Farmers' Bulletin 467, the question is disposed of by inserting into the letter of transmittal the following sentence: "The experimental data upon which the recommendations contained in this publication are based will be published in full in a forthcoming bulletin of the Bureau of Plant Industry." The authors then go on to say (page 10) that "so far as tested" the method is practicable; and on page 11, after giving an account of what they consider a successful attempt to control the disease in the vicinity of Washington, D. C., conclude with the following statement: "It is therefore believed that this method of attack will prove equally practicable in other localities and if carried out on a large scale will result ultimately in the control of the bark disease." Up to the present time the promised bulletin has not appeared and we are still in the dark as to the nature of the "experimental data." I had hoped that it might be presented at this meeting. In justice to the public it should have been published before Bulletin 467. There is great need of some real evidence that the disease can be controlled. Apparently, the sole foundation for the optimistic statements made by Metcalf and Collins in Bulletin 467 is the result of the field test[2] which they made at Washington and I hold that no definite conclusions can be drawn from that test. The chief criticism to be made of it is that there is no means of knowing what would have happened if the diseased trees had not been removed. There was no check, and experimenters are agreed that experiments without checks have little value. This is one of the first principles of experimentation. Weather conditions may have been unfavorable for the spread of the disease.

Most fungous diseases have periods of quiescence alternating with periods of activity, depending largely upon varying weather conditions.

Also, there is reason to believe that the region covered by the test is not now as free from the disease as Metcalf and Collins think it is. Last summer there were found two centres of infection previously overlooked.[3] One of these consisting of a group of six diseased trees, was within a few miles of Washington. In company with Dr. Metcalf and others I had an opportunity to examine these trees on December 30, 1911. One of them, a tree over three feet in diameter, was in an advanced stage of the disease. Large limbs were dead and the lower portion of the trunk was thickly covered with spore masses of the fungus. How long these trees had been affected it was impossible to determine, but it is safe to say that some of them had been diseased for at least a year and probably longer. That is to say, they became infected in 1910 or earlier and must have been discharging millions of spores at the very moment Dr. Metcalf was writing his statement that the country within a radius of 35 miles of Washington was apparently free from the disease.[4] It is quite probable that other overlooked cases of the disease exist in the vicinity of Washington at the present time.

Further, We visited two places where diseased trees had been removed and the disease "eliminated" in 1909. In one case, one tree had been cut; in the other case two trees. The bark had not been removed from the stumps. On one stump we found a few spore masses of the fungus; also on the base of a nearby tree. On the other two stumps no fungus was found. The first-mentioned stump had not sprouted, but the other two were surrounded by healthy sprouts. At both points there were a few chestnut trees in the immediate vicinity, but, so far as could be determined, none of them were diseased. It should be stated, however, that it is very difficult to locate diseased trees in winter. It is inevitable that the bark around the base of a diseased tree and also the surrounding soil, fallen leaves and other litter will become covered with spores carried down by rain. Hence, when the diseased trees were removed thousands of spores were left behind. How long such spores live and retain their power of infection is not known. Now does it seem probable that the failure of the disease to spread to nearby trees was due to the removal of the diseased trees? Is it not more likely that its spread was prevented by the conditions being unfavorable for infection?

Returning now to the main question: No such method of controlling a fungous disease has ever been attempted. Our knowledge of fungous diseases in general indicates that it is impracticable. It will be extremely difficult to locate all of the diseased trees and absolutely impossible to remove all of the fungus after the diseased trees are found. The fungus spores, which are produced quickly and in enormous numbers may be widely disseminated in several different ways, some of which cannot be prevented. The work will be exceedingly expensive and must be continued indefinitely. Taking all these things into consideration, the chances of success are much too small to warrant the expense.

It is true that some fungous diseases, notably the plum black knot, are more or less successfully controlled by the prompt removal of diseased plants or parts of plants; but it should be noted that the diseases successfully controlled in this way have two characteristics which make this method of control possible: (1) The diseased plants may be readily detected in the early stages of the disease; (2) the causal fungus requires a long time to ripen its spores. Plum black knot may be readily detected from one to several months before the ripening of the spores of the causal fungus. Hence, the knots may be removed before they have had a chance to spread the infection. Not so with the chestnut disease. It possesses neither of these characteristics. It is difficult to detect in the early stages, and multitudes of spores may be produced within a month after infection.

Undoubtedly, the spores are carried long distances by birds, especially woodpeckers, which visit the diseased trees, seeking borers, in the tunnels of which most of the infections occur.[5] It naturally follows that the "Immune zone" must be many miles wide,—Dr. Metcalf suggests ten or twenty miles wide. In this connection, please note that while the main line of infection is now somewhere north of the Potomac river, advance infections already occur in southern Virginia and West Virginia, 150 miles or more southwest of Washington. In fact, Metcalf and Collins say:[6] "Observations made by the junior writer indicate that the disease may have been present in an orchard in Bedford county, Va., as early as 1903." The advance infections are widely scattered.

Back of the "immune zone" extensive areas must be inspected frequently and thoroughly. Should the "immune zone" be located at or north of the Potomac, the entire States of Virginia and West Virginia must be covered by such inspection. There is no knowing when or where the disease may break out, and when conditions for its spread are favorable, a single diseased tree overlooked may start an uncontrollable epidemic which will necessitate establishing a new "immune zone" farther south and starting all over.

It is quite generally admitted that it will be difficult to locate *all* of the diseased trees, but there is some difference of opinion as to the importance of this fact. It may be argued that by the destruction of 90 or 95 per cent. of the diseased trees the spread of the disease will be reduced to that extent. This is very improbable. If this disease behaves like fungous diseases in general, its spread depends more upon weather conditions and the susceptibility of the host than upon the number of spores produced. When the conditions for its spread are favorable five per cent. of the spores may be sufficient to nullify any attempt to control the disease. All experience with such methods of treatment goes to show that the work must be done thoroughly, else it is not effective.

The history of the chestnut bark disease is unparalleled in the annals of plant pathology. Here we have an unknown fungus, none of the relatives of which are parasites, suddenly becoming widespread and taking high rank as a destructive parasite. This indicates that it may be expected to behave in an erratic manner and be unusually difficult to control; also, that something unusual has happened either to the host or to the fungus, or perhaps to both, making this epidemic possible. Just what this may be I am unable to say. There is no reason for believing that the fungus is either a recent creation or a recent introduction from abroad. The only rational theory yet advanced regarding the origin of the epidemic is Dr. Clinton's winter-and-drought-injury theory,[7] but even this seems insufficient in some respects.

It has been asked "What then would you have us do? Stand idle while the disease destroys our chestnut forests" My answer is this: It may be well to restrict the transportation of diseased nursery stock, but this is all that it is worth while to attempt at present in the line of combating the disease. *It is better to attempt nothing than to waste a large amount of public money on a method of control which there is every reason to believe cannot succeed.* I believe in being honest with the public and admitting frankly that we know of no way to control this disease. I favor moderate-sized appropriations for investigation of the disease, but none at all to be used in attempts to control it by any method or methods at present known.

What will be the future course of the disease can only be conjectured, but it can be safely predicted that nothing which man can now do will materially alter its course. However, the situation is by no means hopeless. That the disease has already reached its zenith and will now gradually subside is quite possible. There have been other epidemics, and other kinds of trees and plants have been threatened with destruction through disease, but such a thing has never actually happened. So far as known, no plant has ever been exterminated by disease. It is unlikely that the chestnut will be exterminated.

THE CHAIRMAN: It occurs to the Chair that the situation would suggest discussion at this time, but it would probably be better to continue with our programme as it was ably laid out by those who have provided for this Conference, and have the discussion after we have heard the papers. We will, therefore, call for the next paper, entitled "How Further Research may Increase the Efficiency of the Control of the Chestnut Bark Disease," by Professor W. Howard Rankin, Cornell University, Ithaca, New York.

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1. Metcalf, H. and Collins, J. F. The control of the chestnut bark disease. U. S. D. A. Farmers' Bul. 467, 28 O. 1911.

2. Loc. cit. p. 11.

3. Reported by Dr. Metcalf at a conference on the chestnut bark disease held in Albany, N. Y., October 19, 1911.

4. U. S. D. A. Farmers' Bul. 467:11.

5. U. S. D. A. Farmers' Bul. 467:10.

6. Metcalf and Collins. The present status of the chestnut bark disease. U. S. D. A. Bur. Plant Indus. Bul. 141, Part V, p. 46. 30 S. 1909.

7. Clinton, G. P. Report of the Botanist, 1908. Conn. Exp. Sta. Rpt. of 1907-1908: 879-890. July, 1909.

HOW FURTHER RESEARCH MAY INCREASE THE EFFICIENCY OF THE CONTROL OF THE CHESTNUT BARK DISEASE.

BY PROFESSOR W. HOWARD RANKIN, *Cornell University, Ithaca, N. Y.*

Mr. Chairman, Ladies and Gentlemen: Up to this time investigations concerning the chestnut tree canker disease and the causal fungus have not brought forth facts as rapidly as we could wish. It was the opinion of the conference held at Albany, N. Y. last October that we did not have facts enough about the disease and that scientific research was the one thing needed. To emphasize this point we may consider some important phases of the disease which are yet little understood, but the knowledge of which is fundamental to devising efficient control methods. Concerning the means of spread of the fungus from one tree to another we have nothing except secondary evidence. Most writers have theorized on the different methods by which the conidia or summer spores might be carried from one tree to another and a new infection started. Reasoning by analogy with what is known of the behavior of many fungi, such agencies as borers, birds, ants and the wind, etc., have been suggested but in no wise proved to be responsible. It seems that the ascospore stage has not been considered by any writer in the dissemination of the fungus, yet this stage follows the conidia very quickly and is the more abundant fruiting stage which is formed in the red or brown pustules on the surface of the cankers. Under moist conditions the ascospores are shot forcibly out in the air where they can be caught up by the wind and carried for a considerable distance. The speaker found the ascospores being shot from mature pustules during every rainy period last summer. These spores germinate readily in rain water producing a new mycelium of considerable length in fifteen hours. The question at once arises, why could not these ascospores once shot into the air be carried long distances and owing to their abundance cause a large majority of the infection? The time of year at which new infections took place last summer in the Hudson River Valley was evidently about the time when the ascospore stage was just becoming abundant. It is an important matter then to determine the spore stage and the agency responsible for the spread of the fungus before we can hope to advise an efficient and effective control. For example, such precautionary measures as the peeling of logs before allowing them to be moved could be limited to the time of year when this was necessary and thus obviate a great cost.

Likewise the problem as to how the present epidemical characters exhibited by the disease have come about is as far from solution as it was six years ago. The speaker has recently collected and examined a fungus indistinguishable from the chestnut canker disease fungus on dead chestnut bark in several places in Virginia. No case of this fungus attacking living trees was found in the short preliminary examination made near Lynchburg, although several specimens were collected on dead bark of stumps from which trees were cut about two years ago. Also a fungus found in Pennsylvania on white, red and black oak has great similarity to the canker disease fungus. The possibility of having several strains of the same fungus identical as to microscopic characters, some saprophytic and others causing a virulent disease, is at once puzzling. One of two things has evidently happened, either the host plant has, under existing conditions, been altered in its physiological process enough to change its susceptibility to this heretofore saprophytic fungus, or the fungus has developed a parasitic habit independent of any change in the host. Possibly, of course, both factors may have combined to bring about this disease-condition. Preliminary investigations carried on by the speaker seem to point to the fact that the susceptibility of the chestnut tree to this fungus depends upon drought conditions; that is a low water content in the tree. This requires confirmation however by further detailed experiment. Weather conditions causing winter injury as suggested by Dr. Clinton may quite possibly be of importance also in this connection, and accurate data concerning past weather conditions and experiments to determine the effect of low temperature on the chestnut tree in connection with the production of susceptibility is highly important.

If the results of Dr. Munch on the cause of susceptibility and immunity of forest trees to disease should prove true in the case of this disease also, we may hope to be able to control the bark disease in shade, lawn, and park trees, by keeping up the water content of the tree.

Whether nursery stock serves to introduce the disease into new localities is an important problem to be determined by observation and experiment. The present method of inspection and cutting out would be inefficient if the fungus lives commonly as a saprophyte at the base of the tree on dead bark and can attain a parasitic habit with some slight change in weather conditions. If, on the other hand, it exists only as a wound parasite, then inspections would be possible and the cutting out method effective. However, with such problems as these undecided, no one can pronounce definite judgment upon the efficiency of the cutting out method. Once however, these facts are established, modifications may be made in the present method by which its effectiveness may be insured at possibly a lower cost than can now be expected.

The present method which the Pennsylvania Commission has adopted of eradicating only spots where the fungus is distinctly parasitic, can accomplish a great good in a sanitary way, and once sufficient facts are forthcoming, the method may be altered to suit our knowledge and thus its efficiency assured.

THE CHAIRMAN: The next paper, entitled "Recent Notes on the Chestnut Bark Disease," will be delivered by Professor H. R. Fulton, Division of Pathology, Pennsylvania State College.

RECENT NOTES ON THE CHESTNUT BARK DISEASE.

BY PROFESSOR H. R. FULTON, *Pennsylvania State College, State College, Pa.*

The steady and devastating spread of the chestnut bark disease brings us face to face with a grave situation, and raises many questions of great importance. Most of these will centre about the three great questions: Is it possible to check effectively

Orchard chestnut tree girdled at base, showing characteristic growth of sprouts. Scene near Westbury, New York.—*Photograph by Perley Spaulding.*

Large forest tree girdled at base, showing characteristic growth of sprouts; near Richmond Hill, New York.—*Photograph by Prof. Collins.*

Large trees with some branches girdled. Note condition of the foliage. Scene at Westbury, New York.—*Photograph by Prof. Collins.*

Large trees with some branches girdled. Note condition of foliage. Scene at Westbury, New York.—*Photograph by Prof. Collins.*

Orchard chestnuts, (grafted varieties), nearly dead. Note sprouts on the trunks.
Photograph by Prof. Collins.

Orchard chestnut with limb girdled by twig-girdling borer. Easily mistaken at a short distance for chestnut bark disease.—*Photograph by Prof. Collins.*

Examples of tree surgery, showing healing process after cutting out cankers, in treatment of orchard trees. This treatment undoubtedly prolongs the life of the trees.—***Photograph by Prof. Collins.***

Example of tree surgery, showing healing process after cutting out cankers in treatment of orchard trees. Will prolong life of tree.—***Photograph by Prof. Collins.***

Chestnut tree showing early stage of disease; note small girdled twig on upper part of the tree in the centre of the picture.

Large chestnut tree partly dead. Note sprouts with leaves near the top, the dwarfed leaves on the middle right-hand limb, and the healthy lower branches with normal leaves. Scene at Rawlinsville, Penna.—*Photograph by Prof. Collins.*

Early stage of infection in an orchard tree; note girdled twigs with withered leaves at top. Scene in Lancaster county, Penna.—*Photograph by Prof. Collins.*

Complete destruction of the chestnut trees in mixed stand. Note healthy condition of trees of other species. Views along Long Island Railroad, near Richmond Hill, New York.—*Photograph by Prof. Collins.*

Complete destruction of chestnut trees in mixed stands. Note healthy condition of trees of other species. Views along Long Island Railroad, near Richmond Hill, New York.—*Photograph by Prof. Collins.*

Small orchard chestnut nearly dead.—*Photograph by Prof. Collins.*

A dying tree on Long Island, New York.

Examples of tree surgery, showing healing process after cutting out cankers, in treatment of orchard trees. This treatment undoubtedly prolongs the life of the trees.—*Photograph by Prof. Collins.*

the spread of this disease? Is it worth while doing so? What are the best methods to use While no one, perhaps, will venture to prophesy the outcome, all doubtless agree that the great interests at stake justify an aggressive fight; and all alike are anxious to see the warfare waged in the most effective way. Other contests against fungous foes have been won in spite of apparently insuperable obstacles, and we now look back from the vantage ground of knowledge gained through the contests, and wonder that the tasks should have seemed hard. Each year witnesses the conquest of more than one important pest, just as each year is apt to bring into the limelight some hitherto unobtrusive pest. Mention might be made of scores of animal and plant pests that, in the wide interchanges incident to modern civilization, have been brought into contact with new host species, or with new environmental conditions, and have forthwith entered upon a period of riotous devastation. At the present time, federal and state resources are being drawn upon, and concerted state action is being had, in the fights against the gypsy and brown-tail moths in New England, and against the cotton boll weevil in the southwestern portion of the cotton belt. I cannot refrain from recalling to mind the eradication of the cattle tick in certain districts within its range, and the stamping out of yellow fever in territory under United State jurisdiction, as notable examples of success that has in recent times come from complete knowledge of the situations, combined with efficient administration. As a citizen of Pennsylvania, I take pride in pointing to the successful suppression of the foot and mouth disease of cattle, during 1908, by the State Livestock Sanitary Board in co-operation with the Federal Bureau of Animal Industry. These were campaigns of quarantine and sanitation.

These examples of very diverse nature do not prove anything in regard to the chestnut bark disease; but they do serve to emphasize the fact that persistent effort in the right direction may win in the face of great odds.

To the specialist in plant diseases, a most interesting question is, why is it that this disease has made such headway in this country in so short a time. Is it that there are factors involved, aside from administrative difficulties, that are not found in the many fungous diseases that affect our crops,—less spectacular in their working, but none the less damaging in their effects? Or is it that well recognized factors are here found in a unique combination that adds to the seriousness of the situation? Is this disease inherently more serious than pear blight or cotton wilt or wheat stem rust? Answers to such questions involve consideration of the habits and value of the host plant, as well as definite knowledge on all important points in the life history of the causative organism, *Diaporthe parasitica.*

For chestnut bark disease infection to occur, three general conditions must be met just as for any other fungous disease. Broadly stated, these are (1) the presence of infective material, (2) a host plant in a condition of susceptibility, (3) general environmental conditions that are favorable. All rational control measures for the disease must be based on the peculiarities of this fungus with reference to these three things.

The infective material for *Diaporthe parasitica* seems to be pre-eminently the spores, which are of two types, the pycnospores, sometimes called conidia or summer spores, and the ascospores, or winter spores. We wish to know definitely the conditions that influence the formation of each type, the longevity of each under favorable and under unfavorable conditions, their modes of shedding and of transfer, the conditions favorable and unfavorable to their germination, their abilities to establish the fungus upon various materials, and the relative importance of the two types in spreading the disease. General environmental conditions may have their effect upon longevity of spores, upon germination of spores, upon rapidity of growth of the fungus, and upon spore production by the fungus. Susceptibility in the host has reference to qualities of genera or species or varieties or strains or individuals, that render them liable to attack by the fungus, which qualities may be inherent or possibly induced by environmental conditions. Here must be included the exposure through various wounds of susceptible portions of the host; and the protective effects of measures that may lessen the susceptibility of the host. Other points in the general life history of the organism may be of interest and importance, aside from any direct relation to the setting up of infection.

Realizing the importance to the public welfare of more complete knowledge along these lines, the Pennsylvania Agricultural Experiment Station, through its laboratory of plant pathology, has undertaken certain investigations upon the life history of *Diaporthe parasitica,* in hearty co-operation with the work of the Pennsylvania Chestnut Tree Blight Commission. While a complete report cannot be made, in the nature of the case, for a long time, we beg to submit a brief preliminary report on the laboratory work now being carried on by Mr. R. A. Waldron, of the Experiment Station staff; to which is added at the request of the Executive Officer of the Pennsylvania Commission, a summary of field studies made by Mr. R. C. Walton, one of the field agents of the Commission. Credit for the findings reported here is due to the careful work of these two men.

AIR CURRENTS AS CARRIERS OF THE CONIDIA.

The tests were made with the blast from an electric fan, with a velocity of perhaps twenty miles an hour. The material used was bark of chestnut with tendrils of conidia projecting from the mouths of the fruit-bodies. The tests were made with these tendrils dry, with them moist, and with the spray from an atomizer playing over them, the last to imitate conditions prevailing during storms. The attempt was made to catch the spores on the surface of sterilized potato agar exposed about six inches away, in the blast; and to determine the carrying power of the air current from the subsequent growth of *Diaporthe parasitica* in this material. Also, wet cotton was similarly held in the blast; it was then squeezed out in sterile water; this was centrifuged, and microscopic examination made of the sediment, as well as cultures from it. There was unmistakable evidence, from each line of testing, that the conidia may be detached by strong air currents, and carried short distances. The detachment was greater when the spray played over the material. The test will have to be carried further before quantitative results can be given. It seems likely that the detachment was largely of small bits of the tendrils made up of large numbers of spores, and that these are too heavy to be carried great distances; and suggests that under natural conditions infection may be spread short distances by wind.

LONGEVITY OF CONIDIA AND ASCOSPORES.

The length of time that conidia retain their power to germinate will doubtless vary with the conditions under which the spores are kept. Spores from bark collected in late summer and kept dry at ordinary room temperature, germinated readily for four months, but three weeks later could not be induced to germinate. Material exposed out of doors and that kept moist and at about 75 degrees F. in a greenhouse, did not give germination of conidia after four months earlier tests not having been made.

GERMINATION OF CONIDIA AND ASCOSPORES IN DIFFERENT MEDIA.

Both kinds of spores germinate in a decoction of chestnut bark, in rice broth, etc. Ascospores germinate in spring water, the conidia do not.

EFFECT OF TEMPERATURE ON GERMINATION.

Conidia germinate best at a temperature of 60 degrees F., and distinctly less rapidly at temperatures 10 degrees above or below this point.

Ascospores germinate best at a temperature of about 70 degrees F., but a good percentage of germination occurs at 85 degrees F. and 45 degrees F. Even at 38 degrees F. the germination of ascospores was 25 per cent. in the first 24 hours, and reached 70 per cent. in three days. Ascospores germinate readily after at least moderate freezing. These facts indicate that the ascospores may play a more important part in causing infection under certain conditions, than has been commonly attributed to them.

The effect of extremely high and low temperatures on spores has not yet been completely investigated in our laboratory.

EFFECT OF TEMPERATURE ON EARLY GROWTH.

In general the most rapid early growth is at the optimum temperature for germination. In a nutrient solution of boiled chestnut bark, the ascospores will send out a length of mycelium 10 to 15 times the spore length in the first 24 hours at 70 degrees F., which becomes an indefinitely large mass of mycelium in two days. At 38 degrees F., the growth is about one spore length the first day, and 15 times this in five days.

GROWTH ON OTHER MATERIALS THAN CHESTNUT.

In the laboratory the fungus grows well on a variety of artificial media, perhaps most readily on potato agar that has been made slightly acid. Material was submitted to us of white-oak and black oak bark, collected by Mr. J. R. Guyer, agent of the Pennsylvania Commission, which bark had been killed by fire previous to its observation, and showed pustules of what seemed to be *Diaporthe parasitica*. Careful microscopic examination showed that the morphological features corresponded closely to those of *Diaporthe parasitica*, as did also the growth of the fungous in artificial culture. Red oak twigs killed by steaming in the process of sterilization, were readily infected by *Diaporthe parasitica* obtained from a typical chestnut lesion. While it is desirable to carry on further cross inoculation experiments, it seems reasonable to suppose, in the light of present evidence, that *Diaporthe parasitica* may, under unusual circumstances, establish itself saprophytically on portions of trees outside the genus *Castanea*, if these portions are already dead. We have found no evidence that the fungus produces in any sense a disease of such trees as the oak.

RELATION TO LIGHTNING INJURY.

In August, 1908, Mr. George Wirt, of the Pennsylvania Forestry Department, directed the attention of the speaker to a chestnut tree in an advanced stage of infection, that had been struck by lightning earlier in the season, when its leaves were half grown. Where the wood had been splintered along the lightning track, there were numerous pycnidia standing apart one from the other, as is characteristic of *Diaporthe parasitica* when fruiting on wood rather than on bark. Many of these fruit-bodies were deep in the cracks made by the lightning, and evidently had been formed after the stroke. Specimens taken from the wood and from the bark near by, when tested, gave good germination of spores. Probably the bark infection, which seemed to date far back, existed at the time of the stroke, and the fungus spread from this to the shattered wood, the lightning presumably not having killed the fungus in the vicinity.

DEVELOPMENT IN SAPWOOD AND HEARTWOOD.

Where a section of a large infected branch was kept in a moist atmosphere constantly, an abundant development of pycnidial fruit bodies was noted in about two months from both sapwood and heartwood at the more moist cut surface. The similar development in wood shattered by lightning has been mentioned above. In two cases, the fungus was found on young, unlignified shoots; in both cases, the parts had been distinctly injured by insects.

SUMMARY OF FIELD STUDIES AT ORBISONIA, PA.

During the fall and early winter of 1911-12, Mr. R. C. Walton made a detailed study of an advance spot of infection at Orbisonia, Huntingdon county, in Central Pennsylvania. The tract covered some forty-six acres on the north and northwest slope of a mountain. It had been cut over originally forty-five years ago, and at intervals since, the last cutting being in 1908. Most of the chestnut growth was coppice of four years standing. Rather severe fire injury had occurred in 1902, and the land had been pastured recently. Soil conditions and density of stand varied considerably over the tract. The infection was found in detached spots over about thirteen acres. There was one spot that seemed to be the original centre of infection, dating back two years; but elsewhere in the area there were lesions apparently as old. Altogether three thousand and fifty-nine chestnut trees, sprouts, and stumps were examined and two hundred and eighty, or 9.1 per cent. were found to be infected. Of these, practically all were four year coppice growth. The oldest lesions were seemingly two years old, and ten of these were found. The youngest were for the current season, and of the total, about half seemed to be less than one year old; and estimates of the age of all the lesions indicated a very uniform rate of spread during the two years. It may be added from a recent investigation that 153 trees in southeastern Pennsylvania, near Haverford exposed to natural infection, carefully examined and marked as uninfected in January 1911, showed 25 trees infected in a recent examination. This would indicate something, perhaps, of the rapidity of the spread of the disease, where observations were made upon that point.

Out of 18 sprouts showing two lesions, 13 had the younger lesion above and 5 the older, which might indicate the probable work of insects in carrying infection.

Sprouts were originally infected at the base in more than four-fifths of the cases. Forty per cent. of the oldest lesions on sprouts showed twigs as a centre of infection; eighteen per cent. showed cracks, fourteen per cent. wounds; thirteen per cent. beetle holes, eleven per cent. crotches, and four per cent. were indeterminate.

More infections were found in medium dense growth than in dense growth, and very few in rather open growth. Of all infections recorded, 47.3 per cent. were within twenty feet of old logging roads, 7.4 per cent. from 20 to 50 feet away, and 45.3 per cent. at greater distance. Many more infections were found where soil conditions were moderately moist than where they were dry. Of 150 original sprout infections, 62, or 41 per cent. had a north to northeast exposure; 20 or 13 per cent. a south to southwest exposure; and the remainder were about equally divided between the other two quadrants of the compass. This might suggest moisture again as an important factor.

There were 28 cases of pycnidia observed developing on wood. Only eight trees larger than seven inches in diameter showed infection. One of these had a lesion apparently two years old; and half had the oldest lesion less than one year old. All of the tree infection was in the bark of the trunk, none in the tops. Half had development of watersprouts in connection with the lesions. Lesions in the bark of stumps showed fissures at their centres in almost all cases, and in the oldest ones the pustules were usually dark and in the ascus stage.

In connection with lesions on sprouts, trees, and stumps, there were abundant evidences of animal association, principally beetle and other large insect larvae, tunnels and holes; but also woodpecker holes and claw marks, and ant nests and trails. Most of the ant nests were in old dried stump stubs. Fully nine-tenths of all old lesions showed beetle larvae in or near them. These were mainly a species of Leptura. Of the youngest lesions, about two-fifths showed larvae in or near them; and in all cases there were about twice as many larvae in as near the lesions. It would seem that these usually follow rather than precede the infection.

Woodpecker work was noted in about one-tenth of the oldest lesions, and not at all in the youngest lesions,—much less frequently than beetle work. Ants were seldom found actually in the lesions.

It is expected that careful observations of this same tract next year and later, will add much to the value of the present very complete records, which it has been possible to summarize only briefly in this account.

A good deal is known about this parasite; very much remains to be learned. As far as our present knowledge goes, the prompt stamping out of advance spots of infection, and the general cutting off of hopelessly infected tracts, seem to be the only practicable means of control. No one perhaps realizes more keenly than the speaker the difficulties of finding infection and thoroughly removing it in sparsely settled tracts of large extent and of little value for timber. I have had occasion this last summer to be on the outskirts of the line of spread of this disease through the State, and I have seen numbers of these advance spots. It seems that if we can find these spots and remove the timber, we will be doing much to check the advance of this disease. In this State the fight is on, and it is the part of all good citizens to cooperate in the work that is being done. (Applause).

THE CHAIRMAN: Dr. Caroline Rumbold, who is in charge of important research work at the laboratory of the University of Pennsylvania, will present a paper in relation to medicinal remedies for the chestnut tree bark disease.

THE POSSIBILITY OF A MEDICINAL REMEDY FOR CHESTNUT BLIGHT.

BY DR. CAROLINE RUMBOLD, IN CHARGE OF THE PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION'S LABORATORY.

Mr. Chairman, Ladies and Gentlemen: Although in the programme, the title of my remarks has been given as the possibility of a medicinal remedy for chestnut blight, I much prefer to confine myself to a question of medicinal treatment as I believe it would limit me too much were I to try to discuss a remedy, a cure-all, one might say, when we have only started to work out the problems in the case. My main task is to attempt to find the relation between the chestnut tree and the fungus which causes its death; consequently my work is with individual trees.

The question of medicinal treatment should be considered broadly from two sides. Firstly, the side of securing better health conditions for the chestnut trees, in order that they may have the ability better to resist the disease. This we will call preventive treatment. Secondly, the aspect of curative treatment.

Under the first heading come the details of water, food, light, in other words, matters of environment. As for water, there is the question as to whether or not droughts of recent years are partially responsible for the spread of the disease in the chestnut tree. I am now conducting experiments in which chestnut trees are being exposed to infection under varying conditions from dryness to excessive moisture, both of atmosphere and soil. These experiments may also throw some light on the report that the blight spreads rapidly where trees are in a crowded coppice, while trees growing on the ridge of a hill are uninfected.

In the matter of food, various fertilizers are being subjected to tests on growing trees.

I am about to start a series of experiments in which young trees are to be grown in solutions of different chemicals, with the object of hastening the growth of the bark, or of increasing the amount of chlorophyll in the leaves, in order to find out whether or not such variations as this might increase the immunity of a healthy tree. Under the head of preventive treatment is also to be considered the care of wounds, etc. This subject will be fully considered in this conference by other speakers. My own work in this direction is confined to the testing of "washes" submitted to the Pennsylvania Commission for trial.

If the question of preventive treatment is still so far from being satisfactorily answered, that of a curative treatment is in a more inchoate condition. At most, I can describe the methods adopted in the Pennsylvania Commission laboratory, and in which I shall attempt gradually to start experiments along the following lines:—Experiments to test the relative vitality of the mycelium of the fungus, its ascospores and the conidiospores found in summer and those formed on wood during the winter; injection into trees of chemicals toxic to the fungus causing the blight; tests as to the immunity of different varieties of trees. I have started some experiments along two of these lines, but none is completed. According to my experiments so far, the ascospores or winter spores seem to have the greater vitality; then follow the summer or conidiospores. The mycelium and those conidiospores grown on wood seem to be equally susceptible to poisons. The injection experiments which are to be made are those where chemicals are injected into roots and where hypodermic injections are made on the trunks of the trees. These are of necessity dependent on the experiments leading to the discovery of chemicals toxic to the fungus and not deadly to the tree.

Experiments as to relative immunity of chestnuts are now being conducted on two or three varieties of trees. Japanese and American trees have been inoculated with the blight. For the purpose of such experimentation, the Commission has been given the privileges of the Botanical Laboratory of the University of Pennsylvania, where a special room has been set aside for my work. A greenhouse has been recently completed, in which a number of small chestnut trees are now growing.

THE CHAIRMAN: The next paper is entitled "Treatment of Individual Trees," by Professor J. Franklin Collins, United States Department of Agriculture.

TREATMENT OF ORCHARD AND ORNAMENTAL TREES.

BY PROFESSOR J. FRANKLIN COLLINS, U. S. DEP'T OF AGRICULTURE, WASHINGTON, D. C.

Mr. Chairman, Ladies and Gentlemen: For the purpose of calling your attention to one or two points that I want to emphasize as a preliminary to my main topic, I will quote the opening paragraphs of a story published in the fall of 1910 in a well known popular magazine. The particular incident may or may not have been true, it doesn't matter, still, all who have had much to do with the chestnut bark disease will recognize the incident as a fairly typical one, with perhaps a slightly different setting.

The programme of experimentation thus outlined seems formidable, but this work must be thorough if any results of value are to be obtained. It can be said that nearly all of these experiments point to the possibility of curing infected chestnut trees. Perhaps by the end of another year the Pennsylvania Commission laboratory will be able to report, if less of a forward looking programme, at least more of actual and valuable results. (Applause).

"A tall, lean man, with a grizzled beard and the air of wisdom that goes with such adornment, strode across the lawn of an old fashioned Connecticut country seat, and gallantly lifting his dingy Panama hat to the mistress of the manse, said in impressive tones:

'Madam, I have just been looking at your chestnut trees. They are all covered with scale, and are dying. I can save them, if you wish to have it done.'

'Can you?' said the credulous woman, looking up to the dead top of a noble tree. 'I have noticed that there was something the matter with them. How much will it cost?'

'Let's see,' mused the tree-doctor. 'Eleven trees, two dollars apiece. Well, I'll make it twenty dollars for the lot. They're worth more than that to you, ain't they?'

'I should say they were,' said the owner of the estate. 'My husband said before he died that he wouldn't take five hundred dollars for that big chestnut out in front there. I will willingly pay twenty dollars to have them saved.' 'All right. Let me get my outfit.'

He went to his buggy, brought back a paper bag of powder and a whitewash brush, and borrowed a pail, some water and a step-ladder. In an hour he had swabbed the trees from as high as he could reach from the ladder down to the ground, pocketed the pleased widow's twenty dollars, got into the buggy, said 'Gid-dap' to his horse, and was down at the next door yard, swabbing more trees and pocketing more dollars."

It is true that many unscrupulous persons have been making money in a manner similar to the one mentioned in this story. It is true also that the ravages of the disease, and especially the legislative appropriation to combat it in Pennsylvania, have suddenly brought to light numerous unsuspected infallible cures for all the ills (including the chestnut bark disease) to which trees are or ever will become heir, if we should judge only from the statements of the advertisers and inventors.

Apropos of this, the Chestnut Tree Blight Commission of Pennsylvania might relate some of their experiences along this line that would make more interesting reading than the above, though the incidents were less profitable financially to the fakirs.

The main point that I want to emphasize, however, is that the value of ornanmental trees cannot, like forest trees, be gauged by the mere timber value of the wood, nor, like the orchard tree, merely by the value of the annual crop of nuts. The chestnut tree undoubtedly attains its highest value as an ornamental tree. You will all recall, I am sure, certain estates where one or more chestnut trees are the main aesthetic or decorative features. Perhaps the tree may have been a veteran, famous in the countryside, long before the present owner purchased the land and built his domicile. Oftentimes the value of the ornamental tree is largely enhanced by its location with reference to the house, and even more largely, at times, by historic or ancestral traditions with which it may have been, long since, associated. The value placed by the owner of the estate upon such tree may occasionally be almost without limit.

The very fact that the tree is of much greater value to its owner than any tree in the forest could be, means that more labor and more care, can and will be expended upon it, if it needs it, than would be considered possible, from almost any economic point of view, on either the orchard or the woodland tree. Consequently some methods of combating the disease may be profitably applied to ornamental trees that would not for a moment be considered in connection with a tree in the forest.

At the very beginning of the experimental work undertaken by the United States Department of Agriculture, this fact was recognized, and has since been kept in mind. Considerable of the experimental work has had for its main object the solving of the problem as to whether or not it will be possible to eradicate or control the disease on individual trees.

Notwithstanding the fact that much of this work has been done in chestnut orchards, there are probably few orchard trees that would be worth the expense involved in an attempt to save them; however, on account of their smaller size and greater accessibility, they would be more profitable for individual treatment than the forest tree. Consequently these orchard trees become, in most cases, nothing more or less than experimental martyrs for the possible future benefit of their more aesthetically valuable ornamental kin.

It is yet much too early to make a very definite statement, certainly not a final report, upon the possibilities of being able to control fully the Chestnut Bark Disease on ornamental trees without recourse to the radical methods at present advocated for controlling it in a woodland. Nevertheless, certain facts have been repeatedly demonstrated in the course of the experimental work which apparently point in a very encouraging manner to the probable ultimate accomplishment of this highly desirable end though perhaps not on a very encouraging economic basis, as such a basis is usually figured.

I want to call your attention to some of these facts, as well as to the bearing that they may have upon control work of this general character. But in order to make clear certain points I must first refer very briefly to the general line of treatment which is being followed in the experimental work mentioned.

This has been fully described in Farmer's Bulletin No. 467, of the United States Department of Agriculture, and need not be considered in its entirety here.

For this work the most essential implements are a gouge, a mallet or hammer, a pot of tar or paint, and a brush to apply the latter; also a whetstone for keeping the gouge sharp. When a diseased spot in the bark is located, it is carefully cut out with the gouge and mallet, care being taken to cut the bark perhaps one-half inch beyond the discolored area which is usually so prominent a characteristic of diseased bark. It is extremely important that the gouge be kept scrupulously sharp. If it is dull, the pressure required in forcing it through the bark will invariably result in some injury to the delicate cambium cells at the edge of the cut. This means that the new growth will start back under the bark some distance, an eighth, a quarter, a half inch, or even more, and not close to the edge of the cut, where it should start under the most favorable conditions.

During the growing season the new growth begins to lift the old bark within a week or ten days. If this growth does not begin close to the edge of the cut, we shall find in the course of three weeks, under the uplifted edge of the bark, the finest kind of a shelter for all kinds of small grubs, beetles, etc.; all of which are well known danger factors in connection with the spread of the disease.

At most seasons of the year, it is highly important that the edge of the cut along the cambium line be covered with paint or tar as promptly as possible. This is an important, and often essential, point in coaxing the new growth to start closer to the edge of the cut than it ever would under perfectly normal conditions. By using a sharp gouge and promptly covering the cut edges, we have many times had the satisfaction of seeing the new growth start within a thirty-second of an inch of the edge of the cut, and be readily visible to the unaided eye in less than a week. Anything better than this can scarcely be expected. Of course, all portions of the cuts must be finally, carefully and completely painted with tar, paint, or other suitable waterproof coating, and it is, theoretically at least, a good plan to paint the cut surface with copper sulphate or Bordeaux before waterproof coating is applied.

In discussing the possibilities pro and con of controlling the disease on individual trees after it has become established, there are many factors that should be clearly understood and carefully considered. It should be determined just what bearing each will have on the main problem, just how each unfavorable one can be overcome or at least neutralized, just how each favorable one can be made even more helpful in the fight; all these, and more, if we are to enter the combat fully equipped. From numerous points of view it is extremely unfortunate that the disease has spread with such rapidity from its first known centre, that nearly every person who has been detailed by the States or the Federal Government to work on the disease has, of necessity, been obliged to devote most of his energies to locating or destroying infected trees, and relatively little or none to the research or investigation phase of the problem.

Everybody who has had much to do with the disease will agree with me, I am sure, when I say that in our efforts to control it we have been enormously handicapped by lack of just such knowledge as comes only from systematic and painstaking research. If we had this knowledge at the present time we would undoubtedly see with clearness many things which are now shrouded in the mistiness of uncertainty or in the darkness of complete ignorance. Who, I wonder would venture to foretell the effects upon the whole question of control if we had spread before us a complete, or fairly complete, positive knowledge of the many important points connected with the disease, about which we now know so little; e. g., to mention a few of these, its origin, methods of dissemination, detailed effects upon the host, immediate cause of the death or the lost vitality of the spores, resistance of spores and mycelium to toxic agents, climatic influence upon host and disease, the extent to which it is possible artificially to introduce various fluids into the circulatory system of a tree without killing it, the extent to which insects are responsible for the spread of the spores, the precise knowlege of the relation of birds, rodents, wind, etc.; to dissemination of the spores.

In attempting to control the disease on individual trees, there are certain facts, as I have already stated, which have been repeatedly demonstrated in the course of experimental work, that are worthy of consideration at this time. I want to mention and very briefly discuss six of these:

(1). Lateral or oblique conduction.

There seems to be a rather widespread (but erroneous) idea that the crude and elaborated sap of a tree can pass up and down the trunk or branch only in a longitudinal direction, that is, lengthwise of the fibres or "grain" of wood or bark, or at most with but slight deviation from this route. The fact that it is transferred almost entirely in a longitudinal direction in a healthy uninjured tree may be true enough under normal conditions, but it is far from true in trees that have been injured in certain ways, and, as all students of plant physiology know, not strictly true under perfectly normal conditions.

It is a fact of common knowledge that a tree will ordinarily cover or grow over, an area of bare wood where the bark has been removed. It is common knowledge to all observant persons that these scars heal over mainly from the sides. In all probability this is largely because they adjoin the uninjured vessels through which sap is being conducted in the normal longitudinal direction, but doubtless in part also to other causes to which I shall allude directly. If a partially or entirely healed over scar should be dissected, it will be found that in the layers of wood formed immediately after the injury the fibres are curved outward around the injury, and continue in a nearly longitudinal direction both above and below the scar. When the scar is partially covered, the newly formed fibres are straighter, and finally after the scar is entirely covered, the youngest fibres will be found to have assumed their normal longitudinal direction, or very nearly so.

If it were not for this possibility of oblique conduction, a tree that had a large lesion extending half way around the trunk on the north side, for instance, and an equally large one on the south side, either above or below the other, would, to all intents and purposes, be girdled.

In the chestnut tree, the angle from the perpendicular to which these fibres can be made to curve, as a result of experimental cuttings, may seem surprisingly great. In one instance the writer very nearly succeeded in an attempt to force this new growth to produce fibres at right angles to the normal direction: i. e., they were made to bend more than 80 degrees.

The fact that new fibres can, if necessary, be formed at such a great angle from the normal is of very great advantage to the chestnut in the process of healing over scars made, for example, by cutting out diseased spots in the bark. As food is conveyed through a plant in very dilute watery solutions, it is necessary that a great amount of sap be circulated or conveyed to a point where any considerable amount of food is demanded. If the tubes which primarily convey sap should be severed, as when a diseased spot has been cut out of the bark, the free transfer of sap is at most seasons of the year immediately reduced to a minimum in the severed or "dead ends" of these sap conducting tubes, which from the point of view of circulation, now hold about the same relation to the uninjured tubes that the stagnant arm of a river does to the main river.

So far as the actual food is concerned, it is obvious that the amount of sap necessary to supply the requisite food cannot reach the upper and lower edges of a scar by means of the dead ends of the conducting tubes as readily and rapidly as at the edges where there is a continuous stream of sap passing along the uninjured tubes.

Oftentimes just below a broad scar which reaches to the wood, and less often above it, a triangular piece of bark will die. This is due directly or indirectly to the inability or great difficulty that the sap has in reaching these places. In order to preclude the possibility of the bark dying back either above or below a scar, and thus furnishing favorable shelters for insects, the top and bottom of the scar should be pointed instead of allowed to remain abrupt or rounded. Under ordinary conditions it takes no longer for a scar six inches long and an inch wide to heal over completely than it does for one an inch long and an inch wide, simply because the healing over depends almost entirely upon the growth at the sides of the scar. As I have already intimated, all cuts should be made with instruments that are kept very sharp.

(2). Mycelium in the wood.

The mycelium of the fungus almost always produces a very characteristic mottled fan-like appearance in the bark, and appears to penetrate through the tissues of the bark but a short distance, if at all, beyond this discolored area. The mycelium also penetrates the sapwood very freely, when the disease reaches as deep as the wood, as it generally does sooner or later; but, unlike its effect in the bark, no pronounced discoloration is produced in the wood, and it is impossible to determine with the unaided eye the approximate limits of the mycelium, as in the case of the bark.

In all efforts to control the disease without destroying the tree, it is of course necessary to gouge out this disease infected sapwood. The depth to which it is necessary to remove it cannot at present be definitely stated, as insufficient time has elapsed to demonstrate this point experimentally. Many cuttings, some with the sapwood partially removed from beneath a lesion, and others with all of it removed, are now being watched for results. However, in a diseased spot from three to four inches in diameter apparently at least three annual layers of wood in the centre of the diseased spot must be removed.

Of course where sapwood is cut, enormous numbers of minute tubes, which conduct the crude sap from the roots through the trunk and branches to the leaves, are severed, and, should the cutting happen to have been done during warm, dry weather, it often happens that one or more branches directly above the cut-out area will show much wilted leaves within an hour or two. This is a direct and inevitable result of the suppression, from any cause whatsoever, of a considerable portion of the supply of water for the leaves.

Considerable careful judgment may at times have to be used when making cuts of this nature, and occasionally it may be wise to remove one or more healthy limbs, or perhaps to strip the foliage partially from a branch situated just above a place where much sapwood has been removed. This will at least tend to prevent wilting, which if excessive, may result in the subsequent death of the branch.

(3). Preservation of exposed wood from decay.

If exposed surfaces of wood are left with no protective covering they soon become weathered, dried, checked, and easily infected with fungi, causing decay of the wood. In the chestnut, moreover, there is the additional danger of infection from the spores of *Diaporthe parasitica*. In order to reduce the chances of infection from wood rotting and other fungi, it has been the prevailing custom for many years in this country as well as abroad, to paint all exposed surfaces of wood with tar or lead paint. Judging from our own experience perhaps these are as good general preparations for this purpose as any that we care to recommend at this time, though they are not ideal and they do not prevent the checking of the wood. Morever, they must be renewed from time to time in order to accomplish permanent good. Creosote is excellent for a preliminary coating, but it sinks into the wood readily and apparently has waterproof qualities of only temporary value. It should always be followed (within a few days, for example) with some thick or heavy coating, such as tar or paint.

For preventing the drying back of the cambium layer at the edge of a cut, we have so far found nothing better than orange shellac. This does not long remain a waterproof covering under ordinary conditions, and should, as in the case of creosote, be covered with a heavy coating of paint or tar, say within two or three weeks after it is applied. Many other preparations for covering exposed wood have been tried, but those mentioned appear to have been the most satisfactory from the point of view of our experiments on ornamental and orchard chestnut trees.

(4). Sanitation.

In cutting out diseased spots in the trunk or branches of chestnut trees, the chips should be carefully gathered in papers, or better, paper bags, and destroyed by burning. They should not be left scattered about on the ground. In other words, sanitation is one of the essentials for success in this kind of work, just as it is in the case of diseases of human beings. In all of our experiments with the disease on one particular plot the chips were left where they fell. No attempt was made to destroy them. Later many of these chips were examined and apparently good, though dormant, fruiting pustules were present in the majority of cases. To take one particular case: In March, 1911, some diseased spots, with good fruiting pustules, were cut from a chestnut tree and the chips left on the ground in a sunny exposed place on a dry hill-top. These remained on the ground throughout the spring, through the hot dry weather of early July, and the drought of July and August. In early September, two days after the almost unbroken week of rain during the latter part of August, these chips were again examined, and on a few of them which were composed entirely of bark, two or three inches long and half as wide, many spore threads were found. These, remember, from chips that had been lying on the ground for more than five months through the hot summer drought. Possibly this may be regarded as an extreme case, but in any event it clearly emphasized the necessity of extreme care in destroying all diseased bark, chips, etc., in all attempts to control the disease. Again, extreme cases of the sort mentioned are often the very ones that must be guarded against. In certain instances a gasoline torch has proved an efficient adjunct for the burning out of the diseased spot and thus destroying the fungus, whether or not followed by the gouge and mallet.

(5). Insects.

Soon after beginning work on the disease in 1908, our attention was irresistibly drawn to the evident intimate relation that insects bore to the spread of the disease. It is singularly interesting to note that practically every person who has been working on the disease in the field for any length of time has, sooner or later, been strongly impressed with this very apparent interrelationship between insects and the chestnut bark disease. Personally, we have made many observations upon the topic, but as this work properly belongs to another Bureau of the U. S. Dept. of Agriculture, we have limited our work to observations. Here is a phase of the work that could easily influence the plans of control to a large extent if we knew absolutely the relation of insects to the disease. It is gratifying to know that the Commission has an expert entomologist already at work on this particular part of the general problem.

(6). Immunity.

From what is now known regarding the spread and virulence of the Chestnut Bark Disease, there seems little immediate promise of individual trees or variations of the American Sweet Chestnut *(Castanea dentata)* developing immunity. As this species is the only forest tree of the genus in the country, it would appear that the question of immunity can have practically no direct or immediate bearing upon the saving of our forest chestnut trees.

At the present time there is every prospect that we can reasonably expect to procure immune pure bred varieties or species of chestnuts from northern Asia and Japan. Indeed, we already know that some of the Japanese and Korean chestnuts are almost, if not quite, immune to the disease. I think it is safe to say, where Japanese varieties have been killed by this disease, that in more than ninety per cent. of the cases which have come under our personal observation, the trees have been grafted with Japanese scions on American or European stocks, and the Japanese trees have been killed by girdling below the graft. We have repeatedly observed such cases where the stock has been absolutely covered with disease up to the graft line, with not a sign of it anywhere on the Japanese portion. Naturally, this fact in itself is strong proof of the immune nature of these particular Japanese varieties. As these highly resistant, or perhaps immune, trees are with us small, and the nuts, though often huge, are of inferior quality, their value will be almost entirely as ornamental trees, and probably never, in our time at least, of any value in replacing the American chestnut. If the better flavored native and Paragon nuts should disappear from the market, we would doubtless soon turn to the inferior Japanese nut as a substitute.

In recent years much has been accomplished along the line of breeding hybrids or strains of plants which are not only often fine in quality, but also highly resistant to disease. The results that have been attained in this direction within a comparatively few years are truly gratifying, but the future will witness greater results. There is no reason to doubt that we may eventually see an immune hybrid chestnut that will rival the American sweet chestnut in flavor of the nut, and the Paragon in size.

THE CHAIRMAN: You will recall that, while we were listening to the addresses in response to the remarks of Governor Tener, the gentleman from Connecticut stated that he had some results which he desired to present to us at sometime during the Conference. It has been suggested to me that, as it is a little late, it would be best to put over all general discussion until this evening, when we are to have only one set paper and at this time to call upon the gentleman from Connecticut, Professor Clinton, who has his results in the form of two short papers. If that meets with your approval, then, we will ask Professor Clinton to speak at this time. He is not "a long, lean man with a grizzled beard," but he has some other points that will commend themselves to us. (Applause).

PROFESSOR GEORGE P. CLINTON (Botanist, Connecticut Agricultural Station): Mr. Chairman, Ladies and Gentlemen: The first paper that I will present is written by Professor Farlow, of Harvard University. For the benefit of those who do not know Professor Farlow, I will say that he is the oldest mycologist in this country, has had the greatest experience in studying fungi and has some of the best herbaria dealing with fungi, especially those bound in book form, known as Exsiccati, in the world. He took up the study of the nomenclature of the chestnut blight disease, at my request, about two years ago. He has not supplied a title to the paper which I will now present.

PAPER BY PROFESSOR W. G. FARLOW, HARVARD UNIVERSITY, MASSACHUSETTS.

The cause of the disease of chestnut trees prevalent in our Eastern States is ascribed to the growth of the fungus named *Diaporthe parasitica* by Murrill in 1906. If as is generally believed, this fungus is the cause of the disease, in searching for the best method of combating it we not only should obtain all the information possible in regard to the microscopic structure and pathogenic action of the fungus, but we should see whether we may not get some practical suggestions from what has been written in regard to the distribution and pathological action of fungi which are most nearly related to our chestnut fungus.

The first question we may ask is: Is *Diaporthe parasitica,* as at first supposed, really a species new to science? If so, is it a native species which has hitherto escaped the notice of our mycologists, or has it been introduced from some other country? In disease due to fungi the presumption is always in favor of the theory that they have been introduced when they produce sudden and virulent epidemics, as in the case of the potato rot. The presumption, I say, is in favor of this theory, but a presumption it should be borne in mind is not a certainty. If *Diaporthe parasitica* is not a species new to science, what is it, and where did it come from? The microscopic structure of the chestnut tree fungus as we now know it, is well known, and its habit and its reproductive organs have been described and figured in many publications accessible to everyone. What, however, is not so generally known is what has been written in times past on fungi found on chestnut trees in different countries, and a review of what is known to mycologists in this connection may be instructive although, it must be admitted, the subject is not very easy to follow. On account of dried specimens in the older herbaria and a summary of the often obscure and conflicting descriptions to be found in old treatises, even if desperately dull, will enable us to form certain practical conclusions.

When I first received fresh specimens of the fruiting fungus of the chestnut tree I was struck by their great resemblance to what is generally known in American herbaria as *Endothia gyrosa.* Unfortunately most of the specimens of that species in herbaria are sterile and from the habit alone one cannot be sure of the species of a fungus of this group. The fresh fungus also recalled a specimen I had seen in an Italian collection, and on looking it up and comparing it miscroscopically with the fresh material, I found the two to be identical. The gross structure and the characters of the spores and asci were the same in both. The Italian specimen to which I refer is No. 986, First Series of the Erhario Crittogamico Italiana, issued in 1863. The label states that the fungus grew on chestnut trunks at Locarno on Lake Maggiore, where it was collected by Daldini in 1862. The name there given is *Endothia radicalis,* but the question of the name need not be considered at present. As other botanists have examined the specimen just mentioned and agree as to the identity of the *Endothia radicalis* and the *Diaporthe parasitica,* some having already expressed their opinion in print, we may state definitely that our American chestnut tree fungus does not appear to be new but to have been known on chestnuts in Italy fifty years ago.

It may be well to glance at what has been written on the subject in Italy. The earliest reference known to me is that of Rudolphi in Linnaea, 1829, where the *Endothia* is said to grow on *Quercus Ilex, Q. pubens* and *Castanea vesca.* Later accounts were given by Cesati and De Notaris in 1863 in their Schema and the Sphaeriacei Italica, where there is a good description and a rather crude figure apparently drawn from somewhat immature specimens, for the spores are represented as one celled, although in the description they are said to be sometimes obscurely two-parted. The fungus is said to be common on dried branches and denuded roots of oaks and chestnuts in Northern Italy and to occur also on elms.

Italian specimens were distributed in Rabenhorst's Herbarium Mycologicum, Thuemenis, Mycotheca Universalis and Saccardo Mycotheca Veneta; but in the copies which I have examined the specimens had spermogonia but no asci. The most recent notice of the fungus in Italy is that of Traverso in Flora Italica Cryptogama, in 1906, who uses the name *Endothia gyrosa.* It is said to grow on Aesculus, Alnus, Carpinus, Castanea, Corylus, Fagus, Juglans, and Quercus, and to occur not only in Europe and North America but even in Ceylon and New Zealand.

We have early notices of the fungus in France. In 1830 Fries stated in Linnaea that he had received it from that country and Tulasne in his Carpologia, Vol. II, 1863, gave a long notice of the fungus, which he says grows on Carpinus, with critical notes on the synonymy of the species. In 1870 Fuckel recorded its appearance as rare on Alnus at Oestrich in Nassau, and Winter, in 1886, in Rabenhorst's Crytogamen Flora, stated that the *Endothia* grew on different deciduous trees in Germany. The records of the fungus in France and Germany are less satisfactory than its record in Italy, and the specimens distributed from the former countries in exsiccati are few and poor.

From this rather long account of the history of the chestnut fungus in Europe, we may draw the following conclusions: Our chestnut tree fungus is widely spread in Europe and is common in Northern Italy, where it was first noticed as long ago as 1829. It is of interest to notice that writers are very generally agreed that it grows on bark, dried branches, and dead roots, rather than on living branches, and the hosts on which it is said to grow are not merely chestnuts and oaks but a considerable number of deciduous trees. Yet, although the fungus has been so well known in Italy, where it is in some places certainly common, there is no record whatever of any serious disease of the chestnut due to it. The chestnut, which is a tree of great economical importance in Italy, is subject to a good many diseases which have been carefully studied by the Italian pathologists but, so far as I know, not one has suggested that any is due to the Endothia. Were it a fact that the Endothia, whatever specific name we please to call it, is a species endemic in Italy but not found in North America until the appearance of the present epidemic, we could understand why the fungus might cause a serious disease in this country although it causes no trouble in Italy, for, if infected plants were imported from Europe, the fungus, as in other well known cases, might be transferred to our native chestnuts which unlike the chestnuts of Italy have not become immune.

Italian botanists did not and do not regard their chestnut Endothia as merely an endemic species but consider it to be the same as *Sphaeria radicalis* described by Fries in 1828 from North American specimens collected by Schweinitz. We learn from Schweinitz, in his North American Fungi, that the species was very rare on roots of Fagus in North Carolina. The synonymy is too complicated to be followed here but some reasons why it is so complicated should be stated. Prior to the publication of *S. radicalis*, Schweinitz had in 1822 described a *Sphaeria gyrosa* from North Carolina said to grow on Fagus and Juglans. Later Fries made this species the type of a new genus, Endothia. The earlier Italian writers regarded *S. gyrosa* and *S. radicalis* as two distinct species, apparently basing their opinion on the fact that Fries placed the two in different sections of the old genus *Sphaeria* rather than on an examination of American specimens of the two species. Traverso and some later writers, however, consider that the so-called two species are really only two different stages of a single species. It appears to me that their opinion is quite possibly correct, but the question can be settled definitely only by an examination of original Schweinitzian specimens. Thanks to the kindness of Dr. Stewartson Brown I have been allowed to examine the specimens in the Schweinitzian Herbarium in the Academy of Natural Sciences in Philadelphia, and I have also examined Schweinitzian specimens in the Curtis Herbarium at Harvard. Unfortunately I have not as yet succeeded in finding a Schweinitzian specimen of *S. radicalis* which shows ascospores; possibly none of the so-called *S. radicalis* has ascospores, but I am not yet certain that that is the fact. Specimens supposed to be *S. gyrosa* are common in American herbaria and have frequently been distributed in different sets of exsiccati. Unfortunately of the considerable number of specimens I have examined, the greater part were sterile although judging by the habit alone, they might very well be *S. gyrosa.* I have, however, seen no specimens in the older American herbaria where the fungus supposed to be *S. gyrosa* was certainly growing on chestnut. In general the hosts were not specificially stated but a large per cent. were evidently on oak. There is a fungus common on oak in the Southern states which has the external habit of Endothia, and appears frequently in herbaria as *Endothia gyrosa.* An examination of a number of fertile specimens on oak from different localities, having all the appearance of being *E. gyrosa,* has shown that the ascospores are unlike those of the Endothia of Northern Italy or like those of what is called *Diaporthe parasitica.* Stated in words the differences may seem to be slight but in practice one can without difficulty distinguish the two. The spores of the form on oak have hardly half the diameter of those of the chestnut and the spores are nearly linear. Naturally no definite account of the spores was given by Schweinitz and therefore except by an examination of authentic specimens we are not able to say whether the form on oak should be considered the true *S. gyrosa* of Schweinitz or not. As I have said, I have not yet been able to complete my examination of original material, not as yet having found mature *S. radicalis.*

Although further examination is necessary before expressing a final opinion, certain facts seem to be settled. Our form on chestnut called *Diaporthe parasitica,* described in 1906, and that on chestnut in Italy collected by Daldini in 1862 are identical as far as can be determined by a study of the dried, herbarium specimens which we have been able to examine. As far as I have been able to examine the older herbaria, I have found no specimen of Endothia on chestnut in North America. There is, however, an Endothia on oak not uncommonly found in fruit in the Southern States which has spores which seem to me to be specifically different from those found on the chestnut. The question, however, is still open as to whether the form on chestnuts may not also be found on oaks on further examination. If so, however, it must be less common, if I may judge by the considerable number of specimens I have examined, than the form with narrow, linear spores.

DR. JOHN MICKLEBOROUGH, of Brooklyn: Mr. Chairman: I would suggest that Professor Clinton be given the first opportunity to present his own paper the first thing this evening. We have had a very long session, and I think the time has come for adjournment.

THE CHAIRMAN: That seems an excellent suggestion. What is the pleasure of the Conference? Is there objection to it? If not, then, Professor Clinton, if it is agreeable to you, we will ask you to present the other paper the first thing this evening.

The Chair will remind you, gentlemen, that you are invited to register and he would state, also, that the Committee on Resolutions will be announced to-night. We will then now stand in recess until sharp at eight o'clock, when we will again meet in this chamber.

EVENING SESSION.

Tuesday, February 20, 1912, eight o'clock P. M.

THE CHAIRMAN: Gentlemen, the meeting will please be in order. We will first hear the short paper that we had expected to hear at the close of the afternoon session, by Professor Clinton. (Applause).

SOME FACTS AND THEORIES CONCERNING CHESTNUT BLIGHT.

BY PROFESSOR GEORGE P. CLINTON, BOTANIST, AGRICULTURAL EXPERIMENT STATION, CONNECTICUT.

Mr. Chairman, Ladies and Gentlemen:—

At a recent meeting of the American Phytopathological Society held in Washington, D. C., during a discussion of the chestnut blight problem, the writer made the following predictions:

(1). That chestnut blight was not imported into the United States from Japan; not saying that it does not occur in the latter country.

(2). That it is a native American species.

(3). That it is a previously described species.

(4). That there is evident relationship between its rise and spread in this country and weather conditions.

(5). That it is impossible to eradicate it by the cutting out method.

(6). That there will in time be a decline in its prominence due to natural conditions.

(7). Unpublished—by which was meant that the fungus occurs in Europe.

I propose here to discuss some of these predictions, thus giving my reasons for presenting them. There have been advocated two almost diametrically opposed views concerning the chestnut blight in this country.

The first of these, if I understand it correctly, assumes that the chestnut blight is a recently introduced disease, apparently from Japan, and that its spread and destructiveness here have not been at all influenced by weather conditions; that if left uncontrolled, it will continue to spread and devastate our forests until they are practically ruined.

The second view, advanced by the writer, assumes that the chestnut blight is a native American fungus, apparently also indigenous to Europe, and that weather and other unfavorable conditions, which have weakened the vitality of the chestnut trees in the northeastern United States, have had much to do with its sudden, destructive, and wide-spread appearance, and that it will not necessarily wipe out all of our chestnuts, as it is likely to decline gradually with the disappearance of the factors that have favored its rise into prominence.

Between these two extremes there are those who take one or the other view in modified form, or agree in part with both. It is highly important that the truth of the matter be ascertained, since upon the nature of the fungus and the manner of its appearance in this country depend in large measure the practicability or impracticability of the only method now advocated for its control, namely, the cutting out and destruction of the diseased trees.

Before proceeding to a discussion of the reasons why I hold the view I do, let us consider for a moment the apparent reasons for the other view. So far as I can make them out, they are as follows:

(1). The trouble appeared suddenly and seriously, and as it is unusual for a fungus thus to spring up in a country where it has never been known before, it is presumably an imported one.

(2). But such a serious disease of chestnuts has never been known before in any other country. However, insects and weeds and fungi also, that have been comparatively inconspicuous in their native countries, when introduced into a new country, sometimes develop into serious pests because of their new and unusually favorable surroundings.

(3). The Japanese species of chestnut has apparently shown considerable immunity to the chestnut disease, more so than any other. It may therefore be supposed that the fungus is an inconspicuous native of Japan, and was brought into this country on seedlings from there. It spread to our native chestnuts, and finding these much less resistant to its attacks, has suddenly spread through the regions in which it is now known to occur.

(4). The preceding statements being true, there is no reason why it should not go on spreading, and annihilating the chestnuts of the eastern and southern United States.

(5). Preliminary cutting out experiments in a region within thirty-five miles of Washington, D. C., are claimed to have prevented the spread of the disease in that region, and based on this, the much more extensive work in Pennsylvania is now being carried on, and similar work is advocated in other States to prevent its further spread through the south and west.

Now, if the preceding points are true, Pennsylvania has possibly taken a wise step in trying to control the disease. That it can ever be eradicated, the writer does not believe for one instant, and he has serious doubts about the control being effective or financially profitable, since it means a continuous fight, much like the gypsy moth work in Massachusetts, to prevent re-infection. If the above points, however, are not true, it seems to me, at least, that the efforts for control planned for this State will be time, money and trees thrown away.

The author of the first view has not, to my knowledge, claimed that the chestnut blight was imported from Europe, or that the European chestnuts in this country are especially immune to the disease. If he should ever advocate that it is a European importation, I do not see how he can account for the fact that it has caused no very noticeable trouble on that continent, and yet, when introduced here, kills off the European chestnuts as readily as the native ones; unless he admits that weather or other conditions have been unfavorable for these chestnuts, and have thus favored the development of the fungus.

Proceeding now to my own theory, let me take it up point by point.

First, that the chestnut blight is a native of this country. In 1909 I sent to Professor Farlow, of Harvard University, the first specimen of *Diaporthe parasitica* that he had examined, and asked his opinion as to whether or not it was the same as a certain species that Schweinitz had years before described on chestnuts from this country. He replied that it was not, but that it agreed more perfectly with the genus Endothia than with Diaporthe, and that it was closely related to, but apparently distinct from, *Endothia gyrosa*. *Endothia gyrosa* was originally described from Carolina and Pennsylvania by Schweinitz as *Sphaeria radicalis* and *Sphaeria gyrosa*, and reported by him on Fagus and Juglans. It has since been reported in the United States on Liquidambar and Quercus species, chiefly on the latter.

With the clue furnished by Professor Farlow, I found and so stated in my 1908 report, that a specimen of *Endothia gyrosa* on chestnut collected by Scarrado in Italy had been issued in de Thuemen's Myc. Univ. No. 769, and that so far as its gross appearance and pycnidial stage (the only stage present in my specimen) were concerned, I could not distinguish it from *Diaporthe parasitica* Murr. As the ascospore stage was not present, I did not venture to claim that they were the same species.

The writer has since made a careful hunt for *Endothia gyrosa* and has specimens of it on two species of oak collected in Connecticut and the District of Columbia. Cultures have been made of these, and from *Diaporthe parasitica* on chestnut obtained from the same localities. Our studies of these cultures and specimens from various localities are not yet complete, but they have gone far enough to say definitely that *Diaporthe parasitica* belongs in the same genus with the *Endothia gyrosa* on oak, and at least is very closely related to it, though at present my opinion is that they are distinct species. Professor Farlow has also made further studies, and I have presented his paper on the subject.

We have not been able so far to find in literature a reference to *Endothia gyrosa* on chestnut in this country before the outbreak of *Diaporthe parasitica* in 1904. Neither have we found specimens in an herbarium that were collected before that date. We have not, however, quite exhausted all opportunities for investigation along this line. If it is ever proved that our *Endothia gyrosa* on the oak is exactly the same as *Diaporthe parasitica* on the chestnut, of course it is at once apparent that *Diaporthe parasitica* is a native and not an imported fungus.

A second observation that leads me to believe that *Diaporthe parasititca* is a native species is the fact that frequently in Connecticut I have found it as a languishing parasite on the roots and base of trees, where it was doing no very apparent harm, and this is somewhat the way *Endothia gyrosa* occurs on oak here and elsewhere, and is also the way that the so-called *Endothia gyrosa* on chestnut acts in Europe, where it causes no particular trouble. This makes me believe that these particular occurrences of *Diaporthe parasitica* in Connecticut represent the fungus in its native condition as an inconspicuous parasite, rather than as an introduced pest that is bound to kill those particular trees. Likewise, I believe that at least part of the so-called spread of the disease in this country is merely an unusual development of the fungus which has existed there for years in an inconspicuous way.

A third indication that the chestnut blight is a native species is a comparison of the situation of *Endothia gyrosa* in Europe and in this country. In Europe *Endothia gyrosa* has been reported on chestnut, oak and various other hosts in different places, but apparently the natural home of the fungus is Southern Europe, as it has been reported most frequently from Italy and France. In Germany, Winter reported that it produced its pycnidial, but not its perfect stage, though both are found in Italy. Now, if *Endothia gyrosa* has a variety of hosts, including chestnut, in Europe, and prefers a southern habitat, what of its preferences in this country? From an examination of literature and of specimens in the New York Botanical Gardens, it is apparent that *Endothia gyrosa* has been reported much more frequently south of Pennsylvania than north of it. For two years, I and others have been looking for it in Connecticut, and only this winter was it found by our forester. This specimen, like those reported by Winter from Germany, has only its pycnidial stage, though this is the time of year to find the asco-stage. *Endothia gyrosa* has been found on as many hosts in this country as in Europe, and likewise chiefly from the south. Why may we not then expect to find it there on the chestnut? We certainly have had trouble enough with the chestnuts in the South in former years to believe that it might occur there.*

The second point expressed in my view is that the chestnut blight fungus is also a native of Europe. Briefly stated, my reasons for this belief are: (1) The specimens in deThueman's exsiccati on chestnut in Italy already referred to; (2) the statement of Professor Farlow that he has seen identical herbarium specimens of it from Europe; and (3) a recent letter from Professor Saccardo of Italy, who states that he and Professor Hohnel simultaneously recognized that *Diaporthe parasitica* Murr. is the same thing as *Endothia gyrosa*, both in its ascospore and conidial stages. A critical study of more specimens on all hosts from each country may, however, settle differently some points at present not clear to me.

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*After the Harrisburg conference the writer went South especially to see if *Endothia gyrosa* or *Diaporthe parasitica* occurred there on chestnut, as suggested in this paper, though never having been so reported. Stops were made at Roanoke and Blacksburg, Va., Bristol, Va., and in Tennessee and at Asheville and Tryon, North Carolina, and Lynchburg, Va., and at each place there was found the suspected fungus on both chestnut and oak, and more frequently on the former. This fungus occurred as a languishing parasite or as a saprophyte, usually at the base or on the roots of the trees, and was never found forming isolated cankers on the otherwise sound sprouts, as is *Diaporthe parasitica* in the North. Apparently this fungus is the same on both the oak and chestnut, and the same thing as the so-called *Endothia gyrosa* on the same hosts in Europe. What its exact relationship is to *Diaportha parasitica* has not yet been fully determined. In gross appearance its fruiting pustules are scarcely different, except possibly slightly less luxuriant, as a rule. Its pycnidial spores or Cytospora stage is apparently identical with that of *D. parasitica*, but the asco-spores are evidently as a whole less luxuriant; that is, they are somewhat smaller, and especially slightly narrower. Whether these differences are those of a strain, variety, or distinct species, is yet to be determined by cultures, inoculations, and further study.

The third point in my theory is that weather and other unfavorable conditions have weakened the vitality of the chestnut in the eastern United States, and that the fungus has developed into prominence because of this. The reasons I have for advocating this theory are as follows:

(1). The chestnut blight came into prominence suddenly in 1904, just after the severe winter of 1903-4. From my own observation at that time and since, I know that this winter was unusually severe on fruit, and to a less extent on shade and forest trees in Connecticut. I am corroborated in my views by the observations of Professor Stone, botanist of the Massachusetts Experiment Station, who has made a specialty of the diseases and injuries of shade and forest trees. Various experiment stations and other publications show that the fruit trees in New York, Michigan and Ohio suffered from this, and possibly from subsequent cold winters.

(2). Since 1907, speaking particularly for Connecticut, we have had five summers with unusual periods of drought, culminating with that of last season, which lasted from June until about the first of August. I know that these droughts have been hard on forest and shade trees from their weakened condition and from the unusual number that have died. Except in the case of chestnuts, the death of these trees has been laid directly to the drought, by many observers. I have given somewhat more detailed accounts of these weather conditions in my previous reports, and will not dwell further on them here. We have found that chestnut trees on the south and southwest exposures, (and on that side of the trees) where they have suffered most from drought and winter injury, have sometimes developed severe outbreaks of the blight, while the trees on the more protected northern exposures in the same vicinity did not.

(3). We have found cases of chestnut blight developing more severely in woods suffering from fire injury than in surrounding woods not so injured. It has been our almost universal experience that blight develops first and most severely in the easily injured chestnut sprouts from one to ten years old, whose new roots have not yet become thoroughly established, and last on the sturdy old seedling trees. How many times we can renew our chestnut woods by sprout growth is a question, but that such trees in time are weakened foresters generally acknowledge. Most of our Connecticut chestnut timber has already been cut over at least two or three times.

(4). The unusual spread of the disease in very dry years is contrary to the general experience of fungous troubles, which are favored by moist years; and yet here is a case where the severer the drought, the worse the fungus became. If I am wrong about its relation to weather conditions, what a deluge of trouble we may expect with the return of a few moist years!

As to my statement that chestnut blight cannot be eradicated in this country by the cutting out and burning method perhaps no one now thoroughly conversant with the trouble will deny, though there are those that evidently believe it can be controlled in this way. Man never yet has eradicated a fungus so widely distributed as this, unaided by nature, and is never likely to unless he eliminates the host. Professors Stewart and Murrill have given reasons why they believe it is impractical even to try to control the disease. I agree in the main with their contentions. The method that is advocated in the present case aims at the complete destruction of the infected trees and in some regions, if I am informed correctly, of the healthy as well. This is a decidedly unusual procedure in the control of plant diseases, since usually we aim to save not only the healthy plants but the infected ones as well. I know of no similar practice, outside of nursery inspections, except that applied in a few regions for the control of peach yellows. There the infected trees only are destroyed, but the yellows would kill those any way in a short time. There is, however, no National effort to control peach yellows even in this way and at least one State, Connecticut, that started under authority of law to inspect orchards and to destroy all infected trees, repealed that law after a few years' trial.

Now as to my last contention: that the disease of itself will gradually decline with the return of a series of years favorable to the chestnut trees. If unfavorable weather conditions for the trees have been the chief cause of the rise of the fungus as an aggressive parasite, favorable weather conditions for the chestnut will of course bring about the decline of the fungus, unless it has already attained an unusual and lasting virulence from its present aggressiveness.

That chestnuts have in the past in our southern States suffered from disease or injury of some kind yet unaccounted for, no one who has looked up the literature of the subject can deny. I have gathered together statements of this sort from various sources, but will not take the time to present them here. From the fact that no trained mycologist has studied these outbreaks in the past, and from the further fact that the observers often speak of them by such terms as "blight," "root rot" and so forth, and did not find insects responsible, I, for one, am open to proof as to their relation to *Diaporthe pasasitica,* despite the statement of two or three observers who have recently examined trees in the South, that there is no such relationship. Anyway, the chestnuts have suffered severely in these States at different times during the past seventy-five years, and have been apparently crowded out of the lower lands, but they still seem to be quite vigorous and abundant in the higher regions of those States, since the chief object of the campaign in fighting *Diaporthe parasitica* seems to be to keep it north of the Potomac River in order to preserve the valuable timber said to exist south of it.

THE CHAIRMAN: We are now to be favored by hearing an illustrated lecture on Chestnut Culture, the speaker being Professor Nelson F. Davis, of Bucknell University, Lewisburg, Pa.

CHESTNUT CULTURE.

AN ILLUSTRATED LECTURE BY PROFESSOR NELSON F. DAVIS, OF BUCKNELL UNIVERSITY, LEWISBURG, PA.

Mr. Chairman, Ladies and Gentlemen: I wish to take you to-night on a little trip to Irish Valley, situated near Shamokin, Pa. I will take you on this trip by a series of lantern slides. I wish to show you to-night what has been done in spite of enemies, by Mr. C. K. Sober, who has been working with the Paragon chestnut since 1896 and 1897. In 1896 Mr. Sober began to graft the Sober Paragon chestnut, as it is now called, on native chestnut sprouts. He had on his farm in Irish Valley about four hundred acres of waste mountain land. This mountain land he wished to reclaim. It was not suitable for ordinary farm crops. His method was to remove everything and, by means of cleanliness, which he obtained by using the grubbing hoe, the saw, the axe, and the pruning knife, and then burning everything, to keep his growth clean. In this way he hoped to keep out the enemies, such as the weevil, and another worse than the weevil, the burr worm. There are two species of the burr worm, one of which is new to scientists. It belong to the genus *Holcocera,* and has been named. in honor of Mr. Sober, *Holcocera Soberii.* The other larva, the adult of which is not known, is equally injurious. By means of removing the nuts as soon as they emerge, removing the burrs from the grove and burning the shucks as soon as the nuts are taken out, Mr. Sober on fifty acres has practically removed the weevil and burr worm, so that last year the nuts gathered from fifty acres contained scarcely a peck of wormy chestnuts. He has done this by means of cleanliness in every way, and by removing the larvae and not allowing them to mature. In other parts of the grove it has not been possible to do this in every respect, and there the weevil is an enemy. It has been his custom, during the last ten years, to remove every dead limb that has appeared in the four hundred acres and if there was chestnut blight, it has been cut off and burned. An actual count of the chestnut trees now in the grove showed forty-four thousand and thirty-five trees that are bearing, and in addition to those there are others that are not yet matured.

By means of these slides I will take you in harvest time over the grove as it now is, and then, by means of other slides which I have taken during the last ten years, show you the various steps that have been taken in developing this grove. If we may have the lantern, we will begin our trip.

The first slide is a portrait of Mr. C. K. Sober. (Applause).

The next slide represents a portion of a fifty-acre tract, as it appeared when he took possession of it. It was covered with waste wood of various sorts. Very little of this was of any use.

A typical cluster of burrs of the Paragon chestnut.

Distant view of part of 300 acre plot of Paragon chestnut grove, near Paximos, Pennsylvania.

Some could be used, of course, for pulp wood; but notice, among the old stumps, there are a few sprouts coming up. These are sprouts of the native chestnut, and it was upon these sprouts that Mr. Sober conceived the idea of grafting. Of course, it had been done elsewhere, but not upon his four hundred acres. That was the beginning of his Paragon chestnut.

As we approach the grove at the present time, you will see the mountain side in Irish Valley from this view. This shows on the hillside from a distance a portion of the four hundred acres, which is now grafted, and from one end of the picture to the other represents a distance of over a mile.

In the next view, as we approach the farm, coming near to the buildings, you can see the nature of the surrounding country, the hillside. Back in the centre of the picture, at the top, is ninety acres now grafted to the Paragon chestnut.

In the next view we see the farm buildings and, starting from the buildings, we will now visit the grove as it appeared last October.

Driving up the road you notice along the roadside everywhere seedlings grafted to the Paragon. They have been transplanted, and all along the road wherever you drive, you will see these trees.

As we approach the grove, you can see its condition in this view. This is a portion of the four hundred acres. There are shown in the view about three hundred acres. Above you see the the mountain side, as this grove would now have been had he not cleared it.

A nearer approach to the grove shows the grafted trees, and above them the native chestnut principally. This land was originally covered with, I suppose, white pine. That was removed and later hard woods came in its place, oak, chestnut, and other hard woods. Now it meant considerable work removing and clearing and grafting these trees, and I wish to show you the various stages as we pass along.

As we enter the grove, it is harvest time, as shown in this view. They are gathering the nuts, which have been placed in bags at this particular portion, so that we are just entering the grove.

In the next view, the largest tree at the right is about nine years old. Really the work from 1896 until 1900 consisted in experimenting. When the methods were perfected, the real work began, in 1900.

Another portion of the grove shows a tree on which the nuts are maturing. This tree is about eight years old.

A branch from that tree shows the nuts almost ripe, just ready to open. If we examine under the trees, many of the burrs are fallen to the ground. You can see the burrs and the nuts in the burrs. It is harvest time and the harvesters are gathering the nuts and placing them in piles, whence they can be hauled to the threshing machine, which will be shown later.

The next view shows a normal burr, containing three nuts.

I will now show the different stages through which fifty acres of this four hundred have passed. I do not have the photographs taken in 1896 and 97. The photographs I have were taken beginning with 1903 up to the present time. This view shows the work of removing the brush piles, which were left on the ground. These had to be burned, the logs removed and all the sprouts protected. Every native sprout was protected in every way from fire and from injury, and in the front of this view you see a number of sprouts that have been left. These are ready to be grafted. When the logs are hauled out, these have to be protected; when fires are made, to burn the brush and rubbish, these need to be protected. A sawmill was set up, and what wood was valuable used either for railroad ties, or mine props, or pulpwood, for whatever it could be used, so that it partly paid for clearing.

When the sprouts are ready to graft, they are about six feet high. Four sprouts are here shown. The two on this side were cut off about the point where the hand is, and these two were selected because, coming from the stump, they came from lower down and a little farther out and apparently had better roots. So two were selected and two were left. The two were grafted on this side and two left, in case of injury to the other two; so that, if anything happened, the others could be grafted the next season.

Old trees were cut down in different parts of the farm. This shows a giant tree that was cut in order that this little sprout at the side might be grafted. This was about two years after the tree was cut.

This shows another tree from which four sprouts were grafted. This was grafted in May, and in June the sprouts were started. Of course, all buds below the graft were removed in order to prevent the strength passing into the buds.

This view shows the same grafts as they were maturing during the first summer. Three have started; the fourth was a little slow in starting.

Here they are shown after one season's growth. The roots from the old stump contained lots of nourishment and pushed the growth rapidly, so that during one season the growth that you see took place. This was taken in October.

Another view showing one season's growth, after the leaves had been removed. This shows four sprouts grafted. They are growing together.

This is a typical sprout after the first year's growth. Notice it makes a fan-shaped tree. At this point, sometime during the early spring this limb would be cut off here (indicating), this one and the one at that point, thereby insuring the next year a low crown. The growth is so rapid that frequently the wind would break them off if they were not cut back, so that it is much better to cut them back.

The next view shows a grafting outfit. These are the sprouts cut from the Paragon trees, called the "scions," to be grafted on the native sprouts. This shows the tape, which is waxed, and some of the grafting wax. This is the machine for winding the waxed tape, previous to the beginning of the grafting.

The wedge graft was used first. This view shows the method of insertion of the wedge graft. It is then waxed and wound with the waxed tape. The wedge graft was used by professional grafters who were employed in 1897, 1898 and 1899, but only about two per cent. survived. The season is very short during which this could be used, because the bark separates from the stock so early that the union would not take place.

This view shows one of the trees, showing a successful union of the wedge graft. This is one of the oldest trees now to be seen in the grove.

This view shows a wedge graft, one of the original ones, that did grow. This photograph, I think, was taken in 1903, but only about two per cent. of the grafts in 1897, 98, and 99 lived, so that there are only a few of these surviving. The wedge graft method was consequently abandoned.

Then budding was tried. This method you are familiar with. This is the bud to be inserted. It is then inserted, wrapped with wax and covered with the cloth. This method, however, was not successful when used in the grove. A few of them lived. The next view shows such a case; two on either side are buds that did live, and in the centre is a whip graft. Here is one that was successful. After a time the tree heals up perfectly at the union.

This view shows the manner of inserting the knife in the whip graft. It should be inserted at a considerable depth. This one is shown with the top cut off ready for grafting. This is the sprout, on which the graft is to be set.

This shows another view of the whip graft, the method that has been successful. This came in 1900, when Mr. Sober personally took charge of the grafting. He instructed green men rather than professional grafters and had them use his method, being particular to make the scion fit perfectly to the stock. It is then inserted and driven down so that the tongue holds it at that point; it is cut back a little later, waxed there (indicating) and the bud is allowed to develop.

This view shows the completion of it. The stock may be even a little larger than the scion. It is better to have them the same diameter. It is then waxed and wrapped with tape and a little piece of wax put on the top of the scion to keep the moisture in. This is the most successful method with chestnuts.

This shows one after the graft has started. This is waxed muslin, which is old muslin that will tear readily as the tree grows, and will remove itself, so that it does not girdle the tree.

This is after one year's growth, the union practically complete all the way around.

The next view shows a through section, showing the complete union. Here is the tongue which held them together; and here is another section through. Occasionally they decay at that point. This shows a perfect union of the whip graft.

It is very necessary to keep the buds removed from below the graft. The four grafts shown in this view started, all of them, but the buds below took all the strength from them. The bark has been removed from the three on this side; from the other it has not. The sap, of course, flows along the line of least resistance and takes all the strength and the graft dies.

The next is a photograph to show the Paragon grafted on oak. The tree is still living. The oak now is smaller in diameter than the chestnut, the chestnut growing faster. This was not very successful; still, it is succecssful to the extent that it lives and bears nuts.

A defective union. At that point (indicating) enemies can enter,—fungi and beetles. The wind also will frequently break off a tree at the point of union, if the union is not perfect. A sprout was allowed to mature on this and later was grafted. The growth is very rapid, and the chestnut not being a strong wood, many were lost in this way where the union was defective.

This is a portion of the fifty acres as it appeared six years ago.

Here we have a view of it a little later. All the roots of the other trees begin to sprout and it is necessary to clean out everything. If the underbrush is allowed to grow, it will, sooner or later, choke out the trees and will allow enemies to develop; you cannot keep it too clean. Fires will run through it; so Mr. Sober early found that it was necessary to keep the growth clean. Many parts of it are now clean enough to mow with a lawn mower. In many places the grass is beginning to grow. I wish you would notice how clean the grove is in places. This is the condition soon after the grafting. Then it was necessary to employ from twenty-five to fifty men to clean out and, in order to save the young grafted trees, screens were made. At one time I saw as many as twenty-five of these screens. They were covered with asbestos to protect them from the fire, and the young sprouts that have been grafted are back of the screens. These men are grubbing out and cleaning, trying to get the ground clean enough to raise grass.

This view shows one of the screens a little nearer and some of the men, who rested a moment while I took the photograph.

Here they are again. Even after the trees are of this size, it is necessary to finish the cleaning. They are cleaning out everything; any suspicious sign, any dead tree, is cut out.

Another view showing them carrying the material to the screens for burning,—grubbing out sprouts, so that later it was possible to run a specially constructed mowing machine through it, and much of the undergrowth could be cut off in that way. It is possible to run a mowing machine through nearly all of the four hundred acres, except where there are too many stones.

Originally the idea occurred to Mr. Sober to graft the tops of a few of the trees, and we had full sized trees in which eight or ten grafts were set on the top. This view shows one where the top was grafted; this one is another, with the top grafted. That, however, did not prove successful, because you would have only a few limbs in the top, and in a little while the others would catch up with them.

Here is another view of a tree grafted at the top, and this a younger tree, two years old, beginning to bear nearly as many nuts as the grafts at the top of the other tree. You can see, therefore, why that method was abandoned. The Paragon begins to bear very early, the second year after grafting; occasionally the first year a burr or two will mature.

Now the grove is beginning to look cleaner. These trees are two or three years old. This was taken in the summer time, in June, before the trees had blossomed. This is a young tree two years from the time the graft was set, really the third summer for it; a typical tree. It is now making independent roots for itself and in a little while it will be free from the old stump. Many of the old stumps are still standing. Some of them have rotted away.

Another portion of the grove, just a little later, showing trees one, two, and three years old, and the tops of a few trees that were grafted in the top.

This view shows two trees by the roadside, one two years old; the other in the third season of its growth. Notice the shape. They were cut low, so as to secure this low crown, which makes it convenient in harvesting the nuts. It keeps the trees low. It is like it is with a peach tree; the shape is much the same as that of a peach tree.

Group of Paragon chestnut trees, two, four and six years old.

This is a view of an ideal tree, three years old, with a low crown, two feet from the ground.

In this view, the huckleberries are beginning to grow underneath; all through the grove the huckleberries have filled practically everything. The ground has been burned over, to burn up the leaves and the burrs, which contain the enemies, and the huckleberries and chestnut sprouts are coming up; but it is necessary to keep these down.

This view shows how that same ground was cleared, and how it appeared in the winter time. Everything that could be removed was grubbed off and burned, the screens which you saw before being used.

This is a young tree, three years old, in the third summer. From that tree three hundred burrs were removed. Two hundred were left to mature. This was too many, and many of them dropped off. The leaves were picked from that same tree, and this view shows it with over a hundred burrs in which the nuts are practically ripe.

This is the grove as it appeared in 1904. This is a portion not of the fifty acres, but a portion in the flat which was grafted about 1900, some of it in 1899. Notice now that the grass is beginning to grow below the trees. The stumps are there, but the tree is becoming independent. It is now possible to have the mowing done by means of cattle and sheep in the grove.

This is another view showing trees out by the edges, as the sprouts come up. They were grafted until there is a stand all over the four hundred acres, and now it is necessary to use the axe to trim out, because they are too thick.

Another portion, showing a four-year old tree, with nuts.

This view shows the trees a little older. This was taken in 1910 and shows the character of the mountain side. It is covered with stones; impossible to mow around it; it has to be grubbed,—but an ideal place. The stones help to keep the moisture in the ground and the trees do exceptionally well.

This is another tree, a photograph taken in 1911. It was in October and the nuts were ripening on the tree.

The next view shows part of an old hedgerow that had grown up with everything. Stones from the field on either side of this had been thrown along a gully that existed there at one time. In that row, in which there are altogether about twenty-nine trees, three years ago there matured nine and a half bushels of nuts, just on that old hedgerow, that could not be used for anything else, and full of stones. Some of the trees in that row last fall had almost half a bushel of nuts on single trees. The trees on the four hundred acres last year were practically all bearing; some of them less than a pint to the tree; others almost half a bushel to the tree.

This view was taken in 1903, or 1904. Notice the size of the trees, especially. About five hundred sheep were put into the grove and they are doing the mowing and fattening themselves, where the machine is no longer needed.

This view shows the same trees in 1911. The fence by the side shows the growth from 1904 to 1911. They are rapid growers, because they have a good root system.

This is a view of the ridge, a portion of the ridge that has a southern front. There are ninety acres grafted, and all bearing. The red spider appeared on this southern side, the sunny slope, and interfered with the growth.

Here is a near view on the three hundred acre lot. It shows the condition which might have existed up to the top of the ridge. That is Mr. Sober's line. A fence is built,—you can just see the posts,—and that fence is a mile long, running from one end to the other, and below it is what you see and above is waste mountain land, containing chestnut and rock oak. Through that, of course, fires run every now and then and it is necessary to establish fire lanes at the upper end, so that below the fence is a fire lane which will prevent a fire from getting into the grove.

This photograph shows what was there in 1896 and 1897—that same grove that you saw up at the edge. This has been possible with Mr. Sober, and it is possible anywhere where the chestnut grows. You can make the change from this to what you saw before.

This is the identical spot that you were looking at in the picture preceding. The preceding picture was taken five years ago, and here it is to-day. These trees have been grafted two years and three years, and they are bearing. On this fifty acres ever since they have been bearing, every nut, practically, has

Harvesting and threshing Paragon chestnuts.

been removed, so that last year on this fifty acres there was scarcely a weevil, and scarcely a burr worm, in the nuts that matured there.

Another portion, showing young trees bending over, breaking down, almost, on that same fifty acres. It was taken in 1911, about the first of October. The trees are heavily laden, the nuts perfect.

Another view showing the sheep doing the mowing. The cattle help with the work. Pigs help, but I do not have a photograph showing them. A lot of them were put in after the crops were gathered. The men harvested the nuts and afterwards the pigs were turned in and found enough to fatten themselves. I think that on the waste mountain land in this State, you could fatten on chestnuts all the pigs that we raise, if we used it for nothing else.

In harvesting, the nuts gathered in 1911 were hauled to a threshing machine. It was necessary to have a machine made, the problem of threshing the nuts, getting them out of the burrs, becoming so great. This shows a photograph of the men hauling the burrs before they are quite ripe, and placing them in piles. They ripen, the burrs open, and the nuts can then be picked out.

This shows another pile of the burrs. Notice that they are opening. This was taken a little later and the nuts were maturing.

Harvesting before we had the machine. The men had to pick them out. The nuts were taken out and placed in sacks, all by hand. This shows a pile of burrs. Every burr had to be opened with gloves, and it was very tedious. The problem was too great, so that a threshing machine was invented by Mr. C. K. Sober especially for the purpose this last year, and this view shows the machine in operation. The nuts were hauled in piles in the burrs. They were then put through this machine, which is run by a little gasoline engine; the nuts ran out into a basket, were put into sacks, and later they were loaded and carted to the house to be assorted.

This is the assorting room. They are then packed in boxes. Here are crates filled with nuts. Last year a carload was sent to Seattle, Washington. After the season was over, orders were taken for two carloads to be delivered at Seattle next fall, and the same man may take the entire crop next year. What that will be I cannot say. This year it was between three and four thousand bushels, including good and bad nuts.

In this view typical burrs are shown. Notice how thin the husks are on many of them.

Another burr. It does not look as if it could cover the nuts. In fact, it could not now, because the burr has shrunken away as it dried out, leaving the nuts. Four, five and often seven nuts are found in a burr.

This view shows seven in a burr. Notice that they are crowded in, which gives them irregular shapes.

In this view the nuts in the lower row are covering silver half dollars. The seven below measured over ten inches. Eight of them measured thirteen inches.

In this view the nut in the lower right hand corner is covering a silver dollar; the other four covering silver half dollars. Above, are typical burrs.

Here are thirty-two selected nuts, measuring one quart. Another group of the burrs as they were taken from one tree, a little seedling three years old.

Forest fires were started in the mountains above by hunters, carelessly or otherwise. They run down into the grove, so that it is necessary to watch cautiously. Perhaps, however, the burning of the part above helped to destroy some of the weevils and some of the burr worms; but of course the danger is that it will get into the grove, and it did burn over nearly ten acres at one time. This view shows a fire lane; the building of a fire lane, between a grove and the woods above. It shows what the grove would have been had it not been cultivated and put to this use. That is the land immediately above it, full of chestnut timber.

This shows another point, showing on one side where the fire just went through. It did not get into the grove. The trees are dead, not from the blight in that case, but from the fire. It shows on the other side chestnut grafted to Paragon, and the four hundred acres is practically surrounded on three sides by that same kind of timber.

There are other enemies. Meadow mice girdle the young sprouts at times. The sprout shown in this view was girdled

Threshing Paragon chestnuts, Fall of 1911. (Machine designed by Mr. C. K. Sober).

by a meadow mouse. By keeping them clean, however, cutting the grass away and burning it over, the meadow mice are kept down with the other enemies.

The seventeen year locust is another enemy. There is a brood of them every three of four years, it seems. In 1903, 1906 and 1910 thousands of them,—millions, I suppose,—came out. This is one view, which I took looking up, pointing the camera into the tree. These are the empty skins of the chrysalides as they came out of the ground into the tree, the cicadas having crawled out.

This view shows a little wild indigo plant, on which there were two hundred and fifty cicadas. The injury comes when they deposit their eggs.

The next view shows two branches recently stung by the cicada. The eggs are deposited, making holes through which fungi may enter. The wind blows then and breaks them off at places, and the branches fall to the ground; but the cicada has left holes and it is necessary to trim off the branches and prune. This view shows a little tree that has been pruned. The dead branches are below and of course there is not much left. This interferes with the bearing of that tree. A tree trimmed in 1910, in 1911 had no bearing wood on it; a loss of the nuts, loss of a year's crop, because of the cicada. However, if the limbs are not broken, they begin to heal.

You can see in this view where the ovipositor punctured the wood. This was stung in 1906 and the photograph was taken in 1910. They are slow in healing up, and form wounds through which the spores of the fungi may enter.

This view shows still further the process of healing. Some of them heal up entirely and apparently suffer nothing from the injury.

This tree was stripped by the striped oak worm. There are other enemies. Mr. Sober and I have been fighting enemies for ten years. Nearly every one discouraged Mr. Sober. He stood alone; but he is fighting them, and will continue to fight them. In spite of the blight and in spite of everything, he expects to see chestnut trees as long as he lives, and if we could come back in two hundred years, I think we would find chestnut trees there.

One of the enemies that is most serious is the burr worm. At the time the chestnut blossoms, a little moth lays an egg on the young fruit. The egg hatches and a little worm burrows its way into the burr. It seems to prefer living on the burr rather than the nut. This view shows what I have called the "little" burr worm. Here it is. It lives normally in the burr. Occasionally it eats into the nut, but it does not like the nut, but leaves an ugly hole and the nut afterwards frequently moulds.

This shows the adult moth, the *Holcocera Soberii.* It is very similar to the *Holcocera glandulata*, but, according to Kearfoot, of Montclair, New Jersey, it should be called a distinct species, and it has been named in honor of Mr. Sober. This is one of the worst enemies. There are two shown in this view, a "little" and a "large" one. This is the larger one. (Indicating). I have tried a number of times to get the adult of that, but I have failed thus far. It is easy to get them in the larval stage, —you get lots of larvae,—and they will make the cocoons. Normally the cocoon is made in the burr and fortunately when the burr is removed the cocoon is removed; but I have not been able to get them to mature. I do not know the adult of this one.

This view shows the hole it makes into the nut. It is cut away to show it. It has not gone in very far and this has removed all the injury done. The other one is the injured one, showing the spot, in the edge of the screen. This one is injured here. (Indicating). If the nuts are eaten immediately or used, they are scarcely injured; but if they are allowed to stand for a time spores of various moulds get into them and the nuts soon rot entirely. In this case this nut shown has cracked open, and is full of black spores. I am not able to identify all the moulds; some of them resemble very much the ordinary bread mould.

Insect traps were made by Mr. Sober in 1910 and placed throughout the grove, and thousands of moths, many of them belonging to the same genus, the *Holcocera,* were caught in these traps. Lanterns were suspended from the trees beneath which were these tin arrangements, and below was a pan of water on which was placed a little oil. That arrangement caught thousands of moths. That is one method of controlling the enemy.

The grove is full of birds. There are many blue birds, and nest boxes have been put up. I do not know whether it is a good

Insect traps in chestnut grove. Largest trees are twelve years old.

plan to encourage the birds or not. The woodpeckers are there, feeding on insects and the beetle larvae under the bark. It may be a good chance to spread the chestnut blight, but they help to control the moths. They feed on hundreds of them. You see them hunting everywhere. The insect-loving birds are there. You find the vireos, the red-eyed vireo especially; you find the American redstart; you find warblers. They are there looking for the moths and weevils. Chickens were placed in the grove. They search for grubs and everything they can find and, of course, in doing that they destroy many of the chestnut weevils and the grubs of other worms.

This view shows the chestnut weevil, the *Belaninus,* on the burr. These can be controlled by removing the burrs immediately, before they have time to come out on the nut.

This view shows them at work. Several females were placed on this burr, which I have cut in two.

This view shows the long, beaklike proboscis. There is another one, and another in the corner. There was another one here, but it crawled around too much to be photographed. How the eggs are deposited, I cannot say, but in some way, I think through that long beak. They have two slim feelers, with which they can take the eggs from the ovipositor to the end of the beak. This view shows a big one. The weevil, as you can see in the next photograph, never withdrew its beak. There it is, in the picture. This was removed and in its place larvae developed. I have taken out of one nut as many as fifty-five grubs of the *Belanius.*

This view shows them maturing. In this one there were as many as thirty larvae.

This view shows them in different stages; they are practically mature. When they are mature, they come out through the little hole in the nut and burrow in the ground. They remain there until June or July, when they transform into pupae. The next view shows six of them taken in July. In about two weeks they mature. The next view shows six adults, three male and three female. I think in some way the eggs are taken by means of these appendages which will reach the end of the bill and reach the ovipositor. I have never been able to see them do it, but in some way I think the eggs must be inserted by this method.

The demand for the Paragon nut has come from all over the United States, and it was necessary to start a nursery. Mr. Sober, with the cleanliness he practices, will keep this going in spite of the blight. He put away last fall three hundred bushels of nuts, burying them, and now a little later they will begin to sprout. When they are sprouted, in beds of sand, they are taken out and planted. The method is before the nuts are planted, to pinch the large tap roots off at this point, so that a fibrous root is started. Otherwise this (indicating) is what you get, and it is hard to transplant that tree and have it live. To pinch off that root, or to put it in horizontal position, will develop fibrous roots. This one was not pinched off, but was planted with the tap root in a horizontal position, and you see the result. This nut (another view) was planted and allowed to develop for itself; and you see the difference between the two.

The nuts are planted in rows, and here you see them after the first summer's growth in the nursery.

Here they are, two years old, ready to be grafted. Some of the seedlings bear the second year and third year, but they are not true Paragon. Some of them may be better. Last year fifty seedlings, two and three years old, had nuts on them.

This view shows men engaged in grafting these seedlings with the Paragon. This gives an idea of the size of one nursery.

This view shows one season's growth after grafting on the seedling. You see it is nearly five feet high,—one season of growth, grafted on a seedling two years old. It is then trimmed back, of course.

There is one grafted one year, bearing a nut at that point and two nuts at that point, and still others here. They are grafted.

Large trees can be transplanted, but not successfully. It is very hard to get a tree that is five or six years old to stand transplanting. It does not pay to transplant the larger trees. Occasionally they will live, but the others soon grow and catch up with them.

Seedlings from Paragon nuts—to be grafted with Sober Paragon chestnuts.

Paragon chestnut trees, 9 years after grafting on native sprouts.

Now we will go to the barn and get our horse and go back to the station at Paxinos. Good night. (Applause).

DR. MICKLEBOROUGH: Will you permit a question?

THE CHAIRMAN: We will.

DR. MICKLEBOROUGH: I would like to ask the Professor if the blight has appeared in the Irish Valley?

THE CHAIRMAN: If you do not mind withholding that question for just a minute, I want to make an announcement, and then we are going to throw the doors open to discussion. At the afternoon session you directed the Chairman to appoint a Committee on Resolutions, this committee to include the Chairman of the Conference. The Chairman requested that persons attending the Conference should offer suggestions as to who should be included on this committee. He did not receive as many suggestions as he would like to have had, but he did receive a good many, and every person who was suggested has been appointed.

The committee as made up, is as follows:

Ex-officio, Raymond A. Pearson, Chairman of the Conference.

Maine,	Charles E. Lewis.
New Hampshire,	Philip W. Ayres.
Massachusetts,	F. W. Rane.
Rhode Island,	Jesse B. Mowry.
Connecticut,	George P. Clinton.
New York,	G. G. Atwood,
	H. P. Marshall,
	George L. Barrus.
New Jersey,	Melville T. Cook.
Pennsylvania,	I. C. Williams,
	Harold Peirce,
	W. T. Creasy,
	Henry S. Drinker.
Delaware,	Wesley Webb.
Maryland,	J. B. S. Norton,
	William McCulloh Brown.
Virginia,	George A. Kerr,
	George B. Keezell.

West Virginia, ...	N. J. Giddings.
Ohio, ...	A. D. Selby.
	H. H. Bechtel.
North Carolina, ...	H. R. Fulton.
Tennessee, ...	J. W. Fisher.
Canada, ...	Dr. H. T. Gussow.

In a very rough way, it has been endeavored to have the number of members from the States indicate something as to the number of persons who accepted invitations to attend this Conference. The Chair will suggest that the members of the committee meet in the seats at the right of the Chair immediately after adjournment this evening, for the purpose of organizing. Now, according to the program, we are to have a general discussion. The presiding officer almost feels that he should offer you an apology, because he is not personally acquainted with all the persons who may wish to speak. He appreciates that there are some illustrious persons in the audience and that he ought to know them; but, as he does not know everyone, he will ask again that each person, on rising, whether known to the Chair or not, will first announce his name and the name of his State clearly.

The papers that we have heard are all before you for discussion. It is your meeting. The Chairman is your servant, and if you desire to have the course of procedure changed in any way at any time, it is your duty so to state. We will now hear the first question.

DR. MICKLEBOROUGH, of Brooklyn: My question was, Mr. Chairman, whether the *Diaporthe parasitica* had appeared in the Irish Valley.

PROFESSOR DAVIS: Yes; it has appeared there, but in that grove for the last ten years every sign of anything suspicious has been cut out, and the nursery inspector who went through the grounds found forty-four thousand and thirty-five trees that are free from it. If there were some signs that were suspicious, these trees were cut. If it is there now, it is practically under control, and it is very, very hard to find it. We are not certain always that it is there. There is one disease that follows up a fire that so closely resembles it that it is hard to tell it. It is sometimes doubtful. I have not, however, found any ascospores there this fall. The nursery stock shows nothing at all. The idea is to keep it clean, cut out everything, so we do not wait to see whether it is there or not.

DR. J. RUSSELL SMITH, of Pennsylvania: Mr. Chairman: before the cutters-out and anti-cutters-out begin taking up the questions of the afternoon, I want to speak about one point in connection with the recent lecture. Mr. Davis stated, in passing, that the waste land of this State would feed as many pigs as the whole State produces. We have lots of pigs, yet that assertion as to the possibilities of the waste land is understated.

Man, in looking at the botanical realm, began at the wrong end. When the human race looked at the hundred thousand species of plants, it picked out little measley grasses, with a grain or two of seed, from which it developed rye, corn and wheat, while here were the giants of nature, bearing hickory nuts, walnuts, persimmons, peaches, apples, and pears; yet very few of them have been improved, for the reason that, for the annual cropper, his grains permit of easy improvement and the big trees, with their slow generations, were very difficult to improve. Yet they are the potential heavy harvest yielders. Wherever we find land put over to tree crops, it yields several fold the annual crop. Chestnut-growing in Europe, as in Italy for example, is an established industry. Official reports show an annual production of chestnuts in Italy of thirteen bushels to the acre, and I know, by examination of the orchards, that they are not in any way in a high class condition or very carefully attended to in many localities. We average at least that, with the American standard of weight per acre, in the United States. I have not a doubt that if some of those big Japanese chestnuts were bred, selected, and hybridized, we could get varieties of chestnuts which would yield fifteen or twenty bushels per acre on the average, of first-class pig feed. Furthermore, it permits the use of land which is now entirely unusable for anything except forest, which is a very low grade producer of annual cash value. For example, to-day on the train between here and Philadelphia I saw a block of ground which covers twenty-two thousand acres, and is itself covered with stones. It is laughed at by the Lancaster county people, and it is rocky; but chestnut trees are sticking their roots between the rocks which cover the surface and reaching down into the good, strong clay beneath, and that twenty thousand acres of good, strong clay is more potentially productive than the tops of the Apennines, which are to-day yielding thirteen bushels to the acre.

So in the chestnut we have something more to consider in potentiality than mere timber. The time is coming when we will put one hundred dollars in the breeding of tree crops and get ten thousand dollars for the people of the next decade. (Applause).

DR. MERKEL, of New York City: Mr. Chairman: I would like to ask Mr. Davis a point that does not appear quite clear to me. Was the blight kept out of the orchard, or out of the entire valley and out of the surrounding country?

PROFESSOR DAVIS: It is in the valley, but just beginning, apparently, to appear. I have hunted through there and hunted days at a time without finding any evidence. Yet I have found evidences of what apparently is the genuine *Diaporthe*, as I saw it on Long Island; and I will say that I think I saw the blight on Long Island in 1897, or 1898. It was at the time when the Long Island road was building a log cabin near Cold Spring Harbor. Mr. Jarvis was the carpenter building the cabin, out of chestnut logs, and, when he pulled the bark off, under that was found what we recognize now as the chestnut blight. Mr. Jarvis and I discussed it, and did not know what it was. It was in patches; on some of the logs which were ten to fifteen inches in diameter, the patches were as large as my hat, and I do not doubt in some cases that the trees were girdled entirely and the trees were dying. That was at Cold Spring Harbor, and I also saw some of the same thing between Cold Spring Harbor and Huntingdon, and especially back of Huntingdon, through the hills around there. So I think it was in 1898 well established in those localities. Of course, I cannot prove that is what it was, but I have seen so much of it near Cold Spring Harbor that I think it is the same thing.

DR. MERKEL: Then, apparently, the clean-cutting in this case, unfortunately, is not a proof that the fungus can be kept out, because it has not been present long enough; is that the idea?

PROFESSOR DAVIS: Yes.

DR. A. K. FISHER, of the Bureau of Biological Survey, Washington: Mr. Chairman: I would like to ask Dr. Stewart what evidence he has to show that birds are important factors in spreading the disease? Dr. Metcalf made that statement in the Farmers' Bulletin, that birds were one of the important factors in spreading the blight, but, in private conversation with the doctor, he stated that he had no positive evidence; but that birds traveled here, hence, thence, and he thought it most probable. Now the very birds which are accused of carrying blight are the woodpeckers, which are more or less stationary in their life history; especially the downy woodpecker. There is no way of telling just how far a bird will go from the nest in which it was born, but there is pretty good reason to believe that the downy woodpecker never goes over four or five miles from its home. In fact, a woodland of a few hundred acres will hold a pair or more of birds, which probably live there throughout their lives. I know of one or two pairs near Washington that we are reasonably sure to see at any time of the year. It seems to me that wind and weather, which carry other forms of diseases, are very much more liable to carry the germs of this disease. When wind will carry heavy articles a thousand miles and, it is said, carry volcanic dust half way around the globe, it seems to me that we do not have to look to birds or mammals, or even insects, as the means of spreading the disease, when other known factors are present.

THE CHAIRMAN: Dr. Fisher asks Dr. Stewart what evidence he has that birds are responsible for carrying the chestnut tree blight.

DR. STEWART: The evidence is largely inferential. This should be considered: Many of the infections,—in fact, Dr. Metcalf states a majority of the infections,—occur in the tunnels made by borers. The borers are in those tunnels. Woodpeckers go after the borers. Spores are produced in enormous numbers right around those tunnels. It is inevitable that the woodpeckers will get the spores on their bills and on their feet and on other parts of their bodies. Those birds, when they go away, will carry those spores with them and leave them where they alight the next time. If they happen to fall in a wound of some kind and the conditions are favorable, the infection is going to occur. That is the kind of evidence. It is inferential. As for actually knowing that infections have resulted in that way, we have no evidence. Of course, it is exceedingly difficult, if not impossible, to get it. As to the migration of the woodpeckers, I have it on the authority of a competent ornithologist that some kinds of them do travel long distances.

DR. FISHER: There are certain forms of woodpeckers which go south in winter, but those are not the birds which are highly specialized which secure their food from the trees. They are birds which seek their food like the flicker, which feeds largely on nuts, and the redheaded woodpecker, which feeds quite extensively on grasshoppers and other insects, as well as fruits; but our woodpeckers, our native, resident woodpeckers, are rarely migrators. As to the injury to the trees, the nut gatherers, it seems to me, produce very many more wounds than the woodpeckers produce. They either jar the smaller trees with stones that break the bark and form places for the insertion of the germs, or they use climbers which injure the bark, and enter the wood very much further than the woodpecker's bill does.

MR. DETWILER: I have the report of a field agent who has been investigating the relation of birds to the carrying of disease. This investigation has been in progress only about a month, and the data is of an elementary character. However, there are two paragraphs which have a bearing on this subject. First, the field agent says:

"I can truthfully state that every blighted tree I have seen since I have begun this study, has had its bark punctured by woodpeckers, in most cases with scores of holes."

The other pertinent observation is:

"We were surprised by the large number of grubs we were able to find in infected trees. They seemed, too, to be generally distributed throughout the bark of the tree."

The inference being that the grubs attract the woodpeckers to the blighted portions of the tree particularly.

PROFESSOR DAVIS: Mr. Sober wishes me to extend an invitation to any of you, or all of you, to visit his place, when he will show you this grove in person. I forgot to mention it in the lecture, but he invites you to meet him at the Paxinos station at any time.

THE CHAIRMAN: How early are the chestnuts ripe?

PROFESSOR DAVIS: The chestnuts are ripe in the latter part of October.

DR. A. H. GRAVES, of New Haven: Mr. Chairman: There is one thing that has been overlooked here, and that is that the spores are very sticky in these exudations from the pustules. They all stick together, and the wind would carry these spores with great difficulty; so that the theory of the spores sticking to the feet of birds seems very plausible, for that principal reason. The spores might possibly be washed down the tree by the rain and mingle with the dust at the base of the tree; but, as is said somewhere by some authority, these chestnut trees do not usually grow in the dusty places. The spores that are washed down the tree would be covered up by leaves and there would be very little likelihood that the wind would carry them. I think, Mr. Chairman, the sticky nature of the spores should be considered in this connection, with the dissemination of the spores by birds and insects.

DR. W. J. GIDDINGS, of West Virginia: Mr. Chairman: I want to say something more in regard to the means of control of this disease; and I have one suggestion that has occurred to me during the afternoon and evening sessions: That is the possibility, in states where they do not feel it would be wise to make the inspection a thorough inspection, to send out men to do plot work,—I believe that is the proper term,—such as is done in forestry. They can pick out a certain small section where there are chestnuts, and determine the number of chestnut trees there, and the amount of infection. Not only that, but they can find out if there is old infection there. In that way we can find out whether there has been infection in America for a number of years, as has been suggested by some, and possibly get those states interested, if the infection appears to be spreading. In some places that I have seen lately there was evidence of the disease working on trees that were partly dead, but we should find out more about that while the work is going on.

DR. J. W. HARSHBERGER, University of Penna.: Mr. Chairman: Professor Stewart, in his communication this afternoon, discouraged the work which is being done by the Pennsylvania Chestnut Blight Commission in the removal of trees along the outposts of the disease. I would like to present my view of the problem, because I think it is largely a question of the attitude of the State of Pennsylvania toward these larger questions of conservation which have agitated the country for the past few years.

Pennsylvania is the Keystone State. She is so situated with regard to the other states of the Atlantic Seaboard that she occupies a central position, halfway between the North and the South. It would be to the lasting shame of Pennsylvania if she would let the opportunity pass of taking some means of attempting to check the disease. The states to the south and west of us, Ohio and West Virginia, Virginia and Tennessee and North Carolina, which are very largely concerned in this movement, would point to Pennsylvania as having let the opportunity slip of doing something to check the ravages of this disease. Two hundred and seventy-five thousand dollars seems a large sum of money to appropriate for the prevention of the destruction of property; that is, it seems a large sum to use in the combating of a single disease. Yet Pennsylvania is a wealthy State, and, if we take the many millions of dollars which are at stake, the amount of money which the State has appropriated is merely a drop in the bucket, and it seems to me that the money is well spent, because we are standing, as a buffer State, between the onspread of this disease from the locality where it started, and the States beyond. In the future, when we look back on the history of the conservation movement in the United States, this movement in Pennsylvania will be held up as an example of a patriotic movement of the entire people in an attempt to prevent the destruction of our native forests, which are going all too fast. So this movement, it seems to me from my standpoint, is one of the most commendable things which has been done by any State in recent years and, even if no direct result is reached, we can point with pride to the attempt which has been made to check the disease.

At one point there occurred to me a little story that was told in connection with the remarks of Professor Clinton this afternoon, when the paper of Professor Farlow was read. Professor Farlow suggested that the chestnut blight came from Italy. A friend of mine, a botanist in New York city, said that he had often noticed that around the settlements of Italians in the neighborhood of New York and Brooklyn and Jersey City, these smaller settlements that the Italians made outside the city, that the trees always died or were killed, and he thought there was some relation between the death of the trees and the settlement of the Italians nearby. So he suggested rather a curious name for this malady which attacked the trees—he said it was a form of "Dagoeatis." So perhaps, if Professor Farlow's views are correct, the trees which were killed on Long Island suffered from a form of "Dagoeatis." That, you may observe, has no scientific relativity in the discussion of this subject.

MR. CHESTER E. CHILD, President Lumber Manufacturers' Association of Connecticut: Mr. Chairman: I noticed on the map presented this afternoon that it appears that chestnut trees are practically dead in three-quarters of Connecticut. I noticed coming down on the train, between New Haven and New York, that there are a great many dead chestnut trees, and yet there remain a great many that are alive. I know that along the Connecticut River, where the blight is supposed to be working quite freely, that in a tract of timber which was sold on account of the blight being in it, it was stated that at least ten per cent. of the chestnut trees were affected. I know two men about sixty years of age who state that they are positive that they saw this blight twenty years ago, or something that looked the same as is shown in the blight to-day,—that they saw the same thing twenty years ago. I would like to ask, unless the information is reserved to be given us tomorrow morning, whether there is any data to show what the expense is to cut out, remove and take up the infected chestnut trees where the blight is known to be working.

MR. I. C. WILLIAMS: In answer to the gentleman's question, I would like to say that the Chestnut Blight Commission has no data at hand which will answer him directly. The work of the Commission has not been specificially directed to cutting out diseased trees, but has been in the direction of urging persons to do that. It has not been possible to follow that work sufficiently closely to make an approximation of just what that cost would be. The effort that is being made in Pennsylvania will be more minutely described to-morrow morning, and I do not feel that it would be fair to trespass seriously upon that paper this evening; but what evidence there is, and what knowledge we have on that subject, will be laid before you in the morning in the first paper.

Some of the speakers this afternoon seemed to be utterly appalled at the fact that Pennsylvania has thrown two hundred and seventy-five thousand dollars into a rathole. Now it may be of interest to this meeting at this time to realize that the whole work thus far accomplished by this Commission has been at an expense of twenty thousand one hundred and forty-three dollars. That leaves a considerable margin of the two hundred and seventy-five thousand dollars upon which we are privileged to go until the first of June, 1913. (Applause)..

This Commission is built upon business principles. It is not being dashed about wildly, like a potato in a tub, not knowing what it is doing or where it is going. It is trying to find its way. It may be that it will get lost in the blighted chestnut woods, but we are going to make an honest endeavor to get out of the woods. Every known method, and a lot of methods that are not known and about which we heard a good deal this afternoon, will be tried. If there is any virtue in them, they will be followed to a finality. If there is no virtue in them, we want the world to know it,—the sooner the better. The mere fact that somebody believes that something cannot be done is going to have mighty little weight in the work of this Commission. (Applause). We do not care a rap what someone's belief is. If he has any facts to bring to us and lay before us, we are willing to accept them. We want facts; we want knowledge. We have heard a great deal about scientific inquiry. I understand that science is the pursuit of knowledge, and that its business is to get facts. Science simply describes. It has nothing to do with explanations. Therefore, if science will describe to us the things that we are trying to learn, we will be greatly indebted to science, and we by no means are in a position, nor do we wish it to be so understood that we attempt to turn our backs upon scientific inquiry. The truth is that this Commission wants all the facts it can get. It wants the help of every scientist in the land who is interested enough to pursue a line of work and make deductions therefrom that are useful in a work of this kind. We want to go hand in hand with everybody who can lend an iota of strength to this work; but we do not care to join hands with those who see simply gloom and failure, and are unwilling to make any decent effort to determine whether or not a thing can or cannot be done. The experiments that are being made by the Commission are for the purpose of finding out. We heard a great deal about the ineffectualness of the cutting-out method of combating this disease, or checking its spread. I do not know upon what foundation or upon what premises these conclusions are drawn. We have attempted to follow the progress of this inquiry and the knowledge on the subject as closely as possible, and yet gentlemen tell us that it is absolutely ineffectual. Now I would like them to tell us why it is ineffectual, and how much cutting out they have done, and what real knowledge they have derived from that kind of work. If it is going to turn upon someone's opinion, then I would like this meeting to believe that probably one man's opinion is as good as another's. If it is not, let us find out why. I would like to ask Mr. Stewart, in respect to one sentence in his paper this afternoon, which you will remember was one continued negation, I would like to ask him to tell us why in that paper he broke away from the negative attitude and, in the very closing moments, took a positive stand in that he recommended the restriction of the movement of nursery stock. Now if there is no use in cutting out a diseased tree, if there is no real effectual value in doing any work of any kind, if we are simply to sit down and let things go and take their course, if we are going to throw up our hands in impotent helplessness and say "It is the will of Allah," why would he restrict the movement of nursery stock? If there is any real reason for that, let us have it. I do not remember that the Professor stated his reason. That is one of the questions his paper raised in my mind. I do not wish to take more of your time, because these ought to be only short discussions. If Professor Stewart would be good enough to tell us why he thinks we ought to restrict the movement of nursery stock and let everything else go wide open, I for one would like to know it, and I believe there are some others who would be interested in hearing it. (Applause).

DR. STEWART: I will answer that question in this way: That this diseased nursery stock may transmit the disease long distances. In that way the disease may take long jumps, clear across the continent.

MR. WILLIAMS: I understand from the Professor's paper that birds likewise take long jumps. What will he do with that side of the case?

DR. STEWART: We can do nothing there.

MR. A. THALHEIMER, of Reading, Pa.: Gentlemen, I rise to protect the woodpecker. (Applause). I own probably in small woodland patches, two hundred acres of chestnut. Since this blight question first came up, I have gone through nearly all my trees and I have not found a single tree that was diseased, with the exception of some near the city. I have about one hundred and twenty acres near the city, and of course, the boys,—maybe some of you have done that,—want to get the chestnuts. They bump the trees and some of them are bruised in that way. But my section is full of woodpeckers. They are not immigrants; they are stationary and they have not destroyed or infected any trees. I think it takes a long time to get at the bottom of it, and find what really is the cause. I desire to inform you of a subject in which I took a deep interest,—one which leads to this matter, During the war, in traveling through Virginia or through Maryland, you all know how scrub oaks are scattered over all that country. A scrub oak is a very small tree and does not bear any fruit at all. I often wondered where they came from, not having been planted there. In going from here to Washington, or going anywhere, if I knew of any farmer who lived in that neighborhood, I would ask him what he knew about it, and none of them could tell me. I was anxious to know and see if I could not get that information. I wrote to the Forestry Department at Washington, and could get no definite information there. One time in moving from one house to a new house and in rearranging my library, I got hold of a book. The library had belonged to a friend of mine, a lawyer, and I got some of his books in remembrance. I looked through those books and I found a book of birds, and among them I found a picture of a bird called a "tree planter." It gave a description how that bird traveled from Maine to Florida, traveled from the north to the south and migrated again north, and they had a committee,—I do not know whether it was a Committee of Thirteen or not,—but they had a committee which would carry the nuts and plant them for food on both ways. Then, down South, they shoot these tree planters and utilize them for food, and I suppose there are not enough coming back to pick up all the fruit which is planted, and that this is the way it grows up into scrub oaks. (Applause).

PROFESSOR W. D. CLARK, Pa., State College: Ladies and Gentlemen: I came here to-day to this Conference because, being a forester by training and by profession, I am vitally interested in any movement which seeks in a practical way, to control or to eradicate the chestnut blight disease. I fully appreciate the value and importance of the chestnut tree, both as a timber producer, to enhance the aesthetic value of the landscape, as a shade tree and as a nut producer, and I heartily favor the pursuit of scientific studies and experiments in order to determine whether or not there is a practical way, within the means of human agencies, either to eradicate or control this disease. I am, however, very solicitous lest, on account of the obviousness of this disease, the directness with which it works, the quickness of its results, and the generally common knowledge of the disease, we will become blind to two other diseases of trees which, on account of their remoteness, their complex character and their slow, insidious way of working, we are apt to forget. I refer to the disease known as an unjust and unscientific manner of taxing timber lands, and to the disease known as forest fires. Here are two diseases which threaten to destroy not only chestnut trees, but all of our forest trees. These diseases threaten not only to destroy our standing trees but to prevent, or make useless, the planting and growth of any forest trees. These diseases are not well-known diseases which are beyond our control. They are entirely within the control of human agents, and I would be grateful if I could impress upon the mind of every member in attendance upon this Convention that if we could only control the forest fires and bring about a just, scientific, and uniform system of taxing forest land, and then go ahead and plant trees, trees immune from this dreaded disease, pine trees, oak trees, hickory trees, poplar trees, valuable timber trees, we would have so many timber trees flourishing in the State of Pennsylvania that it really would not matter a very great deal if we had no more chestnut trees. We could possibly get along without them. (Applause).

MR. F. B. JEWETT, of Susquehanna county, Pa.: Mr. Chairman and Gentlemen: I came to the City of Harrisburg to-day not particularly to attend this Convention; but, when I arrived here and the programme was thrust before me, every other item of my business stopped, and I have attended your meetings and have been very much interested.

The first dollar that I ever remember of having in my life was derived from the chestnut tree, half a century ago, when, as a little boy, I picked up the chestnuts. I have been very much interested in every phase of the discussion, because, like the gentleman over here, I have several acres that have chestnut trees on them. In this evening's lecture there was thrown on the canvas a view of the harvest of that chestnut orchard in Irish Valley, near Shamokin, and in the picture I noticed the green burrs were harvested. The question that I wish to ask, if Professor Davis is present, is, how they could get those green burrs off from the trees without injuring them? All those that have knowledge from experience know that it is almost impossible to get a green burr from its native branch until the frost comes and kills the connection between the burr and the branch. I remember distinctly a few years ago, perhaps fifteen, I made my first shipment of chestnuts to New York. I sent them to a commission merchant and I was surprised, although I knew that it was early, to receive back in two days' time returns of twenty-four dollars per bushel for that shipment of chestnuts, with this advice: "Ship chestnuts as fast as possible. Your shipment was the first that came into the City of New York this fall." I tried to get another shipment, but I could not get those burrs open, and the last shipment I made to New York that same fall brought me only $2.50 per bushel. I agree with the gentlemen that have read these very interesting papers, so very interesting to us, indeed; but so far as the spread of this disease is concerned, I am on the side of the woodpecker, because the woodpecker has been my friend from my boyhood up, and I have learned to love the music of his beak. But let me tell you, gentlemen, a few years ago I was out in Kansas, and on that wild prairie, a heavily loaded team had passed over in the spring. It was September when I was there, and across that unbroken prairie were two distinct tracks and sometimes, when the forward wheel had not run exactly straight, there were four tracks; and in every one of those tracks was a thrifty growth of sunflowers. Can you tell me how those sunflowers came there? If you will tell me that, I will tell you what spreads the fungus on your trees. It is nature. You know we all of us love up-to-date stories; we do not care about the old "chestnuts" so much. But in this case the chestnut is very important and, in closing, I want to speak a word of commendation for Mr. Williams and for the men who so wisely voted the appropriation of two hundred and seventy-five thousand dollars to this work. I appreciate it. Ever since I have been a boy, it has been grumble, grumble, grumble about appropriations and graft, and so on. New York State can sympathize with us somewhat in the matter of Capitol graft. You remember you got through with it in Albany. We got through with it without as many years of experience as you did, but I remember very well, after the old Capitol burned here, that five hundred and fifty thousand dollars was appropriated. Why, that was a big sum; but you know how that "chestnut" grew, and we got out of it with thirteen millions. I am very thankful that the "chestnut" of the old appropriation is improving; that we have the two hundred and seventy-five thousand dollars appropriated, and that we are getting out of it with about twenty thousand dollars as far as it goes now. So I think that the State of Pennsylvania has done finely in taking the initiative in this work. I pay tax on timber, and I want to pay tax on timber-land. It is fair and square that we should pay it, and let the gentleman that complains of it remember that none of that tax goes into the State Treasury.

THE CHAIRMAN: We wish to hear Professor Clark's reply to the question, but there are a number of others who are prepared to make remarks. The Chair would ask if you have any instructions which you would give to govern our discussion from now on. Do you wish to limit the length of the remarks? I will entertain a motion, if it is your desire.

MR. E. A. WEIMER, of Lebanon, Pa.: Mr. Chairman: I would suggest that we limit our remarks to the chestnut blight. I would also suggest that the speakers be very careful not to bring out facts without careful consideration. The man on my left here talked about the spores being sticky. He did not consider that the spores were sticky only during a certain portion of their lives. Another man on my right talked about the woodpecker, but he did not consider the fact that the woodpecker does not pull out the grub with his feet, and that is about the only place he could get the spores on. We want to be very careful when we are going to get at any facts, not to hunt up facts to base our arguments on, but to base our arguments on facts. I suggest in the future that we deal only with questions dealing with chestnut blight, and accept Mr. Sober's invitation to visit his orchard when the chestnuts are ripe.

DR. MICKLEBOROUGH, of New York State: Mr. Chairman, just a word with reference to the spread of the disease by the spores: During the summer the conidial spores, those thread spores which have been explained to us to-day, are produced in myriads upon the diseased tree. The water, the rain will readily dissolve those little sticky, pasty threads and, when they are dissolved, it takes about eight or nine thousand, put end to end, to measure an inch. They are exceedingly small microscopic objects and they are readily carried by the wind, and not very much by the woodpecker. That is my judgement of the case. The wind will carry those very readily, and sometimes to a considerable distance. I think we can account for the spread of the disease, the carrying of the spores, by the wind. Railroads are sinners to a certain extent in this matter. The trains, as they sweep through the country, will create a great deal of draft, and you will notice along certain main lines that the disease has spread with a great deal of certainty and rapidity. Now these spores, when they are lodged upon a chestnut tree, are washed down by the rain, by the water, by the dews, and you are very apt to find the disease attacking the tree in the fork of the limb. You will find it there perhaps more frequently than any other place, and there is a good place for the entrance of the spore.

Now, to digress from that for one moment, I think, Sir, that Pennsylvania has done a magnanimous and great thing, and I was very glad to hear from Deputy Commissioner Williams. We were told by the Governor that the value of the chestnut stand in this State, I think, was forty millions dollars. The Legislature of the State of Pennsylvania did not appropriate one per cent. of that which is endangered by this chestnut blight. In fact, the Governor told us the estimate was based upon fifty cents per tree. Indeed, if the statistics were carefully made, Pennsylvania has not appropriated more than about one-half of one per cent. to protect the value of a great chestnut growth. (Applause).

DR. GIDDINGS, of West Virginia: Mr. Chairman: I would like to raise some questions in connection with Dr. Clinton's statement. I infer two things from it: One is that the control of the gypsy moth in Massachusetts was not a valuable expenditure of money; another was that, by leaving off the control of the peach yellows in Connecticut, it was to the advantage of that State. I would like to ask if those inferences are correct and if Professor Clinton has data to show that the dropping of the peach yellows inspection has been to the advantage of Connecticut.

THE CHAIRMAN: Professor Clinton, can you answer those questions in a word or two?

PROFESSOR CLINTON: I do not know that I made the statement that gypsy moth work in Massachausetts was not effective. I said it meant a long fight and a continuous fight. This chestnut blight, from the re-infection, would make the fight a continuous one. You could not do it up and leave it there. You would have to keep at it forever, provided the material continued. Regarding the peach yellows law, my statement was that they dropped that. The reason it was dropped was because it made so much trouble with the farmers, by going into their orchards. You would find that same difficulty with the farmers in Pennsylvania that you would in Connecticut.

DR. MERKEL, of N. Y.: Mr. Chairman: I have been on my feet continuously ever since Mr. Williams spoke, and was about to give it up. Some of the points I wanted to bring out have already been brought out. However, I want to thank Mr. Williams. I want to thank the great State of Pennsylvania for passing that law. Pennsylvania has shown all the other States in the Union what it is to pass an unselfish law. If we could only have a Federal law that would be as broad as the law of Pennsylvania ought to be and could easily be made, by simply inserting the words after "the chestnut tree blight," "and any other fungous or insect pest," we would have no trouble with our fungous or insect pests after a certain length of time. Sometime ago I wrote that only when we considered a tree that is dangerously infected with an insect or fungous pest as dangerous as a person infected with smallpox or as a rabid dog, will we get rid in our forests of insect and fungous pests. I was very glad to hear that Mr. Williams and the members of the Commission have not become discouraged by the large amount of cold water that has been thrown on their plans. I am sure that the two hundred and seventy-five thousand dollars that the State of Pennsylvania has appropriated will never be missed, even if no beneficial results are obtained; but that the everlasting shame that the State of Pennsylvania would suffer if she made no attempt to save her chestnut trees, should be enough not to discourage any and all citizens from unselfish effort for their fellow men.

GEORGE G. ATWOOD, of New York: Mr. Chairman: There is a little desk in Albany that has been open for about a year, and in that desk is about everything that has been said, or thought, or dreamed of, relative to the chestnut bark disease. We have had the advice of our friend Stewart, who thinks as Dr. Clinton does, along the same lines. What they have stated here to-day we must accept as the honest statement of men who know enough to make such statements. They know what they are talking about, because they have investigated this disease and they have investigated similar diseases, so that we must take what they say with a great deal of confidence. They have been talking to the point whether chestnut bark disease could be controlled or eradicated. If I were to ask either one of those gentlemen what they would do with a chestnut tree in their own yard that was infected with this disease, they would probably say, "Cut it out." That gives us the keynote of what I think should be done wherever there is a possibility that single trees, or small infections, can be removed. That seems to be the simple thing, and the proper, sensible thing to do. It may have to be done by the force of statute, but a great deal can be done by advising owners of chestnut trees that become slightly infected, asking, urging, forcing them in every way you can, to cut that timber while it is still alive and save it. If that were done in the State of Pennsylvania, their entire two hundred and seventy-five thousand dollars would be well expended. We are up against a proposition in New York. We have probably two-thirds of our chestnut timber still intact, and we want to save it if we can. Now why should we not go out in the borders and carry on a missionary work, or something stronger, and see if we cannot cut a dividing line? Let scientific men go on with their investigations. We need all the advice that their broad knowledge can bring to us; but the other thing is a practical thing, a thing that is at our doors, and a few hundred thousand dollars spent now may result in a saving of that valuable property lying all to the west and south of us. (Applause).

DR. J. RUSSELL SMITH, of Pennsylvania: Mr. Chairman: Professor Clinton advanced a very interesting point; that it was the dry weather that made these trees amenable to blight. The evidence was that people in Connecticut thought the dry weather had killed other trees that died, if I remember the gentleman correctly. It seems to me that that matter of the drought would be much better tested by showing that, in localities of low, moist, abundantly watered soils, the trees had not had blight. There must be many such localities of chestnut in Connecticut where even the recent droughts of past years have not subjected many trees to a dearth of water.

THE CHAIRMAN: Can you answer that in a word, Professor Clinton?

PROFESSOR CLINTON: I was giving the various things that weaken trees. Drought is one of them. We have had severe droughts in Connecticut, and I hold that the situations that have been the most moist have been the regions that have suffered most from the drought, because when a tree is trained to live in a moist place, during a drought it will suffer more than a tree on higher land which has been used to dry soil.

MR. CRANMER, of Pennsylvania: Mr. Chairman: While still well on the sunny side of life's meridian, I distinctly remember, as a barefoot boy on a little farm on the eastern seaboard of New Jersey, the advent of what was known then as the Colorado beetle, commonly called the potato bug. As a little boy about this high (indicating) I was put in between the rows to catch those fellows and get them off the vines. Naturally they appeared on the vines of other farmers in that section, and many of the old fellows shook their heads in despair. They said "We will never raise any more potatoes. The potato crops are done in America." My father did not feel that way, although I would have been pretty well satisfied if he had. He made me hunt potato bugs, and then we later began to use the London purple and the Paris green, and so forth. We are still raising potatoes in New Jersey and other places throughout the United States, with success. We still have specimens of the Colorado beetle in the United States, but we expect to go on raising potatoes, and doing our best. So it seems to me, gentlemen, in relation to this chestnut bark blight, this chestnut tree disease, we are not to hold up our hands in despair and listen to too much of the expert advice and opinion that falls from the lips of our university men. I come from a university myself, and I dare say that. We have heard much to-day. There have been numerous expressions of opinions and of guesswork. We have yet to hear from any person who tells us what he has done in a practical way for the cutting out and eradication of this disease in any extended form and over any very large tracts of land. I am unfortunate in the fact that my chief, who is custodian of all the property at Lehigh University, is not able to be here tonight, Dr. Henry S. Drinker, whose name appears in the roster of officials of the American Forestry Association, and who is president of Lehigh University. He is custodian of a large tract of land, adorned on its campus with many primeval chestnut monarchs from eighteen inches to three feet in diameter, giants of the old forest tract. In the rear of this campus we have some two hundred acres covered with a coppice growth of chestnut and various hardwoods of Pennsylvania. We were exceedingly fortunate, some years ago, in having heard from the lips of Mr. C. W. Levitt, an eminent landscape engineer of New York City, the warning that our chestnut trees were likely to be visited with an insidious enemy, which would destroy them all. It was not, however, until the summer of 1908 that I as custodian of those grounds, saw any unusual discoloration on either the bark or foliage of a chestnut tree, except that which seemed to be natural in the decay of any specimen of deciduous trees. During that summer I saw, on a small chestnut, this unusual discoloration and the appearance of small red or brown pustules. This tree was immediately cut down and portions sent, after all other portions were burned, to Mr. I. C. Williams, Deputy State Commissioner of Forestry of Pennsylvania, who placed it in incubation and pronounced it the chestnut bark blight, or disease. I am not familiar with the scientific name. I was then cautioned by the president to be careful, observant, and vigilant, and to watch for any recurrence of this thing. To hasten from that time on, through the summer of 1910, when it appeared, and in 1911, we have done exactly as was recommended to us by Mr. Williams and by Dr. Rothrock, who visited us during this period of time and walked through our coppice grove of chestnut. I am *not* able to say, after extended experience along this line, that all trees which are treated by severe pruning, which have been touched by this blight, may be saved. We do know, however, that we have tided trees over one year and two years, that were striken with the blight, by removing all such portions as were affected by it, treating them with a composition of coal tar, diluted slightly with spirits of turpentine, so that it might be easily applied with a brush, using it both as a fungicide and insecticide; using it on bark, wood, and broken places. Thus far we feel that our work has been successful along this line. Last year it is true we cut out forty trees, all of them less than ten inches in diameter. We have as yet lost but three trees in all this large tract of land that were more than this size. We have, as I said before, saved many trees by severe pruning and trimming, cutting out all diseased places and treating them with this solution of coal tar, ordinary coal gas tar; so that we feel it is worth while to do something along this line. We do not feel like the dear old lady who stood up on the banks of the Hudson River when Mr. Fulton was about to experiment with his steamboat, and said, as it was puffing and blowing, "It will never move, it will never move," and when the ropes were cast off and the boat moved out into the stream, she said "It will never stop, it will never stop." We hope this will be a successful work, prosecuted for the highest end by this worthy and able Commission of the State of Pennsylvania, and we, as representatives of Lehigh University, Dr. Drinker, Professor Hall, of the Department of Biology, and myself as custodian of the grounds, stand ready to help you with anything we can do for you. We stand ready to listen to what you say to us, stand ready to take your advice as a Commission, and go with you hand in hand along this line. (Applause).

DR. H. S. REED, of Virginia: Mr. Chairman: Regarding one of Dr. Smith's questions, we have a few observations upon the chestnuts in Virginia. Reference has been made this afternoon to the blight in Virginia. It has been found there in some instances,—probably there is more there than we think,—but we have observed this that wherever it has been found, that it was at an altitude of less than 800 feet. Most of the chestnut timber that is healthy, and the greatest majority of it, is at an altitude of more than a thousand feet, and on none of that which is more than a thousand feet above the sea level has any trace of the blight been found; but it is found occurring at altitudes less than 800 feet and in regions where the rainfall is great.

THE CHAIRMAN: On account of the particularly interesting address that we heard from Professor Davis to-night, the Chair thought that there would be some questions directed to him, but it seems that the discussion has gone along on somewhat different lines. There is one question however, which Professor Davis has not answered, with reference to gathering the crop while it is still green, if I remember the question. Will Professor Davis kindly answer that question?

PROFESSOR DAVIS: In September, when the burrs are green, you can shake them from the trees as you can apples, and the entire crop has been harvested without frost. When they are shaken off, they are allowed to dry a little while. When you shake them off in September they color up brown and the frost, I think, has nothing to do with it.

THE CHAIRMAN: This note has been sent to the Chair: "Will you please ask Dr. Spalding, of the United States Bureau of Plant Industry, what has been done in the vicinity of Washington, D. C., to prevent the spread of the chestnut bark disease?" Of course, it will be impossible now to go into that subject at length, but if Dr. Spaulding will tell us, in a minute or two, something of what has been accomplished, and in a word, the main features of the method, I feel sure it will be appreciated.

DR. SPAULDING: I am not very familiar with the work that has been done in the vicinity, because I have been working on other problems most of the time during the last few years. I simply know, in a rough way, that the method of cutting out had been practiced wherever diseased trees have been found and, as far as I know, that has been fairly successful. There are cases where spores have been found on the stump of an old tree. In many cases, I am sure from Dr. Metcalf's statement, no special precautions were taken to remove the diseased chips, or even to remove the bark from the stump, so that certain cases might very well be expected to have the fungus at this time.

THE CHAIRMAN: It seems now, the time being half past ten, that we had best do one of two things: either take a recess until to-morrow morning at sharp nine o'clock, or decide to spend the rest of the night here and finish this subject The Chair learns that Mr. H. P. Marshall is not here and therefore cannot serve on the Committee on Resolutions for New York. He will ask Mr. Merkel to take his place. This Committee will meet at the right of the Chair immediately after adjournment, only for a minute or two.

MR. THALHEIMER, of Reading, Pa.: Mr. Chairman: I was listening to the gentleman from New York. I think he has the proper theory, that is, that the spores are spread by the wind blowing them from place to place, and just according to how the wind blows at a certain time. Take the Orlansa tree. It is called Orlansa in Latin, Lancewood in English and Paradise tree in German. It is a tree like a sumac. There is probably one out of fifty that has a seed on it, like grapes, and at certain times of the winds they are blown for thousands of feet. Some may land between the mortar, or between the bricks, of a building, and a tree will grow there. If you go up Third street from the ferry after you land there, you will see here and there and everywhere in the front yards a nice little tree growing there, if they have let it grow. You have all seen that, especially in Washington. That seed is just like a leaf, and it is as sharp as a knife, and the seed is encased in that leaf and that gets into any crevice. I have had some taken out of my wall that grew there, and they would grow to a good size. I have seen them grow out of a brick pavement, where there was not any sweeping or any work done around.

THE CHAIRMAN: As President Drinker cannot serve on the Committee on Resolutions, Mr. Green is asked to serve in his place.

We will now take a recess until nine o'clock to-morrow morning to meet again in this room.

(Adjourned until Wednesday, February 21, 1912, at 9 o'clock A. M.)

MORNING SESSION.

Wednesday, February 21, 1912, 9 o'clock A. M.

THE CHAIRMAN: The meeting will please be in order. We have a busy session before us and in a few moments opportunity will be given for the presentation of such business as ought to come up, and then we will proceed with our programme. It has been suggested to the Chairman, and he very heartily approves of the suggestion, that we should start our morning session with a good taste in our mouths, which would be provided by hearing a few remarks from our old friend, Dr. J. T. Rothrock, who is recognized as the father of Pennsylvania forestry conservation, and, if there is no objection, the Chair will change from the established order to call upon Dr. Rothrock for a few remarks at this time. (Applause).

DR. JOSEPH T. ROTHROCK: Mr. Chairman and Gentlemen: This question of chestnut blight, although of course it is a portion of the forestry work of the State, is somewhat foreign to the line in which I have been most actively interested. I would say, though, that it was my good fortune in 1880 to spend nine months in the laboratory of Professor DeBarry at Strassburg, Germany. DeBarry at that time was recognized as the leading fungologist of the world. I departed from the faith that was in me then, not because of lack of interest in the field, but because my eyesight gave out, and I drifted then into forestry. So that you will see that I am not wholly without a knowledge of the rudiments of this work that you are engaged in.

Now when a contagious disease breaks out among men or among domestic animals, the first thing that is done is to limit, as far as possible, the spread of the infection, or of the contagion. Meanwhile, the laboratories of the land are doing all they can to find out the causes and what is to be done to end the trouble. The two lines of work are progressing side by side. When the Peronospora invaded the vine-growing districts of France and Germany, the laboratories of the Old World were busily engaged in finding out how the fungus that produced the trouble in the wine-growing districts found its access into the vines. I had the pleasure of having Professor DeBarry point out to me himself the first spore that I ever saw, sending its germ threads down into the tissue of the plant. I do not know who discovered the Bordeaux mixture, but I do know that that was very influential in limiting the spread of the disease and restoring the wine industry to its normal and natural condition. I do not believe, however, that it was discovered by our scientific friends; but they did discover the life history of the disease, which was a most important, permanent contribution to the vine-growing, wine-producing industry of the Old World. Now it seems to me that we are in a somewhat similar condition here. We have with us a pest, which is destroying our forests. It seems to me that the proper thing to do is to destroy every spore-producing specimen that we know is actively engaged in disseminating and widening the area of the disease. That would seem to be one commonsense remedy to adopt. It is along the line of what we know in the treatment of contagious and infectious diseases. In the meanwhile, let our laboratory men go on with renewed energy and keep up the work. I think that every State in this Union ought to have a laboratory of well equipiped scientific men, men who follow their work not for their salary but for the love of the work. Those are the men that give you the permanent results. I would like to see every State in this Union have a laboratory well equipped and well provided with all that is necessary to produce effective work. Mark Twain on one occasion made the remark that they had a queer way of dealing with criminals out West. He said "They hang them first and try them afterwards." Now it seems to me that we have the known criminal with us here. Let us hang him first and then let our laboratory friends try him in the meanwhile. (Applause and laughter).

MR. HAROLD PEIRCE, of Pennsylvania: Mr. Chairman: I move that at 11.30 A. M., the Conference take a recess until two o'clock, and at that time, 11.30 A. M., the Committee on Resolutions meet in the House Caucus room. I would also move that no resolutions be received after 10.30, and that up to that time, all resolutions that are desired to be brought to the Committee on Resolutions be sent to the desk, to be presented to the Resolutions' Committee.

Seconded by Dr. Russell Smith, of Pennsylvania.

THE CHAIRMAN: The motion is that we adjourn this meeting at 11.30, to reconvene at 2 o'clock, and that at 11.30, the Resolutions' Committee meet in the House Caucus room, which is below this room, on the main floor, and that no resolutions be received after 10.30 this morning, and that all resolutions should be presented at the desk during the next sixty minutes. You have heard the motion, which has been seconded. Are there any remarks? If there are no remarks, we will call for a vote.

The motion was put and unanimously carried.

MR. PEIRCE: I have a letter that has been sent me, that I think it would be well to have read.

THE CHAIRMAN: Let the Secretary read the letter.

Secretary Besley read the following letter, written upon letter head of the Harrisburg Board of Trade:

"Dear Mr. Peirce:

It occurs to me to suggest that it might be well to have Mr. Pearson call the attention of the chestnut tree bark disease conference to several things relating to the stay of the delegates in Harrisburg.

1. The Capitol Building, itself easily one of the ten great buildings of the world, with its appropriate and memorable art decorations, is an exhibit worth looking at. There are courteous guides at hand to explain to visitors its features.

2. The State Museum, housed in the Library building, just south of the Capitol building, is almost unique in character. It presents an epitome of the life and manufactures of Pennsylvania.

3. The City of Harrisburg is a civic exhibit well worth the attention of any visitor to the conference. It has in ten years made more progress, in proportion, than any other city in the United States, toward true civic improvement. Its two-mile-improved water front, open to the public; its 55 miles of paved streets; its great park system, including 749 acres, which last

year cared for more than a million and a quarter visitors; its notably efficient and pleasing water filtration plant, open to visitors, on Island Park; its dignified city entrance, at Market Street and the river,—all make it worth a look from those in attendance upon the conference.

I have instructed the secretary of our Board of Trade, Mr. James A. Bell, to present this to you and to proffer his assistance in connection with any information about the city.

Congratulating you on the already apparent success of your splendid work, and on the monumental and unique character of this conference, I am

Yours truly,

J. HORACE McFARLAND,

President."

THE CHAIRMAN: The Chair would suggest that if President McFarland will kindly do so, it would be most agreeable if he would be in the ante-room at the close of this session, to meet delegates who desire to secure further information or suggestions from him. Certainly his letter is much appreciated. Is there further business to be attended to at this time? One of the first rules of physics is that two objects cannot occupy the same space at the same time. The Chairman is reminded of this rule when he looks at the programme and reflects upon several requests that have come to him for other matters than those mentioned on the programme to be presented in the short session of this morning. The fact is, we have now just two hours, and a programme which easily could occupy double that time. If members wish to give instructions for the guidance of the proceedings this morning, it might facilitate matters.

MR. SHEPPARD: Mr. Chairman: I move you that the Chairman be empowered to confine all discussions to three points upon this morning's programme, and that all talks on these subjects be limited to three minutes.

Seconded by Mr. Merkel, of New York.

THE CHAIRMAN: The motion is the discussion on this morning's session shall be confined to the three points on the morning programme. It woud save a little time if Mr. Sheppard would tell us just how he defines those points, there being four papers.

MR. SHEPPARD: First, the Pennsylvania programme, the third, the chestnut blight and the future of the forests, and the fourth, the chestnut blight and constructive conservation. The second item (reports of the State Foresters), is one that would be so general that it seems to me we could hardly get very far with it.

THE CHAIRMAN: It is moved, then, that we confine discussion to those three subjects, remarks to be limited to three minutes, which, of course, would govern except by exception being made by unanimous consent.

PROFESSOR CLINTON, of Connecticut: What is this? A Pennsylvania Conference, or a Conference of the United States?

THE CHAIRMAN: Are there other remarks?

PROFESSOR HOPKINS, of Washington: It might be well, Mr. Chairman, to state some additional subjects that are to be presented this morning, to be taken into consideration along this line. We would like to discuss the insects before we are through.

THE CHAIRMAN: There have been numerous suggestions that we should give some attention to insects.

MR. PEIRCE: I think it would be well for that resolution to carry this morning, not in order to cut off discussion, but because the programme this morning was formed for constructive work and for utilization; and I think it would be well if wewould carry out that line this morning. An opportunity will be given this afternoon, I should think, for all other subjects to be presented. If we confine ourselves to the one thing that is specially mentioned in those three subjects, I think we can get more effective work that if we try to have a diverse discussion this morning.

THE CHAIRMAN: If you observe the subjects on the programme I think you will find that they would not confine discussion to Pennsylvania questions. Are there further remarks?

MR. CASSELL, of Pennsylvania: Do you think it might be well, under the circumstances, to make No. 2 on your programme No. 4? Then, if we have time for it, it could come up and some of our friends, who have come prepared to report under that, would have their opportunity.

THE CHAIRMAN: Do you offer that as an amendment?

MR. CASSELL: Yes, sir.

THE CHAIRMAN: An amendment is offered, that question No. 2 follow No. 4. Is the amendment seconded?

The amendment was seconded by Mr. Peirce.

THE CHAIRMAN: Do you wish to take any further action, or suggest any further action? If not, we will put the amendment first.

The amendment was put and carried.

THE CHAIRMAN: Now you have the original motion as amended, that discussion be strictly confined to the three subjects. Is there any desire to open up the insect question this morning? If so, we should hear another amendment.

PROFESSOR CLINTON: I understand that Mr. Hopkins has something to say, and I, for one, should like to hear what he has to say. I move that, at sometime at least, we hear from him. I do not care whether it is this morning or this afternoon.

THE CHAIRMAN: The Chair would be glad to entertain an amendment.

PROFESSOR RANE, of Massachusetts: It seems to me that we are losing a good deal of time on these amendments. I should like to hear the papers, and then also hear Professor Hopkins on the insect question.

MR. PEIRCE: I would move that Professor Hopkins present his paper at two o'clock this afternoon.

The motion was seconded.

THE CHAIRMAN: The Chair has one motion before the House, to confine the discussion to three subjects and remarks to three minutes in each case.

(The motion was put and carried).

THE CHAIRMAN: Mr. Peirce makes a motion that Professor Hopkins be requested to speak on the insect question at two o'clock this afternoon.

The motion was seconded by Mr. I. C. Williams, was put and duly carried.

THE CHAIRMAN: Having executed the criminal, we will proceed with the trial, and ask Mr. Hopkins if that will be agreeable to him.

PROFESSOR HOPKINS: I had planned to leave for Washington directly after dinner, at least at three o'clock, and I am afraid that will interfere with my plans; but, if it is the wish of the meeting, I will submit.

THE CHAIRMAN: It would be very kind of Professor Hopkins to remain over. It seems almost the unanimous wish. We will proceed with the morning programme, the first paper being "The Pennsylvania Programme," by the first secretary of this Conference and the executive officer of the Chestnut Blight Commission, Mr. S. B. Detwiler. (Applause).

THE PENNSYLVANIA PROGRAMME.

By S. B. DETWILER, EXECUTIVE OFFICER, PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION.

Mr. Chairman, Ladies and Gentlemen: Although a determined effort to control and eradicate the chestnut bark disease was made by a number of public spirited citizens, residing in the vicinity of Philadelphia, it soon become evident that they were unable through individual efforts, to save their valuable chestnut trees from destruction. As a result, Pennsylvania took up the fight against this destructive tree disease in earnest, realizing the necessity for prompt and vigorous action on the part of the Commonwealth. A Commission was appointed in

June, 1911, for the purpose of thoroughly investigating the chestnut blight, to devise and apply ways and means through which it might, if possible, be stamped out.

In 1909, according to the report of the State Auditor General, there were 7,633,180 acres of forest land in Pennsylvania, of which it is estimated that 21 per cent., or approximately one-fifth, is chestnut timber. Allowing two poles, four ties, and two cords of wood per acre, and allowing $2.00 per pole, 33 cents per tie, $1.00 per cord for wood, the total value of the chestnut timber in Pennsylvania would be $55,000,000, in round numbers. If we allow $15,000,000 as the total value of the nut crop, and orchard, park, and shade trees, the total value becomes $70,000,000. This does not consider the value of chestnut forests as protection for water-sheds. By dividing the counties in the eastern half of the State into zones, as shown on the map, on the same basis as the above estimate is made, the value of the chestnut trees already killed or affected by blight in Pennsylvania is estimated at $10,000,000. Of this amount $7,000,000 is the value of poles, ties, and other wood products, and $3,000,000 is estimated as the value of orchard, park, and shade trees, the loss to nurserymen, and to real estate owners. It is believed that $3,000,000 is a low estimate for the value of these trees, since the loss to real estate owners and to owners of shade and orchard trees has been particularly severe in the southeastern corner of the State where the chestnut tree is of great importance in this respect.

No reliable estimate of the annual income from the sale of chestnut products in Pennsylvania can be given. The statistics of the Forest Service, for the year 1909, show that for the United States, the value of the annual cut in that year was approximately $20,000,000. Of this amount, about one-half was the value of lumber, lath, and shingles, the other half representing the value of poles, ties, and extract wood.

The Pennsylvania Chestnut Tree Blight Commission began its investigations in August, 1911. The general plan adopted by the Commission is that recommended by Dr. Metcalf in his recent bulletin on the control of the chestnut bark disease. In brief, this consists in first determining the exact range of the disease, especially the advance points of the infection. The diseased trees of these spot infections are destroyed as soon as possible after being located. Ultimately, it is planned to establish a zone free from the disease which will be constantly patrolled for new infections. The portion of the State west of this zone will be thoroughly scouted over at least once each year and new spot infections eradicated as soon as found.

East of the immune zone no immediate attempt will be made to eradicate the disease, partly because most of the energy will be required to fight the disease in the immune zone and westward, and also because of the poor market for chestnut products, especially cordwood, of which a large amount will be produced. It is planned, however, to place competent men in the region of general infection for the purpose of encouraging timber owners to cut their diseased trees before they deteriorate, and to assist them in finding a market for this material. In communities east of the general advance line where the per cent. of blight is not high and the owners desire to co-operate in cutting out the diseased trees, the Commission plans to give all possible encouragement and assistance.

At the risk of being tedious, I will give a resume of the provisions of the Act which governs the work of the Pennsylvania Commission.

Section 1. A commission consisting of five persons, to serve for three years, is created.

They are given power to use all practical means to destroy the chestnut tree blight.

The Department of Forestry is directed to work in collaboration.

Section 2. The Commission and its agents or employes are given power to enter upon any property to determine whether trees are attacked by blight. They are directed to co-operate with owners for the removal of the trees and eradication of the disease. The commission will furnish every owner with information respecting the location of his blighted trees.

Section 3. If an owner refuses to co-operate with the Commission in applying remedies or doing any act directed to be done to prevent further spread, the Commission may give him twenty days' notice that it will proceed if he does not. At the end of the period of notice the Commission may cause trees to be destroyed and the cost of doing such work is collectible from the owner; and if the cost be not paid within sixty days, the Commission is directed to proceed by action at law.

An owner may appeal from the decision of a member of the Commission or any of its agents or employes, within ten days after receiving his notice. The Commission will then direct a re-examination and accord a hearing to the person making the appeal. Proceedings in the meanwhile will stay.

Section 4. The Commission is given power to establish a quarantine or destroy trees not affected by blight, if so doing will result in preventing spread of the disease. Good trees so destroyed are to be paid for at current stumpage prices. In case an owner be dissatisfied with an amount allowed him for the destruction of good trees, he may appeal to a court for such remedy as he thinks he may be entitled to.

Section 5. Violations of this Act or any of the regulations adopted by the Commission, or resistance to an officer of the Commission, are declared to be a misdemeanor, and upon conviction, the defendant may be fined $100 or imprisoned one month; and the provisions of the Act are extended to corporations as to individuals.

Section 6. The Commission shall receive no pay but actual expenses only. The employes of the Commission are to receive such compensation as the Commission may determine.

The superintendent of Buildings and Grounds shall furnish them with suitable offices.

Twenty-five thousand dollars is appropriated for scientific research and office expenses, and $250,000 additional for general field work.

Section 7. Repeals all inconsistent legislation.

A quarantine on the shipment of chestnut nursery stock was declared by the Commission soon after its organization. Regulations were made requiring that all nursery stock prior to shipment be inspected by an agent of the Commission and dipped for several minutes in an approved fungicide, preferably Bordeaux mixture, in the presence of an inspector. Nurserymen are prohibited from shipping, and transportation companies from carrying chestnut stock not bearing the Commission's tag. Chestnut nursery stock shipped into the State from without is to be held at the border of the State for inspection. The nurserymen and transportation companies of the State deserve credit for willingly co-operating with the Commission to make this regulation effective.

A field force of over thirty men has been organized and the extent of the blight in the State has been determined approximately. The infected region in Pennsylvania occupies the eastern two-fifths of the State. The western-most line of general advance may be shown by drawing a line from Susquehanna to Williamsport, and southward through Huntingdon to the southern boundary of the State, although there are scattered spot infections west of this to near the Ohio State line, in the southwestern corner of the State. The field work done by the Commission last summer and fall was largely scouting to locate the extent of the disease. From January 15 to February 15, 1912, 1,352 infected trees on 87 tracts have been disposed of according to the regulations of the Commission, and fully as many more are in the process of removal. This is part of the work, in addition to general scouting and the holding of meetings for the purpose of educational work on the part of the field agents. During the summer months, when the work is carried on to the best advantage, it is planned to increase the field force so that the State may be thoroughly scouted and all diseased trees cut out west of the advance line.

On the advance line and to the westward, the owner of the trees marked for removal is required to burn the bark from visibly diseased or cankerous portions of the trees. He is also required to destroy the bark of the stumps of infected trees, either by peeling the bark to the ground line and burning it, or by burning the brush over the stump until the bark is consumed. Experiments are being tried to determine if it is not practical to cover the stump with kerosene, crude petroleum, tar, or some similar material, to make the destruction of the bark thorough and less expensive. A trial shows that one man at this season of the year can peel six stumps 10 to 15 inches in diameter in an hour. That is a conservative figure.

It is the policy of the Commission to use every possible means of securing the co-operation of owners in cutting infected timber, before resorting to their power under the law. The power that the law gives the Commission is sufficient to insure respect for its powers, but we realize that the law alone is not sufficient to make the plan of controlling this disease effective unless it is backed by strong public sentiment in its favor. This is being accomplished by educating the public to recognize the symptoms of the disease and to realize its serious character through lectures, field meetings, circulars, newspaper articles, and other work of an educational nature, such as interesting school children and boy scouts in the movement. So far, no serious opposition has been met with in the work of eradication; on the contrary, we have had exceptional co-operation from all classes of timber owners.

The Commission maintains a laboratory for determining doubtful infections, and for conducting experiments in the control of the disease through the use of sprays, fertilizers, and medications. The Commission is giving an impartial trial to the many remedies submitted, to determine their effectiveness. These experiments are being pushed forward as rapidly as may be done, but no remedy will be endorsed by the Commission until its efficiency has been demonstrated beyond all doubt. Most of those submitting remedies for the blight have in mind the size of our appropriation rather than the practicability and efficiency of their remedies to the public.

The Commission keenly realizes its responsibility to the public for the proper expenditure of the funds placed at its disposal. Yesterday's proceedings of the conference emphasized the great need for comprehensive scientific investigation into all phases of the blight problem. It is only by finding out all the facts relative to the disease that we can hope to eradicate it, and it is evident that many scientific facts of practical importance are still unknown. For instance, it has not yet been definitely determined what agents are of primary importance in distributing the spores, or to what extent the disease may be spread by the transportation of barked and unbarked products of diseased trees, two points which have a direct bearing on cost and efficiency of control.

The woodpecker and other birds have been blamed for spreading the blight, when in my opinion it is more apt to be the fault of insects. Further investigations may prove this to be as much a problem for the entomologist as for the pathologist. We feel a sentimental interest in the birds. Nevertheless, this does not free us from also investigating them to find out scientifically their exact relation to the spread of this disease. In other words, we must investigate everything, whether we believe one thing or another. At the present time three field agents have been detailed to make special studies of field conditions for the purpose of securing further facts relative to several of these problems. Many lines of co-operative investigation and experiment are in progress and others are planned. Detailed knowledge of the agents causing infection and the time of year when infection occurs, which will be obtained as the work progresses, will undoubtedly assist in making control more effective and in cheapening the cost of the work of eradication, by pointing out the simplest methods required to give satisfactory results. In the meantime, however, it is our belief that sanitation is practical and should give good results in checking the spread of this disease as it has done in the case of other diseases. Quarantine measures proved successful in checking outbreaks of yellow fever *after the mosquito was convicted.* It is more than probable that by destroying the diseased bark of infected trees in the eastern half of the State, we shall also destroy the agency which spreads the disease.

In my opinion, the big problem which confronts us and which more than any other will determine the success or failure of our undertaking is the question of profitable utilization. A satisfactory market for the various classes of chestnut wood which must be disposed of as a result of the cutting-out method of control, appears to me to be vital to the ultimate success of the plan. The active co-operation of chestnut owners cannot be willingly secured if they must do the cutting at a loss. We have found that owners who were reluctant to cut have been willing to do so after they found a market for the product which enabled them to follow our regulations without expense, or perhaps at a profit. The Commission, by acting as a clearing house to bring buyer and seller together, will be able to assist materially in solving this problem. There are over thirty commercial uses for chestnut wood, and it seems likely that all the chestnut wood which will be produced can be utilized, provided it can be delivered to factories and other consumers at a price which will allow it to compete with other woods. The solution of this problem seems to lie in lower frieght rates on chestnut products. All classes of chestnut products will probably become more or less of a glut on the market, unless rates can be secured which will enable such material to find a market over a much wider territory than at the present. The greatest present difficulty however lies in the disposal of chestnut cordwood.

Pennsylvania's programme may be summed up as doing all that can be done along the lines indicated to save the chestnut trees. If successful, we shall be most happy; if we fail, after an honest fight, we shall have the satisfaction of knowing that it has been money wisely spent. Even though we accomplish no more than to secure the best utilization of the blight killed material, the expenditure of money and effort is justified; and in addition, we have the educational value along forestry, conservation, and pathological lines; an object lesson to the State and Nation, of which we must not lose sight.

Pennsylvania hopes for two great results from this conference; first, the united effort of the states here represented in attempting the control of the chestnut blight, and second, assistance from users of chestnut products in devising ways and means of profitably disposing of the products of diseased trees. The other thing needful to ultimate success, that is, the complete scientific facts of the disease, will be obtained in the course of time through systematic investigation, through the collection of facts, not through hypotheses. (Applause).

THE CHAIRMAN: The next paper is entitled "Chestnut Blight and the Practice of Forestry in Pennsylvania," by Dr. H. P. Baker, Department of Forestry, State College, Penna.

THE CHESTNUT BLIGHT AND THE PRACTICE OF FORESTRY IN PENNSYLVANIA.

BY DR. H. P. BAKER, PENNSYLVANIA STATE COLLEGE.

Mr. Chairman, Ladies and Gentlemen: I am glad indeed of this opportunity of presenting a very informal paper, and I wish you would consider it as an introduction to discussion only. I feel like apologizing a little for presenting so short a paper. In fact, I received a telegram in regard to it just as I was leaving State College and have not been back to the College since, so that what I have gotten together has been on the run and I am afraid will not be facts entirely.

The Chestnut Bark Disease *(Diaporthe parasitica)*, which was first observed in this country in 1904 in the vicinity of New York, has now spread through the hardwood forests of ten to twelve of the eastern States. Up to this time the loss from destruction of chestnut trees of all ages has probably been more than fifty million of dollars. (From Mr. Charles Marlatt, of the Bureau of Entomology, United States Department of Agriculture in National Geographic Magazine). The chestnut, because of its sprouting capacity, rapidity and vigor of growth, and the natural durability of its wood, is one of the most valuable hardwoods of our eastern forests. It is especially valuable for farmers' wood lots, because of the simplicity of management necessary to produce repeated yields of posts, poles and ties, and that within a shorter time than possible with any other common hard wood, or wood of equal value. The length of rotation for production of posts and poles may be made so short, with proper care and protection of the wood lot, that the ordinary cry of too long an investment for profit will not apply to the growing of chestnut under simple coppice. By simple coppice we mean the cutting of the forest and its reproduction by sprouts from the stumps. This method has been praticed by our wood lot owners for a good many years. They have not called it simple coppice, but it has been that just the same, and they have been practicing it very successfully indeed.

I cannot believe, in view of the great value of chestnut wood and the rapidity and vigor of its growth, that we can get along without it in our Pennsylvania forests, or in our eastern forests. I am optimistic naturally, and I do not believe that we will ever carry on forest management in this country without using chestnut.

With the possibility of the complete *commercial* destruction of this valuable tree, it is indeed time that the foresters of the country consider what the effect of the removal of this tree will have upon the future of the forests and whether or not the introduction of some special method of management may not make it more difficult for the disease to spread or make it easier for the tree to resist the disease by keeping it in the most healthful and vigorous growing condition. These are not easy questions to answer, because we have no precedent to follow, either in the practice here or abroad. We have never had such a serious enemy of the forest working in a well settled region of the country, and at a time when both the national and state governments are so well disposed to appropriate sufficient funds for combating the pest. In the State of Pennsylvania we are now carrying on work against this disease which was undreamed of when we were suffering earlier from special insect devastations in our forests.

A very brief statement of the devastations of two similar pests may help us to appreciate somewhat our problems in connection with the blight. In 1882 the Larch Saw-fly worm appeared in the native larch or tamarack in Maine, and during the next five years did tremendous damage throughout northern New England and New York. By destroying the needles of the trees it caused their slow death and not until the territory had been pretty thoroughly covered by the insect and until certain natural enemies arose did this insect finally disappear. Nothing, of course, was done to combat the insect or prevent its spread. While it was not possible to estimate the damages resulting from the work of this insect, it must have exceeded several millions of dollars. There was no serious re-occurrence of this pest until last year, when it appeared in the tamarack swamps of the Northern Lake States. It is reported that Michigan is studying this pest with the hope of being able to do some effective work against it. I mention this pest because it practically wiped out the tamarack in northern New England as a commercial tree, though after the pest had passed there were single trees and also considerable areas left that were not touched at all. We heard little of it, because there was lots of timber everywhere else, and people were not interested. It was not brought home to them as the work of this chestnut disease is here in Pennsylvania. Yet the tree was not wiped out entirely, and I cannot believe that, even though this blight disease may spread ever so widely through the Appalachians, that the chestnut will become extinct.

The second and better known devastation of forests by an insect was that of the Nun or Spruce Moth which appeared over considerable areas of the spruce forests in southern Germany in 1891 and 92. Bavaria alone spent over three hundred and seventy-five thousand dollars in combating this insect and finally by the use of bands or rings of viscous tar on the trees prevented the upward movement of the larvae from the ground and thus the pest was destroyed. Great areas of forests were clear cut and the market was glutted with spruce poles and logs of certain sizes. Dr. Endres, the great forest statistician of Munich, reports that even though there was an apparent over-supply of timber from these clear cuttings, yet the market did not suffer and a good average price was received for all material. The methods followed in Europe for combating either insect or fungous pests are hardly applicable here because of their denser population, cheaper labor and smaller and more accessible forest areas.

Much was accomplished in Bavaria and the states of southwestern Germany by the clear cutting of the forests in broad strips. In replanting these strips some attempt was made to replace the spruce by species not susceptible to injury by the moth. This, however, was not followed out to any large extent, because the spruce is the most profitable tree for southern Germany. I believe that no system we may use in wiping out this chestnut disease, if we are able to do it, will preclude the use of chestnut in our future forest management. The forester is going to grow the tree from which he can make the most money, if the agencies of nature will let him do it. Of course, the agencies of nature are against us now in this chestnut disease fight. Strips of forest in Germany often a half mile wide were left while the cleared areas ranged from a dozen rods up to a quarter mile in width, depending both upon the age of the forest and topography. The Government having the right of condemnation entered private holdings at any time and forced owners to cut infested areas. It is fortunate that the act appropriating money for the control of the chestnut blight gives this same right. We must, however, proceed with great care in condemning trees and timber so as not to arouse the opposition of the people to the work of blight eradication and the introduction of methods of management which will perpetuate best the remaining chestnut and other hard woods.

The two pests described above are unlike, of course, a fungous disease such as the blight. Insects are always more easily controlled than fungous diseases. I mention this last one to bring out especially the fact that Germany used a definite system of forest management to overcome a great devastation of the forest and that successfully.

Along the northern and western extension of the blight there should be as clean a cutting of the worst infested areas as the market will justify. The creation of a belt or zone in which there is no chestnut is, probably, not practicable in combating this disease, which is carried both by birds and insects. In localities where there are good markets for ties, mine props, acid wood, and like small products, there will be no question as to the practicability of clean-cutting over considerable areas. Where a proper market exists the possibilities of future returns under the system of coppice will be most excellent in our hard wood forests. The United States Forest Service, in a recent statement as to the possibilities of this sprout land, estimates returns as follows:

"Good quality of oak and chestnut sprout land in the Appalachians can be purchased often for less than five dollars an acre. Careful study shows that in fifty years these lands will yield seven hundred cross ties to the acre. Assuming that two cents an acre each year will pay the costs of efficient fire protection and that a cent and a quarter per acre will pay the annual taxes, the cross ties would have to be worth, at the end of the fifty-year period required to produce them, eight and one-half cents on the stump to return five per cent. compound interest on the entire investment in land, protection and taxes. Any advance in the price of tie stumpage within the fifty-year period would mean that much profit over the percentage given."

I have referred to those returns from sprout land simply to show what can be done in the way of practicing simple coppice effectively over our hard wood forests. We can, I believe, stimulate a market for certain forest products. I know that many say we cannot help the present market conditions, but I am optimistic in this as great manufacturing concerns are stimulating the market for certain special products. Why should we not be able by showing fully the uses of chestnut stimulate its use to a greater extent than at present, at least? We must emphasize continually the utilization phases of the problem, it seems to me, in seeking methods which will accomplish the greatest good for owners of chestnut timber.

Simple coppice, which many of our Pennsylvania wood lot owners have been carrying on, in a way, for years, is without doubt the best method both for the perpetuation of the wood lots and for keeping them in such condition as to insure the chestnut being as hardy as possible against the work of the blight. That is, I believe we can accomplish a great deal by putting our chestnut forests into a more healthful condition. A tree in a healthy, rapid-growing condition, is going to be able to resist the blight and other diseases much more effectively than if it is in the condition in which too many of our wood lots and chestnut trees are at the present time. Wood lots have been run over repeatedly by fires, the humus is gone and the soil has been depleted. The trees are just hanging on, we might say, and no wonder they are susceptible to any disease that may come along. We can accomplish a great deal by methods of control that will put our chestnut forests into a better growing condition. Unfortunately, a considerable proportion of our wood lots, in which there is chestnut, have been cut very carelessly and little or no protection given the developing sprouts from either fire or grazing. There has been more or less complaint as to this method because of the gradual dying out of the mother stump. A great deal of our cutting is done carelessly. Too high a stump is left, so that, when the sprout comes out, it is liable to be broken off by wind; whereas, if the stump had been cut low, even though it required a little more bending of the back, the sprout would be able to establish a root system of its own, and there is then almost no limit whatever to the life of the mother stump. If a high stump is left and the sprout comes up six, eight, or ten inches from the ground or further, we cannot expect anything else than the gradual dying out of the mother stump; hence a great deal can be done in properly cutting the chestnut which we want to reproduce by sprouts. Another cause for unsatisfactory results from reproduction by sprouts, and perhaps a justifiable one, in view of present markets, is the leaving of old misformed trees and forest weeds. These low-growing, half-trees are usually very tolerant and shade the sprouting stump in a way that prevents vigorous growth. A certain amount of shade is desirable, but, as a rule, in our wood lots the owner, or the contracting cutter, does not pay much attention to these weeds and leaves them. They take advantage of the space and so shade the ground or the sprouting stumps that the sprouts are not vigorous. One or two cleanings to remove these undesirable trees would make the competition for space and light much less severe and no doubt would result in better formed chestnut and oak, and the chestnut, because healthier, would be better able to resist both insects and fungi. These cleanings can be made as repeated cuttings on an exceedingly short rotation, even though the product will be of value for posts and mine props only. If, instead of this weeding out, so to speak, of blight-infested trees, here and there, we might induce the owners to use a definite system of cutting, I believe we would be accomplishing more permanent results. If instead of this destruction of scattered infested trees, which may be and probably is effective in the southeastern part of the State, on small tracts, if, in the place of this weeding out process, I say, we could induce the owners to use some such system as clear-cutting and planting with non-susceptible trees, or cutting so as to keep the forest reproducing rapidly by sprouts, I believe we would accomplish very much more for forestry in Pennsylvania. If we could in some way bring about such market conditions as to justify clear-cutting and repeated clear-cuttings until the blight has disappeared, might we not only get rid of the blight, but in the process bring about the introduction of definite forestry practice?

I am not condemning entirely the method of eliminating blight infested trees. That method may be used more successfully over small areas of woodland such as occur in the southeastern part of the State. When one thinks of the tremendous areas of woodland which the State owns and is owned privately for instance, through Centre county and on up into Clinton county, the proposition of going in and cutting out infested trees is a hard one to consider. If over such lands we can bring about the introduction of some method of cutting on as short a rotation as possible, and as often as the returns will justify it, it is easy to see that we will keep the forest growing rapidly and healthfully and that we will do more toward keeping the blight out and perpetuating the chestnut than going here and there through that great area and cutting out infested trees. While this Commission, which is doing such a splendid work, and work which will always redound to the credit of Pennsylvania, is eliminating infested trees here and there through the State, might it not be able also to introduce a system of management among our woodland and forest owners which will continue beyond the life of the Commission? At the present time, by the practice of eliminating diseased trees you are getting rid of those infested trees only. In saying this I am not discountenancing or underestimating the tremendous educational value of the work which the Commission is doing, but if you carry on this method of eliminating individual trees only, what have you done for the owner after you get through with it? You may have stopped temporarily the blight, but if at the same time you can introduce a system of management that is going to put the whole wood lot into better growing condition, I say you are going to accomplish more in the way of permanent results and more in a forestry way in this country. (Applause).

THE CHAIRMAN: The next paper is entitled "The Chestnut Blight and Constructive Conservation," by Dr. J. Russell Smith, of the University of Pennsylvania.

THE CHESTNUT BLIGHT AND CONSTRUCTIVE CONSERVATION.

By DR. RUSSELL SMITH, OF THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA.

"A horse, a horse, my kingdom for a horse!" In these words Shakespeare makes the defeated King Richard III express the value of a certain piece of property, as he paced the field of defeat, seeking flight,—not what the horse would actually cost in the horse market; not what he would bring in the horse market, was the basis of valuation, but what was going to happen to Richard III if he had to go without him.

On that basis I question if the estimates of the value of the chestnut species have been placed anywhere near high enough. The United States, with a big timber cut, is within from one to three decades of an era of timber scarcity which will put us in the position of having to go *raise* timber, rather than go *find* timber. In the timber-raising epoch the chestnut comes to the front. Taken altogether it is for the next sixty years of this nation a tree without a peer, for no other tree can touch it for all-around efficiency.

1. It grows rapidly. No other good tree of the forest can equal it in the speed with which it makes wood. By the time the white oak acorn makes a baseball bat the chestnut stump has made a railroad tie. Cut it down and it throws its shoots up six feet the first year and keeps them going. This astoundingly fast start, in connection with its record fast growth, makes it a forest marvel.

2. The wood of no other tree is so generally useful. It is durable in the ground as posts, a quality which makes it a standard telegraph and telephone pole, and a good railroad tie or mine prop. It is durable above ground, giving it many virtues as lumber. It is also a beautiful, prized, and much used wood for interior finish. Lastly, it is full of tannin, so that any chip, top, slab or scrap can be digested for this valuable manufacture.

The Blight Threatens a National Loss. Who Loses?

If anybody thinks he is not a loser because he has not a chestnut forest all his own, he has another think coming.

(a) Do you wear shoes? If so, the chestnut interests you, because we are just beginning to make tannin for leather from the wood of the chestnut.

(b) Do you read? The pulp that remains after the tannin is gone makes paper; also a new industry just starting.

(c) Do you rent a house? Chestnut wood is one of the most satisfactory woods for finishing the plain man's house.

(d) Do you use the telephone or telegraph? Chestnut makes one of the best telegraph and telephone poles.

(e) Do you go a-trolleying? The chestnut is the tie-producing tree of the future, if we do not let the blight kill the species.

(f) Do you own a farm or a town lot? Chestnut is one of the great fence post trees of America.

Lastly in its list of virtues we should not forget its value, and especially its possibility as a producer of food for man, and sheep, goats, hogs, and possibly other livestock. Already the chestnut orchards of Europe make rough mountain sides worth one hundred and fifty dollars per acre. Compare that to American farm lands. The chestnut forests of Italy are reported to make more bushels of nuts year after year than the continuously cropped lands of Dakota and Minnesota yield in wheat. Fully one-fourth of the State of Pennsylvania, which is worthless for wheat or corn, is better fitted for chestnut culture than any other use now in sight. If we make them yield no better than the Italians do, that would give us ninety million bushels of nuts, an amount 50 per cent. greater than our wheat and corn crops combined. It would make this one of the greatest sheep and pig fattening states of the country.

The stake in maintaining the chestnut species from destruction is large. The estimate of three hundred million dollars is probably under, rather than over, the proper figure. In the absence of definite knowledge of the cure, how much are we justified in spending in uncertain efforts? The problem is one of insurance. Forty billion dollars' worth of property in the

United States was insured last year against fire, at an average rate of 1.14 per cent. or four hundred and fifty-six million dollars for fire insurance in one year.

Now ninety-nine and one-third per cent. of that property was insured against a fire that did not come. American property owners are paying over one per cent. of the value of their property to be insured against a chance of less than one in one hundred and thirty-three. Now it is pretty generally agreed here that the blight has a better than a one one hundred and thirty-third chance of winning out if we sit still. Therefore, business analogy tells us that we can at least afford to pay an average insurance rate on the risk. Don't forget that this fire has already broken out. If we raise an average insurance rate, for a fighting fund, we have about three million four hundred thousand dollars per year coming to us. Thus far the whole American nation has not spent over one per cent. even of that sum, and the blight has already destroyed nearly or quite one thousand times as much as we have spent to stop it.

If there is any such thing as constructive conservation, this chestnut blight is blowing the whistle for us to come and construct, and get about it quickly.

What Can We Do?

1. All agree that we can stop the movement of nursery stock.
2. All agree that we can go home and start careful and thorough surveys of actual conditions in our various States.
3. Every State can start scientific investigation to get more knowledge of the trouble.
4. Every State can try the cutting-out method of control, at least on small outbreaks, if not on a larger scale.

Therefore every State that has any blight needs an appropriation of ten thousand dollars to fifty thousand dollars for the season of 1912, depending on the size of the State. The Federal Government also needs a substantial appropriation. Altogether this will make but a fraction of the common sense fund that would be produced by a one per cent. insurance rate on the property involved.

There is no evidence to bring out in proof of the final efficiency of cutting as a cure. On the other hand, actual observation has shown that when a forest fire jumps your fire line, you jump on it while it is little and stamp it out rather than let it run while you devise a theoretically sound method of attack.

We are indebted to the two gentlemen who have had the courage to come here and tell us that we didn't know. We don't know. But at least let us exert ourselves to the extent of average insurance cost. We don't know, but neither do the courageous Messrs. Stewart and Clinton. Their objections savor largely on the temperamental. For example, Professor Clinton tells us that he thinks drought and other climatic causes may be responsible. This is very reasonable, but it is astonishing that the gentleman did not bring something that was at least near-evidence. If drought is the promoting factor, there have been abundant opportunities to compare trees that were in different relations with respect to water. Connecticut, with its many infestations of blight has given great opportunity to find chestnut trees languishing for water on rocky, sandy, shaly, and otherwise very dry knolls. These could be compared with trees growing near water tables, in moist coves, below mill races, and in other moist locations. Such comparisons would be in the nature of proof for what is otherwise an entirely unproved theoretical suggestion. Mr. Stewart opposed the cutting-out plan, mentioning as evidence the fact that Metcalf and Collins had cut out an infestation and two years later the stumps showed a fungus and six trees nearby had the blight. Would it not be better to note that, after informal and experimental cutting out, *only* six trees had blight? Mr. Stewart also mentions as a cause for despair the fact that an outbreak at Fontella, Va., had been going since 1903. A Virginia report states that this outbreak has in that time spread to about an acre of woodland.

A Lesson From the San Jose Scale.

This miserable little bug with an umbrella on his back had us scared nearly to death ten years ago because he killed our fruit trees so mercilessly. Now any farmer can turn him into soap and keep his orchard clean, and the scientists are now telling us to go at the chestnut blight; only there is this difference

—a *man* can go after the scale. It takes the State, and much better, all of the States, to stop the chestnut blight, for he travels faster than the scale.

A National Scientific Campaign, or a National Standup Fight. An Example from Africa.

We have national corporations, national parties, national co-operation to make a meal even, and now we have got to make a national organization to fight a tree enemy just as we would to fight a man enemy. The problem is big, but we know how if we will.

We have a splendid example in the South African cattle plague. It swept for hundreds of miles, taking all cattle before it as frost does the flies. Then the South African Governments drew a quarantine line around it and fought it to a standstill right there. The United States should try the same with the chestnut blight.

An Example from the Peach Yellows.

The peach yellows is a disease of which we know just two things. The first is that it is a sure kill for trees, the second that it can be controlled by rigid quarantine. Before we knew the second fact, the disease had actually broken up communities, as in the Michigan peach belt, and reduced land values from one hundred dollars an acre to thirty dollars per acre. With quarantine in operation, and the disease still unknown, these same localities have more peach trees than ever and are again prosperous.

A Lesson from the Foot and Mouth Disease of Cattle in Pennsylvania.

The foot and mouth disease in this State,—which cost us the life of one of the most efficient men we have ever had, namely the brother of our Chairman, Dr. Leonard Pearson,—the foot and mouth disease, which is, practically, sure and quick death, and so contagious that a stableman can carry it miles in his clothes, broke out recently in Pennsylvania in many places. Yet this State jumped on it, and by a sharp, stiff, stand-up fight, it was absolutely stamped out in a few weeks by the rigorous establishment of a dead line. I think this chestnut disease calls for constructive conservation of just that kind. (Applause).

THE CHAIRMAN: Last call for resolutions: All resolutions should be presented without delay at the desk.

We are now to hear reports by State Foresters. What is your pleasure in reference to the time to be assigned to this part of the programme? Do you desire to place any limit on reports? We desire, of course, to have them unlimited but, in your judgment is it necessary to place any time limit on these reports?

PROFESSOR HARSHBERGER, of Pennsylvania: I believe we have a time limit of half past eleven, and it is now within an hour of that time, so I believe we are obliged to have these reports within the next hour.

THE CHAIRMAN: In your opinion, would it be well, then, to limit the reports to say eight minutes, except by unanimous consent for more time?

PROFESSOR HARSHBERGER: I would imagine so; eight minutes with two minutes leeway, making it ten minutes in all. I make that motion; that the papers be limited to eight minutes, with two minutes allowance.

The motion was seconded and carried.

THE CHAIRMAN: The motion prevails. It can, of course, be excepted to under unanimous consent. Is the State Forester or a representative prepared to report for Maine? (No response). New Hampshire? (No response). Massachusetts?

PROFESSOR RANE; Is the idea of this report to give something along the line of work being done in the State

THE CHAIRMAN: The Chair will read the subject as stated on the programme: "Reports of State Foresters or other officials on the present extent of the bark disease; an estimate of the present and possible future losses." In answering Professor Rane's question, it would seem desirable to the Chair to discuss this subject from the standpoint of his own State, if that answers your question.

PROFESSOR RANE: Mr. Chairman and Gentlemen of the Convention: In so far as Massachusetts is concerned, we have this chestnut bark disease and we have also gone at it in what seems to us a practical way. I simply wish to give you an idea of how we are tackling the problem. In the first place, the disease was found scattered here and there. I made arrangements with Dr. Metcalf, because I considered he was the man of the hour to give us instructions and ideas, to go forward and carry out this work. Dr. Metcalf came on to Boston and we went over the whole proposition, and finally arranged to have a man come on last spring and go over the whole State. He spent the months of June, July, and August, visiting on a motorcycle all the forest sections of the State, to study the problem, and we found that the disease was far more prevalent than even Dr. Metcalf realized. Now when the report came out from Dr. Metcalf's assistant, the first idea he conveyed to us was that the State of Massachusetts should call upon its Legislature for a large sum of money. Most of you know undoubtedly that we have been tackling the gypsy and browntail moth problems, and that these depredations, which have been pretty much confined to Massachusetts, and more recently New Hampshire and Maine have incurred much expense. Now we have been tackling problems more or less of this sort and, as State Forester, I certainly did not wish to make the mistake of plunging into this chestnut disease problem before I was sufficiently familiar with it. We have a pretty thorough organization in Massachusetts from the forestry management standpoint, and of the papers and discussions that have come up here, the one that pleased me perhaps most was the talk that was given by Professor Baker of the State College. Gentlemen, it seems to me that in spite of the question of our needs for plant mycologists and specialists, that the necessary thing is to get further at the root of the trouble, and that is to introduce a better organization in this present development of our forest states and nation, a more definite forestry management from a fundamental standpoint. The whole problem, it strikes me, of insect and fungus depredations, is one of looking at it and studying it from the broader viewpoint, namely that of the system of forestry management. We have had the gypsy and browntail moth work in Massachusetts, more or less similar in a general way, to this chestnut disease. We are spending in Massachusetts practically a million dollars every year on these insects. Furthermore, if Massachusetts had not taken hold of this problem as it did, undoubtedly these moths would have been into Pennsylvania by this time. But we have taken hold of it and we have methods and we understand more about this problem than we possibly could without this large appropriation. The business-like way in which the State took hold of it has commended itself. The State of Massachusetts is greatly interested as we have been discussing the pro and con as to means and ideas with regard to this blight disease. It is the same thing, going through the same thing only of another kind that the gypsy moth fight in Massachusetts has been. Even some of the best entomologists of the country seemed to think originally that the attempt to destroy the moths was money thrown away, but the people living in the infested country have appreciated the importance of it and we realize to-day that the money has been well spent. We have spent practically seven millions of dollars on these insects. On this chestnut blight disease, therefore, we do not care to go to a big expenditure in Massachusetts. What I have done thus far with this chestnut disease is to endeavor to systematize the work and carry it out along the same line that we are carrying out our gypsy and browntail moth depredation work and our general forestry work. Forest fires have been mentioned. The economic importance of putting a stop to forest fires came along after the moths came. One thing has evolved into another. At the present time I veritably believe that in certain sections of Massachusetts the gypsy moth has been a blessing to those sections. Why? Because formerly there was no system of forestry management and little forest education developed. We have gone in, cleaned up stumps, dead wood and debris, selected better species of various trees, that are now protected, and in twenty to twenty-five years I veritably believe the product will pay for all the expenses we have been to up to the present time.

Now this question of the blight disease again: As I have looked upon it,—my observations may not be very keen,—but as I have looked upon it in my own mind, we find it where the conditions are unbalanced. That is here appears to be the worst condition we have. I was out with a man owning seven thousand acres in the western part of the State last Friday. The disease was the worst where thinnings had been made and a few trees allowed to stand because they were not large enough to cut into ties. These forests were unbalanced and the air and sun allowed to get in. The blight was on the southern side; the cankers showed up largely there. But in the stands where we had normal conditions, we found only a diseased tree once in awhile. There is an unbalancing condition again where forest fires have raged through the State year after year and the trees are abnormal and only half alive anyway. There you find the disease seems to travel more rapidly than it does where the trees are under normal conditions and have a forest floor where there is plenty of moisture and the conditions are more favorable. I have gone over it with some of our best practical men, lumber men, and they seem to think that it is a problem that is going to solve itself. They are good, practical men; they have been in the business a great many years, and are reluctant to believe that we will lose all our chestnuts. The way that we are endeavoring to solve this problem in Massachusetts is this: I have a forest warden in each town, who is appointed by the officials of the town, subject to the approval of the State Forester. I am endeavoring to educate these men so that they will know this disease. We have notified all of our papers throughout the State that it is up to the people that own chestnut trees that they become familiar with the disease; otherwise they are likely to lose their chestnut stand. We are sending out literature. We have just sent out a recent bulletin. The idea of the bulletin was to show photographs so that a man could take the bulletin and go out and determine whether the disease is present or not. We send men from the office, at the expense of the State, to assist anybody in cutting out, at the same time giving them ideas as to better forestry management; and with that the idea of education, endeavoring to make the work self-sustaining, so that the people will attend to it themselves and without necessitating State expense. I believe the first law is preservation, self-preservation, and I believe we ought to educate, ought to put out more practical publications that people will read. If boiled right down to the essence of the work, farmers will look after their own trees, and I think forestry management will ultimately solve the problem as much as anything. There are lots of ideas that I would like to suggest; for instance, the comparative conditions as between insects and fungous diseases. We have had a great time in handling the gypsy moth; but in their case we can see the egg clusters, while, when you come down to a fungous disease, it is quite another proposition and a proposition also that it seems to me we cannot begin to fathom so quickly as one can in the handling of the insect. (Applause).

THE CHAIRMAN: Does anyone wish to ask one short question of Professor Rane?

PROFESSOR CLINTON: I understand when they began the work in Massachusetts, they were going to locate the disease and cut it all out, and that Professor Rane had the authority to send men into private woodlands of the farmers of the State and destroy those trees, if he saw fit. He has not done that. Why?

PROFESSOR RANE: As for the question of cutting out the chestnut tree, that was our plan when Dr. Metcalf sent his man in, and we went all over it. I selected one of our best woodchoppers and he was to follow along and wherever the expert found a tree,—we expected to find one in about every other county in Massachusetts,—he was going to cut it out. This fellow started out with an axe, and when we came to some old trees that were about ten feet in circumference, and there was some question as to whether the disease was there or not, but they thought they had better cut it out anyway, this man did not feel as if he was equal to the occasion. It was practically impossible to do anything along those lines and the trouble was that, even among the experts, there was quite a discussion as to whether the disease was prevalent or not. It is an impossible problem to cut out under our conditions. The forestry management end of handling the wood lot, and taking it out where you can, I think is the practical solution.

THE CHAIRMAN: Connecticut.

PROFESSOR CLINTON: We have no appropriation in Connecticut to fight this trouble or to stop it. We have merely carried on our investigations with ths usual appropriations of our State. We are asking for no special fund.

I have a paper which I desire to present, and I want to state that it is signed not only by myself as botanist, but also by Mr. Spring, State Forester:

CHESTNUT BLIGHT SITUATION IN CONNECTICUT.

First Reports.

The first specimens of chestnut blight from Connecticut were sent to the Experiment Station in November, 1907, by F. V. Stevens of Stamford, who had found the disease doing considerable damage in his region during that summer. He also stated that he thought he had seen the disease in one or two other towns in the state. Since that report, others have stated to us that they had seen the disease earlier, but had not known its nature at the time. For example, Mr. G. H. Hollister, who is here today, states that in the summer of 1905 he found a tree on the Edgewood Park Estate at Greenwich that he now believes to have had the blight. Our forester reports that a farmer in the town of Easton also noticed the disease as early as 1905. These three towns are all in Fairfield county, next to New York State. In the winter of 1909, Mr. Newton J. Peck brought a specimen to the Station from Woodbridge, New Haven County, and stated that he had noticed the disease in his forest for four or five years. So far, then, we have no information of the presence of the disease in Connecticut before 1905.

Subsequent Reports.

In the report of the Connecticut Experiment Station for 1908, we noted the disease in twenty-two of the twenty-three towns of Fairfield County, in eight towns of New Haven County, and we had an unverified report of its occurrence in New London County, in the eastern part of the State, making thirty-one towns in all.

In the Station report for 1909-10, we listed the disease from all the twenty-three towns of Fairfield County, twenty-one towns of New Haven County, fourteen of Litchfield, seven of Hartford, two of Middlesex, three of Tolland, one of Windham and one of New London County. Thus we found the disease present in all of the counties of the State, and in seventy-two of the towns. Of these only seven towns were east of the Connecticut River, but this region had not been carefully examined. At the Albany conference, held October 19, 1911, we reported the disease present in one hundred and twenty towns of the State. To-day (February, 1912) we have records of its presence in 164 of the 168 towns of the State (all but Ashford, Eastford, Putnam and Haddam), and we have every reason to believe that a careful search would reveal its presence in these four towns.

Present Situation.

The present situation in Connecticut, then, is that we have the disease in more or less abundance in practically every town. We are surrounded on three sides by states that have the disease more or less abundant in their different counties. On the south, we are separated by Long Island Sound from Long Island, which also has the disease.

In Fairfield County as early as 1907, the disease was doing considerable harm, and by 1909 it was very serious, while to-day, from fifty to seventy-five per cent. of all the chestnuts are affected or dead. New Haven County began to show evidence of trouble in 1908, and at present the disease is present in most of the forests and serious in many of them. Litchfield County did not begin to show the trouble until 1909 and 1910, but last year it was doing considerable damage there. Hartford and Middlesex counties also last year began to show its presence in their forests, in some places very prominently. These counties are all west of the Connecticut River. East of the river the trouble is not nearly so general or abundant, but in some places in 1911 it was causing considerable damage.

The year 1911 more than any other seemed to be favorable for the spread and injurious effects of the fungus. This we attribute to the unusual drought of that year, lasting from early spring until the last of July. This is the fifth and most severe of a series of drought years that we have had since 1907.

Control Work.

Our work in the field, besides locating the disease, has been along the following lines:

(1) Studying the progress of the disease on marked trees.

(2). Setting out seedling chestnuts, including a few cultivated varieties, in infested forests, to see how the disease will affect them.

(3). Attempting control in a badly diseased private forest by the cutting out method. This did not prove of value, and after two seasons we have discontinued the work. Opening up the forest there seemed harmful to the chestnuts left, especially on south and west exposures.

(4). Attempting control by the cutting out method in a state forest where the disease was not conspicuous. This work has just been started in our forest at Portland. Previous to 1911, only a few diseased trees had been seen in this forest. Our preliminary survey this winter, however, has shown it now present more abundantly than we expected. On account of the time it took to locate the diseased trees and the labor and cost of cutting them out, we cannot advocate this as a practical method for general use in the State, even if it proves successful, which we doubt, since the disease is generally present in the neighborhood.

Recommendations.

In Connecticut we are not asking the legislature for any special appropriation to fight this disease, and do not expect to. We are taking no concerted action to control it and we do not think this feasible. We are only occasionally advising cutting out, when the disease first appears, as a possible, though not a proved method of control. Where a wood lot as a whole is merchantable, and the disease is present, we advocate that, if market conditions are favorable, it be cut and disposed of in the ordinary way. Where the trees are not as a whole of marketable size, and the disease is present, we advocate the removal of the dying trees, and their disposal as poles, ties or cordwood, as their size may permit. We have no uniform recommendations for treatment of sprout growth too small for market purposes. We are trying to prevent a glut of the market by discouraging wholesale cutting of the forests, and as yet we have noticed no general glut and drop of prices except for cordwood in certain towns, and for 7 x 9 ties, for which the demand on the part of the railroads has evidently gone down. On the whole, however, there has been more timber cut than usual. We have no small factories for the utilization of waste products, such as bark and wood for tannin. The brass factories and the brick kilns use up most of the chestnut cordwood in their vicinities, thus preventing much of a glut. Lime kilns also utilize considerable of the cordwood. A relatively small amount is made into charcoal.

THE CHAIRMAN: Are there any questions for Professor Clinton?

MR. CHESTER E. CHILD: I would like to ask Professor Clinton what was the result of the cutting out of the infected trees on any tracts or estates he knows about; where the affected trees were removed, what was the result on the trees that re mained?

PROFESSOR CLINTON: That was on the estate of one of the wealthiest men in Connecticut, so he had money enough to cut them out if he wanted to. It was on the southern exposure of a hill and we found that, where cut out, the trees left seemed to suffer more from drought, etc., and be more injured by blight. We also found that by cutting out the trees and not removing the bark from the stumps, about thirty per cent. of those stumps showed the disease present on the bark that was left. Up to last summer the forests in the same region, on the northern exposure, had not suffered much from blight. This gentleman said that he would go on if we wanted to continue the experiment, but he thought, as far as he was concerned, in the future he would prefer to cut the trees as they died. That was not a thorough, careful experiment like they are going to conduct here in Pennsylvania, by cutting every diseased tree down and burning the bark and all that, but it was about the way a practical man would do it.

THE CHAIRMAN: There is time for one more question, if anyone desires to ask one.

MR. THALHEIMER: Have you found out whether the conditions differ between low and high ground and the exposure, on the southern, northern, or eastern and western sides; that is, whether you found any infected trees on the eastern side of the mountain?

PROFESSOR CLINTON: It shows most frequently on the eastern and southern side and around to the western and southern side of exposed trees. That is, the more northern slopes are generally less affected, in our experience. Examine the chestnut trees in Fairmount Park in Philadelphia, and see if the blight does not come out more on the western and southern side. Look at your trees and see if you do not see injuries on that exposure, that is, before the trouble becomes general.

THE CHAIRMAN: New York State.

MR. G. L. BARRUS, of the Conservation Commission: Mr. Chairman: First of all, I want to say that the commissioners and Superintendent Pettis hoped to be here for this Conference, but were unavoidably kept away, and I regret to say that we have not any definite statistics to give as to the value of the chestnut or the amount that has been destroyed. I think this question has brought up the need of such statistics; if it has not done anything more, it has brought up that need. We have been confining our efforts in New York, been confining this forest policy to sixteen counties, which include the Adirondacks and Catskills. About six million acres of forest land are included in that area. Outside of that, there is another six million acres of farm wood-lot land ,which has had little thought in the past as regards forest management. This question of chestnut bark disease has brought our attention to this other six million acres of land. If it has not done anything more, it has done that, and we are now concerned in finding some way of branching out, taking care of and giving management to this portion of the forest land of the State.

As to the distribution of the chestnut, I might say that we sent about four thousand circular letters throughout the State, asking if the chestnut was found in the towns where these different persons resided, and asking if the chestnut bark disease was present. The public showed their active interest in the subject in the way they replied. We got over a thousand answers to those letters, from all parts of the State, and in that way we are enabled to give a rough map of the state, showing where the chestnut is found and, to a certain degree, where the chestnut disease is found.

We find that the chestnut belt of New York State covers forty-six per cent. of the total area of the State (approximately 23,-000 square miles), and on that area I think it is conservative to say there are thirty million dollars worth of chestnut timber. The diseased area, or I might say the chestnut belt, includes the Hudson Valley and the southern part of the western half of the State. The Adirondack region has no chestnut, and the same may be said of the Catskill region. The diseased area is confined primarily to the Hudson Valley, and includes one-quarter to one-third of the chestnut belt. West of the Catskills, the chestnut bark disease has been found in one case in Tioga County, on the Pennsylvania line; one case in Broome County, near the Pennsylvania line, and in two or three cases, in Delaware County; a matter of from one to twenty trees in a batch. That is the best information we have at the present time.

The loss due to the chestnut bark disease cannot be estimated, inasmuch as we have not had the time and the money to put men in the field in that portion of the district. We have confined our attention to the outlying districts where the disease was spreading, and I dare say there is at least ten million dollars worth of timber that is already destroyed, or will be destroyed before it can be utilized. The problem of utilization is a big one in New York State and, in order to do something in this way, several conferences have been held in connection with the Eastern Foresters' Association, and it was found that little could be done to develop new markets for the chestnut. The leather market and the tannic acid market seem to be flooded, and in such a condition that it would not encourage any new industries in the tannic acid business in New York State, the tannic acid plants preferring the southern chestnut in most cases rather than the New York chestnut. I do not think that the chestnut is so much of a glut on the market at the present time that it is necessary that New York State people should cut out their trees and sell at a sacrifice. The poles have been taken out gradually, and that market is not flooded at the present time. There is also a good market for cordwood in most portions of the State.

I just want to say one other thing in regard to Professor Clinton's attitude toward this question: It seems to me that it is an encouraging fact, if the points he has brought out are found to be true; I think it is a most encouraging statement; I think that if favorable weather conditions are going to help to bring the chestnut back to increased vitality, so that it may be able to resist this disease, I think it should encourage us to eliminate as much of the infectious material as we can at the present time, and thus aid nature in anything she can do to restore the chestnut to vitality. In New York State we have had several articles in the newspapers, bringing this subject before the people. We have gone about the work of finding out where our chestnut stands are, and have had the wood-lot sections, as I say, outside of the previously reported preserved area, brought to our attention. It occurs to me, who should get the credit for bringing out these points? Who should get the credit for this Conference here to-day? Who should get the credit for calling several conferences relative to the utilization of the chestnut, and were those conferences worth while? It seems to me that it should be given to the men who were willing to stake their scientific reputations on something that could be tried, rather than to give it to the men who were afraid to stake their scientific reputations, and who say, "It cannot be done." (Applause).

THE CHAIRMAN: Is there any inquiry regarding the New York situation and methods?

MR. J. W. FISHER, of Tennessee: I would like to know what per cent. of old timber, as against young timber, is infected by this disease; whether or not the young timber is the principal timber that is infected.

MR. BARRUS: In those sections of New York State where the chestnut disease is present, most of the marketable timber has been cut out, fire has gone through the remainder, and, as the result, there is a great majority of the chestnut which is sprout growth of small dimensions. I should estimate that one-fifth of the chestnut is of merchantable size and perhaps, in the district where the disease is, more than four-fifths is under merchantable size.

MR. FISHER: Does it not appear that the several years of scant rainfall which the whole eastern country has endured, together with frequent fires in this young timber, is not this possibly one of the greatest sources of the disease?

MR. BARRUS: I believe that is a question touching on the technical and scientific sidė, and perhaps Professor Clinton——

THE CHAIRMAN: As we are confined to State reports now, we will ask Mr. Fisher kindly to let that question go until we get into general discussion. The next is the State of New Jersey.

DR. MELVILLE T. COOK: Mr. Chairman. I regret that the State Forester of New Jersey is not present. I have been in the State only a short time, and so cannot speak first hand. However, as most of you know, the State of New Jersey, being close to that point where the disease is supposed to have originated in this country, has suffered probably more than any other State, in proportion to its area and the amount of standing chestnut. The disease has swept through the State (excepting the southern part), and has proved extremely destructive. We have no special appropriation for the study of the disease or for fighting it, and I believe that you will all agree with me that such a campaign as is being carried on in the State of Pennsylvania would be absolutely impossible in the State of New Jersey at the present time. We are, however, continuing our scientific investigation, so far as possible, and wherever we receive inquiries from farmers who are timber owners, reporting the disease present on their properties, we advise them to turn their chestnut into cash as quickly as possible, and to clean up as thoroughly as possible. We also advise persons contemplating planting chestnut not to do so. We also advise the nurserymen to discontinue handling chestnut stock at the present time. So far as possible, we are stimulating the market by advising builders to use the chestnut for interior trimmings.

I cannot say anything more in regard to our campaign in New Jersey. However, I wish to give just one or two observations which I have made upon this disease: So far I have been unable to confirm the observations of Dr. Clinton in regard to the weather conditions. His observations may be absolutely correct, so far as the State of Connecticut is concerned, but in the territory which I have examined it has been impossible to confirm them. I have on two occasions, found the disease in dense timber on the sprouts, down under the heavy, large growth, when it was impossible to find it in the tops of the trees or at any point near the one on the ground line. I do not know how much that observation will be worth to you, but undoubtedly the surrounding trees in the vicinity were not so infected as to make it noticeable in walking through the timber and making careful observations. The only points where we could find the disease at all were close to the ground, and the sprouts there were badly infected.

THE CHAIRMAN: We will now hear from the State of Pennsylvania. We will call on Deputy Forestry Commissioner I. C. Williams.

MR. WILLIAMS: In speaking for Pennsylvania, I think probably the subject has been well covered and that I should say little. I want to say something, however, about the appearance of the blight in the forest reserves. The Pennsylvania forest reserves to-day are included within twenty-six different counties and aggregate nine hundred and seventy-two thousand acres. The line of reserves on the west approximately follows the dark line on the map, extending somewhat west of it on the north. Beginning with Potter county, which is at the middle of the northern line, and dropping a line southwestwardly to western Clearfield and then southwardly to eastern Westmoreland, you will include east of such a line all the forest reserve counties. The chestnut blight has appeared in the forest reserves equally as it has appeared on private tracts. In the westernmost reserves, the foresters and other officers are busily at work seeking it out and destroying every infected tree they find. The Pennsylvania Department of Forestry proposes to take no chances in leaving an infected tree stand, out toward the west. That tree comes down. If we can sell it, well and good; if not, it is converted into ashes to fertilize the ground. That is a method that I think we shall continue to pursue.

I would like to say a word further with respect to the cutting-out method. We have heard considerable in this series of meetings about the importance of our doing things. Whenever I hear a man talking about "impossibilities," then something begins to boil. I do not believe in "impossibilities" that are simply guessed at. It was no impossibility for the Pennsylvania lumbermen to sweep over this State from the Delaware to Ohio and take down every merchantable tree within the State; and that has been so completely done that Pennsylvania has figuratively been combed of her merchantable forest trees. If it is not impossible to do a thing when there is a money reward behind it, why is it impossible to do it when there is simply some altruistic thing behind it? This method of dealing in impossibilities is mighty misleading business, and I want you to know that we believe it is so. The cutting-out of this diseased stuff in the forest reserves, then, is going to continue. We propose to find a market for it if we can; but if we cannot, it is going to be destroyed. To that extent the Department will contribute its small share to do what it can, to stop the westward advance of this scourge.

Let us not talk about impossibilities until we know we are up blank against the stone wall. You have well gathered from the uncertainty which has pervaded these meetings with respect to methods and means, that it ought not to lie in the mouth of anybody to come here and talk about impossibilities, especially with regard to things that are not half way investigated. Let us investigate and work: not investigate first and work afterwards. Let us get busy all along the line and, when we have utterly tried out every method and are absolutely and abjectly defeated, then it is time to talk about impossibilities. (Applause).

THE CHAIRMAN: Is there any inquiry?

PROFESSOR SMITH: I should like to repeat the question of Mr. J. W. Fisher, because I believe Mr. Williams is in position to throw some light on it. We have had a great deal of trouble with fat lands near Philadelphia, on the lands of rich men, where forest fires are unknown. What has been the testimony there with regard to this climatic matter?

MR. WILLIAMS: I happened to be in charge of that Main Line investigation, and probably know something about it. We found there all conditions of forest growth. We found that mature forest giants, running up in diameter anywhere from five to seven feet, and we found the tiny sprout coming out of the stump. We found the infection attacking trees of all sizes. It seemed not to prefer any particular age or size of tree. I have in mind to-day a splendid old tree belonging to a gentleman living near Philadelphia, that was worked on by a tree doctor. He punched it full of holes with his climbing spurs, and in a few months afterwards that tree was infected from top to bottom in those punctures. That was a tree, the owner told me for which he would not take a thousand dollars if it were possible to save it. In working on a tract to the north of Philadelphia, near Jenkintown, we found large timber prevailing in the area. There were some three hundred and forty trees in the tract. The trees probably averaged over a foot in diameter. We found that in the top of the largest trees there was occasionally a single dead branch, and that always, of course, excited attention; but the minute investigation that was made of the tree was at the ground line, about the trunk; and almost invariably, in those big trees, when we found any suggestion of infection in the top, we found pustules nearly at the ground line, and it made no difference what the size of the tree was. We likewise found sprouts no thicker than a straw badly infected, and from that size up to the giant forest tree. Frequently we found pustules at the base of large trees, but were unable to find anything in the crown of the tree. With the strongest spyglasses which we carried with us, we could pick out nothing; but getting down on our knees and going around the base with a hand magnifier, almost invariably, where the disease was in the neighborhood, we would find a pustule or two on the base of the tree, and of course that classed it as infected. I take it that this disease shows no preference in trees, and, while it is probably true that it will attack somewhat more readily the young, sappy sprout growth and kill it much more quickly, it is equally certain to do its work with the older trees.

THE CHAIRMAN: Does that answer the question, Mr. Fisher?

MR. FISHER: Yes, sir.

DR. J. M. BACKENSTOE, of Pennsylvania: Mr. Chairman: I would like to ask the speaker with reference to the treatment that was given to these thousand dollar trees.

MR. WILLIAMS: We came in contact with a good many interesting propositions down there, and we were visited by tree doctors from the day we arrived until the day we left. When we went in they implored us, and when we went out they cursed us. One of the methods of treatment was that they would prune off every infected piece of bark or branch, and cover the wound with some dressing. But in the process of doing this work, they used telephone linemen's climbers. This they thought was the proper thing, so they did it. We discouraged that and finally broke it up. We did not think that method of treatment was good. Then we were met with the idea of throwing some chemical on the ground, in order that when the rains would dissolve this material, it would enter the soil and be taken up by the roots. Generally, we were met with a proposition to buy some of the material and try it ourselves. It was most infrequent that we found these things were being tried by the people who recommended them. Then there was the idea of introducing into the sap of the tree some medication. There was another idea, with respect to watering the tree. The plan advocated by gentlemen engaged in the business was, that they would take a large chestnut tree, say three feet in diameter, and after some examination conclude, just empirically, that it was suffering because of lack of water. That may have been entirely true; but the method of treatment was to run down a series of two-foot lengths of two-inch gas pipes, or one-inch pipes, as the case might be, at a short distance from the trunk of the tree, and then turn a hose into the pipes and moisten the ground. I believe if those pipes had been put down at the proper place, good results might have followed. Water might have been introduced into the feeding roots of the tree. But it is of little value to introduce water under the tree near the trunk, where there is little absorption from the ground. There were other methods of treatment advocated. I do not remember them all now, but they have been tried out there pretty generously. Men who are owners of trees of that character, wishing to preserve them if possible, have paid large sums of money to allow treatment to be applied, but I do not know of any instance yet where it may be said that any particular treatment has been a complete success. Occasionally, and very frequently of late, we have been reading about methods of treatment in the newspapers, where men say they have just the thing. For instance, we had a letter the other day from a gentleman in northern Ohio. He said he had a preparation that would kill the chestnut blight and he wanted us to buy it right off. Now, there is no chestnut blight in Ohio, and I take it that this man had never seen a blighted tree and does not know what the chestnut blight is; yet there he has the remedy all prepared. Much of this remedial business is just of that character. I believe also there is an opportunity to try out a lot of remedies and get some results, but there are no results of value to be had from jumping at conclusions and saying "This thing will do the work," or that thing, until we know it actually has done it. Therefore, the Commission is giving all reasonable latitude to these gentlemen who have anything of the kind to offer, and every opportunity to try out their methods, in the hope that something will be found that will do some good. That is part of the Pennsylvania proposition, to let nothing be untried, even if it does not produce results.

THE CHAIRMAN: If that does not fully answer Mr. Backenstoe's question, we will ask him to bring it up later. The question was with reference to the treatment of thousand dollar trees.

MR. WILLIAMS: All trees down there are thousand dollar trees.

THE CHAIRMAN: Delaware.

PROFESSOR C. A. McCUE: The chestnut grows naturally in the two northern counties of Delaware. It is found in the southern county only here and there, and mostly in plantations. The disease is common over the entire State. While I do not say that it would be impossible to quarantine against this disease in the State of Delaware, I do say that, considering the way we have the disease now, it would not be a good proposition in the State. I am not in favor of the State of Delaware appropriating any public money for methods of eradication of this particular disease. I think the disease is scattered too generally throughout the State. We have no need of a quarantine line on the east, because we have the Delaware River and the ocean, nor on the west because our friends over in Maryland already have the disease. The Chesapeake Bay does not seem to have stopped it on the west. I think our solution of the problem, if we have any, lies in the question of management, and I am rather loath to believe that even the chestnut is entirely doomed in the State of Delaware, even where the infection is as general as it is, as I believe,—I am optimistic in the matter,—that with proper management, brought about with proper educational propaganda, we will be growing chestnuts in some manner, a great many years hence. We have many chestnut plantations in our State. We are not advising our growers to plant chestnuts for nut culture, neither are we advising the planting of chestnut trees in our forests. But we believe that, by cutting out diseased trees, especially the larger trees, as soon as their usefulness passes, and putting them upon the market,—that is, when the annual increment falls down below the amount of damage done annually by the disease,—that in this way, the disease may be gradually eliminated, to such an extent, that in certain localities, finally all the diseased chestnut trees will have been taken out, I believe, that there will still be left a number of chestnut trees that have never taken the disease. By proper management and by encouraging people to take out trees as they become diseased, I believe that in years hence, we will still find a great many chestnut trees growing in our Delaware forests.

There is another point regarding infection, which I have not heard spoken of here, that has come under my observation. I have noticed that where hunters are allowed in young coppice growth that a great many of the young sprouts are injured by the shot, and that in areas infected by the chestnut disease that every shot hole offers a point of entrance for the disease. Hunters should not be allowed in young chestnut coppice.

Having, as we do in Delaware, a number of chestnut orchards, it throws a rather interesting light upon the question of drought as a predisposing cause of the chestnut disease. Those orchards are under cultivation the same as our apple orchards. They are not suffering from drought, neither are they suffering from a scanty food supply. They are in good, thrifty condition. We find that practically every chestnut orchard in the State is infected with the chestnut disease. In Delaware, at least, I am not inclined to believe that drought plays any part whatever in the chestnut disease problem.

THE CHAIRMAN: Is there any question?

PROFESSOR NORTON: I would like to ask if the blight is equally bad on the Japanese chestnuts?

PROFESSOR McCUE: It would be rather hard to answer that question definitely, because I do not know whether we have any simon-pure Japanese chestnuts in Delaware or not. We have a lot of varieties called Japanese, but the probabilities are they are natural hybrids with the American; yet we have found infection in the so-called Japanese chestnuts the same as in the American.

MR. WILLIAMS: What is Delaware doing to prevent the shipment of infected stock beyond the borders of the State?

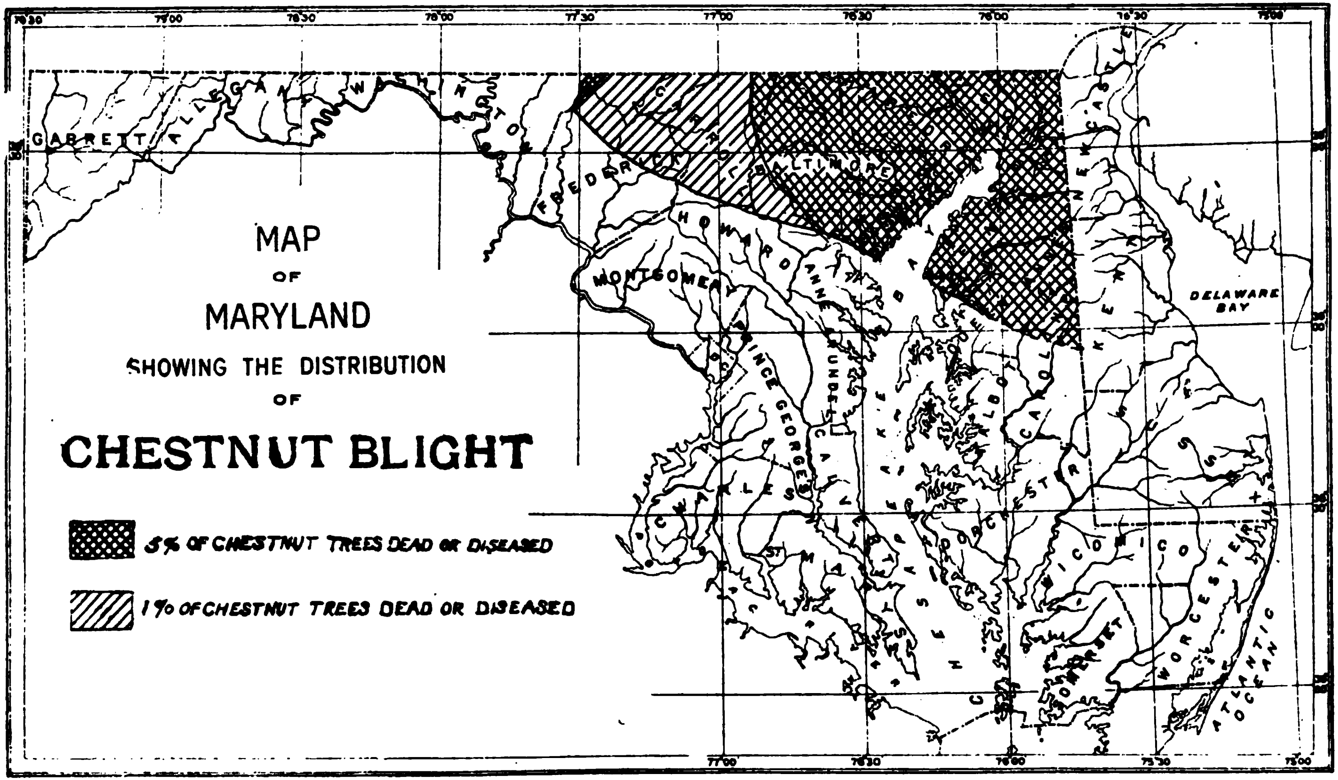
PROFESSOR McCUE: With the permission of the Chair, I will refer that question to the secretary of the State Board of Agriculture, Professor Webb, who has charge of the nursery inspection work of the State.

THE CHAIRMAN: Professor Webb, will you please inform us what Delaware is doing to prevent the shipment of infected nursery stock beyond the borders of the State.

PROFESSOR WEBB: I believe at the present time we have no nurseries growing chestnut trees, but, if diseased chestnut were found in them, the trees would be destroyed.

THE CHAIRMAN: Maryland. As one of the secretaries of the Conference, we have present Maryland's State Forester, Mr. F. W. Besley.

MR. BESLEY: As far as the chestnut bark disease is concerned, I think all eyes are on Pennsylvania. Pennsylvania has established, as it were, a great experiment station for the treatment of the chestnut bark disease, and we are all looking with


MAP
OF
MARYLAND
SHOWING THE DISTRIBUTION
OF
CHESTNUT BLIGHT
5% OF CHESTNUT TREES DEAD OR DISEASED
1% OF CHESTNUT TREES DEAD OR DISEASED
GARRETT
ALLEGANY
WASHINGTON
FREDERICK
CARROLL
BALTIMORE
HOWARD
MONTGOMERY
PRINCE GEORGES
ANNE ARUNDEL
CALVERT
CHARLES
ST. MARYS
KENT
NEW CASTLE
CAROLINE
TALBOT
DORCHESTER
WICOMICO
SOMERSET
WORCESTER
CHESAPEAKE BAY
DELAWARE BAY
ATLANTIC OCEAN

a great deal of interest to the results which may be accomplished through this work. I came up here for the purpose of listening. I want to hear what has been done. I hoped that we might have some definite cases where the chestnut bark disease had been eradicated from specific spots. It should be remembered at this time that, Pennsylvania has only taken it up recently. There has been less than a year's operation of the new law and of course, we cannot expect very extensive results, but it seems to me, and it has already been pointed out by a number of speakers, that there is the necessity at this time of treating individual trees and of keeping an accurate record of them, so that we will know exactly what we may expect in the way of eradicating the disease. Professor Clinton has spoken of certain diseased trees that were cut out, and he mentioned the fact that the bark was left on the stumps. We know absolutely that where the bark is left on the stump of a diseased tree, in which the spores very naturally work down the tree we are pretty apt to find them around the base; so, of course, we cannot consider that a very effective way of treating the tree, or a fair test of the cutting-out process. What we want to find out is where somebody has treated a tree, cut the tree out, then destroyed the bark, and kept a record of that for some years, two or three years, possibly, to see if there is any recurrence of the infection. I was talking with Dr. Metcalf sometime ago along that line and he says that, in the vicinity of Washington, they have for the past two or three years carried on a rather extensive campaign for the detection and eradication of the disease, and I think I am correct in the statement that he has located certain spots, cut the disease out, and there has not been a recurrence of the disease. I should much prefer to have that statement come from Dr. Metcalf, or somebody from the Bureau of Plant Industry; but, if that is the case, this Conference ought to know about it, because it seems to me there is a ray of hope there that we may be able to combat this disease. There is, of course, as shown by this Conference, a general interest in this bark disease, and I cannot help but believe that a Conference of this sort is going to lead to very productive results. The interest in Maryland is a very important one. We realize that it is necessary for us to do something *now*, if we are going to do *anything* at all. We find that the disease has spread over the eastern and northeastern sections of the State. Perhaps one-fourth of the State has been generally invaded. Probably about five per cent. of the chestnut trees in the area is lost up to the present time, and I may say this is based on an investigation of last summer to determine the extent of the damage caused by the chestnut bark disease in Maryland. I might say also that this investigation was prompted, at least, by the very excellent example that we have in Pennsylvania, because we felt that we might use it as data, not only for the State of Maryland in trying to control the chestnut bark disease, if it is possible to do so, but for other States in co-operation with the State of Pennsylvania. We found that the amount of damage up to the present time was about thirty thousand dollars, that is, the stumpage value of the chestnut trees, and in the area of infection that the stumpage value of the chestnut was something like six hundred thousand dollars. The disease appears to be spreading very rapidly. The total stumpage value of all the chestnut in Maryland is something like two million dollars. So, if there is some way by which we can control the chestnut bark disease, it is going to mean a great deal to the forest interests of the State. What we propose to do,—and we have already started the machinery going, but the results of this Conference are going to determine very largely the manner in which we are going to press that,—we thought it might be possible, by establishing a sort of dead line just outside the area of infection to prevent the spread of the disease. Now I do not know whether that is practicable or not, but it seemed to be the only solution offered at the time, and in carrying out that idea we have introduced a bill, which is practically a copy of the Pennsylvania law, into the Legislature of Maryland, now in session, carrying a small appropriation for the purpose of putting this work into operation.

Now we have had several people speak about the management of the chestnut as being perhaps the solution of the difficulty. It seems to me that where a man has the chestnut bark disease in his woods, it would be simply commonsense business policy to cut out those diseased trees and utilize them wherever possible, and I think we can depend on the individual land owner to do that. Now whether it will be possible for us to go much further than that in recommending the prompt cutting out and utilization, where possible, of the diseased chestnut trees, I am not prepared to say. I doubt whether it will be possible to go any farther than that, but it seems to me, outside of this area of general infection, if we can establish a sort of quarantine zone beyond which we can protect the rest of the chestnut trees in the State, that the work will be well worth while, and that is the line along which we are proceeding at the present time. Now as to the question of management, I think that simply by cutting out diseased trees and by a coppice management of the chestnut, I do not see how that is going to eliminate the disease, because we know definitely that the stumps are more apt to be diseased, and this infects the sprouts as soon as they come up. I have seen that time and time again over the State of Maryland, that those sprouts become immediately diseased, and the whole tree dies very quickly. What has been done has furnished the basis of the proposed work, and I hope that we will be able to evolve from this Conference some definite programme, which other States can adopt with some hope of ultimately controlling the chestnut bark disease. I realize that it is a very big proposition, and we are not going to do it all at once; but I think by concerted action and a definite policy, we will certainly be able to limit the destruction by this disease, which has already done such an immense amount of damage in the northern States. (Applause).

THE CHAIRMAN: Are there any questions?

MR. BRAUNBERG, of Pennsylvania: Are those approximate figures you gave of the damage already occurring in the State of Maryland to the chestnut trees? You made an approximate estimate of the damage to the chestnut trees, also an approximate estimate of the value of the chestnut trees. May I have those figures?

MR. BESLEY: The present damage was estimated at fifty thousand dollars, based on a stumpage basis, and the total stumpage value of the chestnut in Maryland is about two million dollars.

THE CHAIRMAN: Mr. Detwiler will comment on one point raised by Mr. Besley.

MR. DETWILER: Mr. Besley asked for some definite facts concerning the efficiency of the cutting-out method. I have some facts, which are not conclusive, but may be of interest. Mr. Peirce, Secretary of the Commission, cut several hundred trees on his property, near Ardmore, last year. The stumps were barked to the ground and the sprouts came up abundantly. Two weeks ago I sent one of our fields agents to investigate thoroughly, and he reported being unable to find a single sprout diseased, and those sprouts are now a year old. It may be that after two years they will be diseased, but at the present time they are still sound.

THE CHAIRMAN: Virginia.

DR. H. S. REED: Mr. Chairman: The Experiment Station has studied the chestnut blight in a small way, since we have had, up to the present time, very little complaint of diseased chestnut in the State. We have heard, though, from several here at this meeting, that there are a few centres of infection in the State. We know the disease is present just across the Potomac from Washington, and we know it is present in Bedford county, at Fontella. We have reports, however, which have not been fully verified, of the disease in Albemarle county and also in Henrico county, near Richmond. I went over the last named territory with Dr. Metcalf last fall, but we were unable to find the disease in the field. We have, however, in the State, a disease which has existed for about twenty years and has caused a very considerable destruction of chestnut timber, south and east of Lynchburg. I visited this region about ten days ago and found there a fungous disease, of which we have not yet been able to determine the exact nature. Some of the gentlemen who are here have found the *Diaporthe* fungus near Lynchburg. If the *Diaporthe* fungus has been there for the last twenty years, it is evident that it is acting somewhat differently from what it is acting in the North. We have this question under observation. The diseased areas are at present confined to the Piedmont district; none has been reported from higher elevations in the Blue Ridge or Allegheny mountains in the State. There is a bill before the Legislature now in session, asking for a small appropriation to be used against this disease, which will not permit of any extensive eradication, but we hope to use it in getting a good survey of the damage which has already been done and to get a basis for future recommendations.

THE CHAIRMAN: Are there any inquries regarding the situation and methods in Virginia? The next State is West Virginia.

PROF. GIDDINGS: I will make my remarks brief, because we have done but little in West Virginia in regard to it. So far as we actually know, there were three infections in West Virginia. Those were scattered through the State; one in the central part, one in the northern part, and one fairly well south in the State. One of them came from nursery stock. The tree was purchased from a nursery, set out by a lumber man, and he discovered that there was something wrong. That tree has been destroyed. One of the other diseased areas, in the northern part of the State, we believe has been destroyed through lumbering operations which have been going on there, as I understand the infected trees could not be found last fall. We undoubtedly have more of the disease, especially along the northern border and near the Pennsylvania line, as there is considerable infection in the southwestern portion of that State. We hope to get some work done during the coming season. I know that a number of interested parties will make a very strong effort to have at least a small amount of careful work done in West Virginia to determine the prevalence of the disease in certain sections of the State. We cannot hope to do much, but our Legislature will meet a year from now and if conditions warrant, there will, I am sure, be no trouble in securing funds to continue the work. The possible losses in West Virginia are considerable. I have secured several estimates as to the chestnut stand in the State. One firm which is reported as doing the largest lumbering business in the State, dealing in timber land and well acquainted with the subject, places the present stumpage at ten billion feet. As proof and in support of their statement, they gave me reliable data in regard to the chestnut stand in some regions of the State. A stumpage value of $2.50 per thousand, which they quoted, would make twenty-five million dollars for the chestnut in West Virginia, and certainly some effort will be made to determine the extent of infection and the best methods of handling the disease in the State.

MR. BESLEY, (acting temporarily as Chairman): Are there any questions to be asked Professor Giddings? The next is Ohio; is there anyone to represent the State of Ohio? (No response).

North Carolina. Is there anyone to speak for North Carolina? (No response).

We will next hear from Tennessee.

MR. J. W. FISHER: Mr. Chairman: As far as I know, there is no infection in Tennessee. We are extremely interested in the matter, because we have such a vast area of chestnut forest, and a very large amount of it is the original forest. We have very far-sighted Congressmen down our way, who have been fortifying, or are about to fortify, us against such infection, by having a bill passed through Congress appropriating one million dollars, to establish forest reserves in western North Carolina and eastern Tennessee, known as the Appalachian Region. Just last week the Government purchased eighty-five thousand acres near me, in eastern Tennessee, for a forest reserve, and will continue to purchase large areas, so that we will have the backing of the Federal Government in the fighting of this disease in the future. I shall, however, call the personal attention of the Governor to this matter, so that we may take it up ourselves, as a State, and I trust that, when the matter comes to our attenion personally, we shall have some means that will help to battle with the disease, if it should occur. I am very much interested in listening to these discussions, and I think I shall go home very greatly profited. As I am a tanner and an extract man, I am personally and financially interested in the prevention of any loss of chestnut timber. I might say to you, for your information, that a large number of the trees in our country are very old. The Federal Government inspectors who have been in those forests have placed the age of those trees from two hundred to four hundred years, and some of them range as high as eight feet in diameter,—immense trees. The area is so large and the chestnut timber growing so thickly that it affects us, or would affect us, vitally in a number of directions. The water supply or water sources will be vitally affected if this disease should get the better of us and cover very much of our vast territory. I assure you that none of you are more vitally interested in this matter than the people of Tennessee, for the great reason that we have so much chestnut.

THE CHAIRMAN: Is there any inquiry from Tennessee? The next is Canada, Dr. Gussow.

DR. H. T. GUSSOW: I do not think I need to take up the time of the meeting this morning. I have already expressed my observation that the disease is not present in Canada, and that we have very few chestnuts. I have come here to profit by your information, which I am grateful to say, I have been able to do.

THE CHAIRMAN, (Mr. Pearson): The Chair committed a slight error in suggesting that President McFarland would be available to make suggestions regarding seeing the city. He should have mentioned Mr. Bell, who was mentioned by President McFarland, and who will be available after this meeting.

I have been requested to make the following announcement: Please inform this meeting that a good photographer will be at the main entrance immediately after adjournment to take a group photograph,—at the main entrance where the statuary is. The size of this will be 11 x 14 and the price one dollar per copy for those who desire to get copies. It is urged that each one go at once to the main entrance, so as to be in this photograph, whether you choose to buy it or not.

Deputy Commissioner Williams will present a communication from the President of the United States.

MR. WILLIAMS: The following letter accompanied by certain documents, has just been received by Governor Tener, and I am requested to present it to this meeting:

"White House, Washington, February 19, 1912.

My dear Governor:

I herewith enclose a communication from the Secretary of the Department of Agriculture, in which he gives all the information which is available in his Department upon the question of the chestnut bark disease which is to be considered in a public meeting in your capital to-morrow.

I hope that this communication may contain certain information of value to your people in fighting this very destructive enemy of one of our most beautiful trees, and you have my very earnest sympathy in your efforts to accomplish the desired end.

Sincerely yours,

(Signed) W. H. TAFT."

(Applause).

MR. WILLIAMS: This is accompanied by a letter of Secretary Wilson, transmitting the information requested by the President, a copy of Bulletin No. 467, and a statement of the present status of the chestnut bark disease, signed by William A. Taylor, acting chief of Bureau.

It was moved and seconded that the communication be referred to the Committee on Resolutions.

The motion was put and carried.

The letter of Secretary Wilson, referred to above in the letter from President Taft, is as follows:

"Department of Agriculture,
Office of the Secretary,
Washington, February 19, 1912.

Dear Mr. President:

Our experts in the Bureau of Plant Industry have given the chestnut bark disease situation much attention for some time past, and are convinced of the urgency of the present situation. They have prepared the inclosed memorandum which indicates the present status of the chestnut bark disease and the importance of prompt action, if its further spread is to be prevented and serious loss to the people of the entire Appalachian region is to be averted.

Sincerely yours,

(Signed) JAMES WILSON,
Secretary.

To the President."

The communication referred to in Secretary Wilson's letter to the President, indicating the present status of the chestnut bark disease, is as follows:

United States Department of Agriculture,

Bureau of Plant Industry,

Office of Chief of Bureau.

Washington, D. C., February 19, 1912.

MEMORANDUM FOR THE SECRETARY.

Regarding present status of chestnut bark disease.

This disease, which was first recognized as serious in the vicinity of New York City in 1904, appears to have been present on Long Island as early as 1893. Its origin is unknown, but there is some evidence to indicate that it was imported from the orient with the Japanese chestnut. In southwestern Connecticut, southeastern New York and northeastern New Jersey a majority of the chestnut trees are already dead from the bark disease. Outside of this area in western Connecticut, eastern New York, western New Jersey, southeastern Pennsylvania, northern Delaware, and northeastern Maryland the chestnut trees are practically all infected. Outside of this area from the northern border of Massachusetts and from Saratoga county, New York, southwestward to the western border of Pennsylvania and the southern border of Virginia, scattering areas of infection are known to occur and may be expected at any point. So far as is known the disease is limited to the true chestnuts and chinquapins. It is not certainly known to occur on oaks, beeches, horse chestnuts, or other forest trees.

The bark disease appears ultimately to exterminate the chestnut trees in any locality which it infests. The financial loss from this disease in and about New York City was estimated three years ago at between five and ten million dollars. A conservative estimate made in 1911 by the experts in the Bureau of Plant Industry indicates a loss in the states infected, up to that time, of twenty-five million dollars. The heaviest damage thus far has been to chestnut trees in localities where this species is grown chiefly for ornamental purposes, rather than for lumber. It has now reached a point in its spread where the entire chestnut timber belt of the United States, comprising portions of the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New, Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Ohio, Indiana, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama and Mississippi are likely to become involved. As the disease is spread from tree to tree by spores of the fungus which causes it, the spread is usually rapid after a single tree in a locality is infected.

There is evidence that the spores are spread through short distances by rain; through longer distances it appears possible that it is spread also by birds, insects and rodents, such as squirrels. The disease is carried bodily for considerable distances in tan bark and in unbarked timber derived from diseased trees. It is also frequently transported on diseased nursery stock.

No method of immunizing individual trees is yet known and no method of treating or curing them when once attacked is certain in its results. This being the case, so far as the chestnut forests are concerned, the only practicable method of dealing with the situation is that of prompt location of isolated centers of infection in advance of the main line of the disease, coupled with the prompt cutting out and destruction of such scattered diseased trees. This method has been tested sufficiently to indicate that it is practicable to control the disease where the situation is effectively attacked before a general infection has resulted. In addition to this it may be found necessary to establish an immune zone by destroying all chestnut trees, diseased or healthly, in a belt ten to twenty miles wide, or possibly less, in advance of the main area of infection, with a view to barring its progress. A regional quarantine of chestnut products likely to move from the area of complete infection to protected territory may be found necessary. This is now a subject of consideration in the investigations that are under way.

The disease having already done much damage in eastern Pennsylvania and northeastern Maryland, but not having appeared to a destructive extent in the states farther south, it is peculiarly important at this time that effort be made to stay the progress of the disease before it reaches the heavily timbered chestnut areas of Maryland, West Virginia, Virginia, and the mountain regions farther south. The fact that the State of Pennsylvania has appropriated $275,000 for the eradication or control of the disease within its borders is an indication of the importance with which the matter is regarded there. Congressional action with a view to making possible effective co-operative effort to control the disease by Federal authorities in co-operation with the authorities of the several states interested, before it is spread to a point beyond control, appears to be of the utmost importance.

Very truly yours,

(Signed) WM. A. TAYLOR,
Acting Chief of Bureau.

NOTE.—The accompanying document sent with the President's letter, "Farmers' Bulletin, No. 467," is not reprinted herein, but may be obtained without charge upon request, from the United States Department of Agriculture, Washington, D. C. This Document is entitled "The Control of the Chestnut Bark Disease," by Haven Metcalf and J. Franklin Collins. Issued under date of October 28, 1911.

THE CHAIRMAN: The programme now calls for coming together at two o'clock, and the first paper will be by Dr. Hopkins, on the insect question. No one can regret more than the Chairman that the general discussion has been crowded out this morning. Would it seem wise to begin our meeting this afternoon at a quarter before two, in order that we may have a little more time?

MR. WILLIAMS: I make that motion.

The motion was seconded and duly carried.

THE CHAIRMAN: I am asked to announce that the professional foresters,—all professional foresters, are invited to meet in this room at 1.30 P. M., fifteen minutes before our meeting time, for some general purpose.

MR. WILLIAMS: I wish to announce that the Committee on Resolutions will meet in the House Caucus room, immediately beneath this chamber, after adjournment, this morning.

The Chairman announced that the Convention stood in recess until 1.45 P. M.

AFTERNOON SESSION.

Wednesday, February 21, 1912, 1.45 P. M.

THE CHAIRMAN: The meeting will please be in order. We are to have first this afternoon, a paper by Dr. A. D. Hopkins, who is in charge of forest insect investigations, Bureau of Entomology, U. S. Department of Agriculture.

DR. HOPKINS: Mr. Chairman: I regret exceedingly that the insects are interfering in this trouble, and making more of it. Heaven knows they are making enough trouble of their own all over the country. They are killing the merchantable sized pine in the Rocky Mountains and on the Pacific Coast at a greater rate than that by fire alone. They are killing the pine in the South. They are killing the hickory, they are killing the oak and the hemlock, and now they are interfering in this disease. They are also killing chestnut on their own account.

Mr. Chairman, I have two papers here, both about the same thing. One is an abstract which will take about ten minutes; the other is the whole paper, which will take about half an hour. I presume you would like to have the abstract, which will take less time.

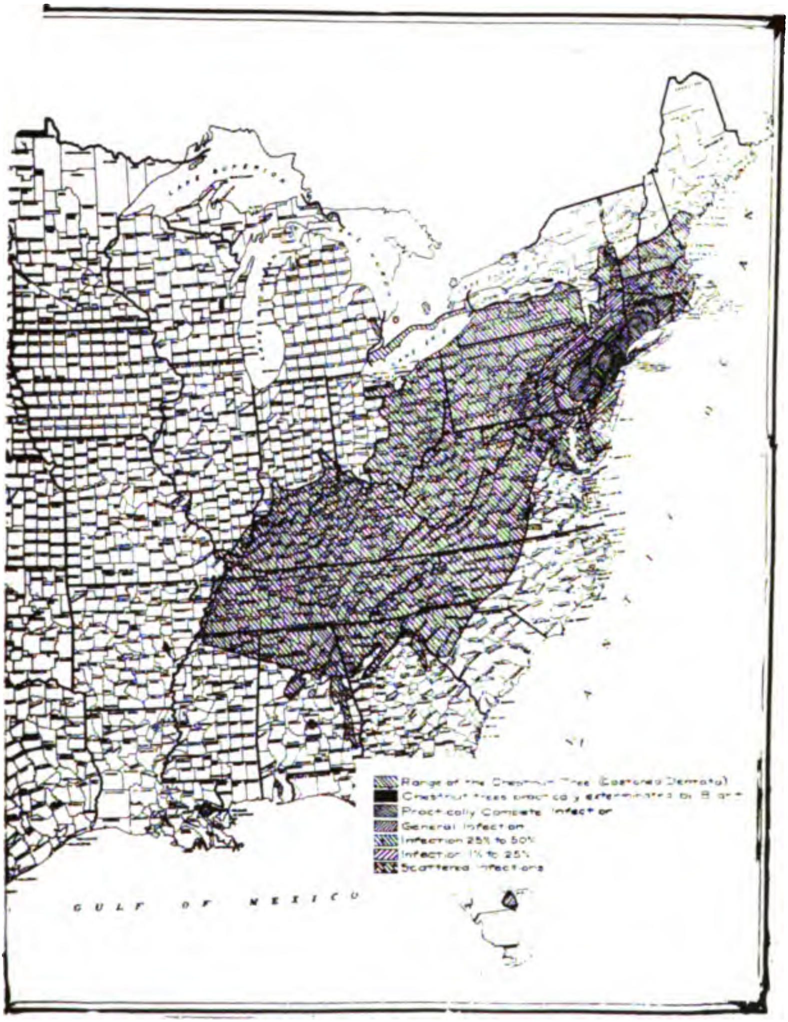
THE CHAIRMAN: I presume it would be better to give us the abstract, and then, if there is more time available, let it be spent in general discussion. Will that meet with your approval?

DR. HOPKINS: Yes; that is what I intended to do.

Dr. Hopkins read the following paper:

While the history of the discovery of the chestnut blight disease and its spread from a local to an interstate problem is well known and much interest is manifested in the subject, the history of extensive dying of chestnut from various other causes is not so well known.

When we review the history of extensive dying of chestnut during the past half century in Mississippi, Tennessee, Georgia, South Carolina, North Carolina and Virginia, it is surprising



Map showing range of the chestnut tree, and comparative percentage of the chestnut bark disease.

that there are any living trees left. In fact, there are not many left in some sections of these States where the tree was abundant and healthy fifty years ago.

It appears that there are a number of agencies of destruction other than this new chestnut blight disease, and that these agencies have been in operation in the area affected by the disease as well as in areas where this disease is not known to occur. Therefore, they must be taken into consideration and investigated before the problem of protecting the chestnut can be solved.

There appear to be other diseases and we *know* that there are insects which have been directly or indirectly the cause of the death of a large percentage of the chestnut over extensive areas.

One species of insect, the two-lined chestnut borer, is perhaps the most destructive insect enemy. It has been investigated and methods of controlling it determined and demonstrated, and there is no lack of published information on the subject.

There is also a combination of insects and the chestnut blight disease. Investigations by forest pathologists have revealed the fact that the spores of the chestnut blight find their way into the living bark through some wound and that the majority of such wounds appear to be caused by bark-boring insects.

Recent investigations by forest entomologists tend to verify this general statement, and that a large number of species of insects are involved.

Inasmuch as the insects make a primary attack and the disease is largely dependent upon insects to continue its destructive work, it is also plain that we have an insect problem of perhaps equal importance to that of the blight itself.

It is also plain that this interrelation of insects and disease presents a new and complicated problem which will require a great deal of exact scientific research by the forest entomologists and the forest pathologists before we shall be warranted in arriving at definite conclusions, or in giving specific advice on methods of control and prevention.

Considerable work has already been done on the general subject of chestnut insects by the West Virginia Agricultural Experiment Station and the Bureau of Entomology of the U. S. Department of Agriculture since 1893. The published and unpublished records of these studies show that three hundred and fifty-four species of insects were found to inhabit the chestnut. We find that other observers have recorded one hundred and sixty-four species. By eliminating all duplications, the total is four hundred and seventy-two. So you see that the chestnut is pretty well inhabited by insects. This is only a beginning. There are many more insects to be found on the tree and a great deal to be learned about them as a basis for practical conclusions and action. A more specific and comprehensive study of chestnut insects is now being carried on under a special project of the Branch of Forest Insects of the Bureau of Entomology. This investigation will be extended into all parts of the country where the chestnut is, or has been, an important forest tree, and especially in those States and sections where the people representing the private, municipal, and State ownership manifest a special interest in this phase of the problem. We are assured of the co-operation of the Commission and other State officials in the work carried on in Pennsylvania and we hope to have the co-operation of other States in any work done within their boundaries.

Possibilities of Control.

You will note that I am not discussing the control of the disease, because I do not pretend to know anything about that, but that, as the insects are related to the trouble and the primary cause of the wounds, we must consider control of the insects as a primary measure.

In the consideration of the possibilities of controling depredations by the insects, it may be stated that under certain conditions of public interest, with facilities for utilization of the affected product, and with a knowledge of the fundamental facts and principles relating to the depredators and their control, it is entirely possible and as a business proposition it will pay.

On the other hand, it has been forcibly demonstrated in a number of cases that have come under our observation that any direct attempt to combat an insect depredator without a knowledge of essential facts and principles will result in failure and a waste of energy and money. It has been shown that a few hundred dollars expended in practical application after the essential facts have been determined will accomplish more than many thousands of dollars expended without such knowledge. In other words, practical application must follow and not precede scientific investigation and expert advice, just as legislation for the control of forest insects to yield good results must follow and not precede education on the principles and methods of control.

The steps toward the successful protection of forest trees from their insect enemies are:

1. Investigations to determine the essential facts about the principal insects which are capable of killing the trees.

2. Concentration of the investigations on the most important species to determine their seasonal history and habits, and the most economical and effectual methods of preventing serious depredations by them.

3. Dissemination of authoritative information on the essential facts and principles of control and prevention, by means of circulars, press notices, lectures, special field instructions, and field demonstrations.

4. Practical application of this information by the owners of affected and threatened timber, under a strict adherence to the recommendations.

I might pause at this point, to make it clear, that we are conducting now and have conducted a number of practical demonstrations to prove that our recommendations will work, and we have proved it in a number of cases. In one case last summer, involving the cutting of over twenty thousand trees, over a very large area in Oregon we demonstrated the practicability of controlling one of the worst insect enemies of western forests. In one locality in Montana over ten thousand trees were cut by private owners, small owners. They cut the timber and worked it into fuel and burned it during the winter and stopped insect depredations which had been going on for twenty or thirty years and killing an enormous amount of timber. The timber stopped dying the next year. I had a letter informing me, just before I came here, that over one hundred Indians were cutting and barking timber according to our recommendations in an Indian reservation in eastern Montana. This is a demonstration project, and the Indians are so much interested that they have authorized the expenditure of ten thousand dollars, and they are cutting the timber and barking it themselves. This, we believe, is almost certain to be a success, and we will be prouder of it than anything else we have done, because it shows that, if the Indians can do it, anybody else can do it.

Continuing my paper, in conclusion, I want to say that in our general investigations and practical demonstrations, we have recognized that the State and Federal governments can render the greatest service through investigations and the dissemination of information and that it is the owner who should make the practical application. Therefore, this chestnut problem is the people's problem and especially that of the people who are owners of valuable natural or cultivated growth. It seems to me that the only way the successful protection of the chestnut resources of the country can be brought about will be through individual and co-operative action by the owners. They are the ones to be directly benefited, financially and otherwise. I am sure that, as a rule, they are anxious to do everything they can afford to do, if someone will show them how and demonstrate to them that, as a business proposition, it will pay. They will then not only try to protect their own timber but they will realize that there is a common interest involved and will be impelled to help their neighbors, their county, and their State.

I have some photographs here which I took in 1903 in North Carolina, showing the extensive dying of chestnut there. The chestnut, practically dead as far as you could see in every direction, the white, barkless trunks appearing as ghost trees in the forest. I have also a list of the insects found on chestnut, which of course you do not want me to read.

THE CHAIRMAN: Dr. Hopkins has some photographs here illustrating some of the insect pests, and I am sure he will be glad to show them to those who are interested, after this session is over. The paper of Dr. Hopkins is open for discussion. I know he will be glad to answer questions that may arise pertaining to the relation of the insects to the chestnut bark disease, or any other questions that may come up in relation thereto.

DR. MURRILL, of New York: I would like to ask Dr. Hopkins how far these beetles which attack the chestnut have been known to go from tree to tree in a forest?

DR. HOPKINS: That is not known. We have no way of determining how far they will go. But they have wings and can fly. There is no reason why they should not go long distances.

DR. REED, of Virginia: I would like to ask how many of these insects are borers in the chestnut that would inflict any wound in the bark which would be large enough to allow infection by a fungus?

DR. HOPKINS: There are a number of insects which may cause wounds which will give entrance to the spores. When the insects hatch from the eggs, they are almost microscopic; therefore, the burrows made going into the bark will hardly give entrance to the spores unless there is a flow of sap from these small wounds, which sometimes happens. My observation in Virginia and the section south of Washington indicates that there is a disease, possibly a bacterial one, which does get into these minute wounds, on account of a small amount of the sap oozing out, and in that way it works into the cambium. This is only a possibility which has been suggested time and time again to me by my observations; perhaps it acounts for the fact that great numbers of dead trees in the South, do not show any traces of insects. The trees die and the bark falls off and yet they show no evidence of insects. Of course, the majority of dead trees do show such evidence. We have had a man down in North Carolina in 1903-1904 studying the insects, and trying to determine the cause of the extensive death of the timber in that state, and there was no doubt that a great many of the trees were killed by insects, but that insects were not the cause of all of the trouble.

DR. REED: Is there any part of the tree which is invariably attacked by these insects, or does it occur generally on the tree?

DR. HOPKINS: The principal point of attack, the most vital part of a tree, is the middle trunk. We have found, in the study of insects which kill trees, that they attack the middle portion of the trunk. They girdle the tree at that point. The two-lined chestnut borer does this especially. Other insects attack all parts of the tree including the leaves, and some of them are associated with the chestnut blight, as has been determined by Mr. Craighead, who has been carrying on work under my instruction here in Pennsylvania.

MR. BARRUS, of New York: I would like to ask: Is there any case where the larva of the insect is found under the bark, and the mycelium of the fungus is found radiating from the burrow of that insect? I would like to know whether that is known to Dr. Hopkins, and whether that means anything relative to the spread of the disease? Would it be possible that the spores of the fungus were deposited at the same time the insect was deposited there in the egg, and a mycelium growth had gone on parallel with the development of the larva?

DR. HOPKINS: That is a problem yet to be solved. It is a problem in which we will have to co-operate with the forest pathologists. We are studying that feature of the problem. We find insects undoubtedly associated with the disease. We find them going into the perfectly healthy bark of some trees and we find the disease following them. We find also that insects go into the healthy bark or other trees, and the disease does not follow; so that it is one of the complex problems to be worked out. I think it is absolutely necessary to work out a few of these problems before we can do much towards control. I think it will save money. We certainly ought to know something about what we are doing.

MR. BARRUS: A number of articles have been sent in for identification, reported as the work of insects which had not worked in healthy trees, and I wondered whether it was meant by that whether those insects would work on a tree after it had lost a certain degree of vitality, even before the tree had died.

DR. HOPKINS: It depends on the species. There are very few people who can recognize the different species of insects in the larval stage. We have specialists working on this now. The identification of species from the larval stage is something the general entomoligist cannot do. Any assumption, from the larval form alone, that certain insects will do so and so, is mere guesswork. Some species of insects will bore in the living bark. Others can not possibly exist in the living bark but must bore in the dying, dead or decaying bark. There are many species, as this list shows, over four hundred and seventy-two species, and out of those there are only a very few which attack perfectly healthy trees. So that the others live in various ways. If a lot of insects is found in a diseased tree, we must know which of these are the insects that attack the living bark and which come in after the bark begins to die, or after it is dead, and whether or not any of them can carry spores after they transformed into the adult stage and come out. I doubt whether the relation of insects is as important a factor as has been suggested, because as a rule when insects develop to the adult or winged stage, and emerge from the bark, they fly away very quickly, as if to escape some enemy. They do not as a rule crawl about over the bark before they fly.

MR. W. HOWARD RANKIN, of Ithaca, New York: Can you tell us whether in your estimation, the Leptura species of borer precede infections of the blight, or follow it?

DR. HOPKINS: That is a problem we are working on, but we are not ready to form an opinion on it. It will require a summer's work before we can state definitely just what relation they have to the disease and the dying of trees.

MR. RANKIN: I would also like to ask the Doctor if he is acquainted with some chestnut trouble in Otsego county, New York? There is a lot of chestnut dying in that locality from what I took to be insect trouble.

THE CHAIRMAN: Mr Rankin calls attention to apparent losses caused by insects in Otsego county, New York

DR. HOPKINS: The matter has not yet come to my attention.

THE CHAIRMAN: Are there further questions?

PROFESSOR CLINTON: I would like to ask Dr. Hopkins if, during the past few years, the insect troubles of trees in general have been on the increase or decrease, over the previous ten or fifteen years?

DR. HOPKINS: I have been studying the subject in relation to dying timber for the past twenty years, or since I started to study forest insects, and the question of climate has been one to which we have given considerable attention; because every time trees start to die someone comes up and says they are dying from drought, or if it is a wet season they claim they are dying from wet weather. We have demonstrated conclusively, I think, that insect troubles do not depend on drought. In fact, the most destructive insects work better under moist conditions. So far as the relative abundance now and formerly is concerned, it is the habit of all destructive insects to be very destructive for a series of years and then practically disappear. This is, under natural conditions they go in waves. There is no particular period, but whenever the conditions, whatever they may be, are favorable for their rapid increase, and their enemies are not present in numbers, they start another invasion and sometimes kill off nearly all their host trees. The most striking example of the complete extermination of an insect throughout a vast area was in 1893. In 1891 and 1892 the pine throughout West Virginia and Virginia was dying at an enormous rate. We found that it was being killed by the southern pine beetle, which was threatening the total destruction of all the timber in those two States, and did kill from seventy-five to eighty per cent. of the best merchantable timber. In the winter of 1893, in January, it was twenty-five degrees below zero in many sections in this area. The next spring when we went into the woods to continue our investigations, we found all of the broods of this beetle dead, and as we continued the investigation we found them dead all over the area. Since that time to the present, there has not been a single specimen of that beetle found in the area mentioned. This is an example of climatic influence. If we could have something of that character come along and clean out the chestnut blight, it would settle all this trouble; but we can not depend on such things to happen. This killing of the southern pine beetle by cold was due to the fact that it is a southern insect which had worked its way northward during mild seasons, so that when the extreme cold came it was exterminated. This cold did not kill any of the local insects that were working in the bark with it. The same insect is now threatening the destruction of the timber throughout the southern States. Our work in the south during the past summer has led to the extensive cutting of infested trees by the owners in carrying out our recommendations, and I think the beetle will be controlled.

THE CHAIRMAN: You will all be pleased to know that Governor Tener very willingly accepted an invitation to come in and say a few words this afternoon before our final adjournment.

This morning, after considerable labor, we formulated some rules to govern a discussion that never occurred. It occurs to the Chairman that it might be well to open up the subjects of the morning session, in connection with the one subject presented this afternoon, under the rule adopted this morning and continue along that line until the Committee on Resolutions is ready to report. If no objection to that proposal is made, it will be understood that it is the wish of the Conference so to proceed, having the paper presented by Dr. Hopkins and the papers presented before us this morning for discussion on a three-minute rule.

DR. MICKLEBOROUGH, of Brooklyn: Mr. Chairman and Gentlemen: I have given some four years of study, more or less, to this fungous disease causing the death of the chestnut trees. A great many of you have seen the pamphlet which I wrote for the State of Pennsylvania. I am indebted for my first knowledge of this subject to the gentlemen just in front of me, Dr. Murrill, of New York. My attention in 1907 was called to it in Forest Park in Brooklyn. Let me say a word or two to those who are using the microscope. I think perhaps one or two errors may have been stated here, and I want to call attention to the spores that are developed by this fungus, the *Diaporthe parasitica.*

This fungus produces four kinds of spores. The two most abundant and generally found are the sac spores in the winter stage and those other spores in thread masses called conidial spores, and which are present in the summer stage. Besides these there will be found in some specimens, numerous small spores (or cells) which are developed in a flask or perithecium called a spermagonium. These very minute spores (or cells) of the spermagonium are called spermatia. Besides being very small they possess great motility. There is a fourth kind also developed in a flask or perithecium which is called a pycnidium.

The pycnidial spores (or sporules) are from two and a half to three times the length of the conidial spores. The sporules are borne on pedicels and are not contained in sacs as are the winter spores. A pycnidium may properly be called a stylosporous perithecium. These four kinds of spores, vary in size and are of a different origin. The condial spores are the only kind not produced in perithecia or flask-shaped bodies. The conidial spores are borne on filiform, simple hyphae. The sac spores are called *sporidia,* the thread mass are *conidia,* the minute spores (or cells) are the *spermatia,* and the pycnidial product are the sporules.

THE CHAIRMAN: Doctor, I think I will have to ask for unanimous consent, because we have now gone to the limit of our rule.

DR. MICKLEBOROUGH: I would ask consent that I may be able to present a statement that I think is of some importance in the work which I have been doing just lately.

THE CHAIRMAN: Can you give us an idea of the time?

DR. MICKLEBOROUGH: I will take just a few minutes.

THE CHAIRMAN: Dr. Mickleborough asks unanimous consent that he proceed for a few minutes to complete this statement. It seems to be necessary to ask that, because we are working under a rule. Is there objection? If not, the consent is given.

DR. MICKLEBOROUGH: I will take up the other feature. I have had under consideration all forms of sprays and cutting and things of that kind, and have examined the cuttings in many parts of New York State and also in Pennsylvania. I want to make this statement, not to produce any sensation or create any false impression: Within the last five months I have had associated with me in this work an experienced bacteriologist, and last Friday I called upon my associate and I asked him to give me the language that I might use as to what we had accomplished up to this time in trying to find an entirely different remedy for the chestnut tree blight. I will read you the words that he approved of last Friday; that was February 17, 1912:

"The work has advanced sufficiently to state that temporary immunity is assured to a certain degree." That means over certain areas and over smaller things with which we have had to deal in the bacteriological laboratory. "And spore development in affected areas has been arrested."

Now we have started out largely with the idea that dog will eat dog and that we will have to meet this from the bacteriological standpoint. I do not know; and I do not promise success. We are going ahead with this work and many experiments will have to be preformed this spring. I am not sure that we are going to be successful, anl I am not going to tell you whether it is going to be a toxin or an anti-toxin, as we might call it, or a serum which can be used.

MR. STEVENS: This is a very interesting paper and we enjoyed it; but we have taken up so far in our Conference the negative side of the question and, with the limited time left, I think we have all we can do to consider ways and means of procedure. I think it should be the sense of the meeting that we should give the remaining two hours of time to positive work, in the procedure of the work of this Conference.

DR. MICKLEBOROUGH: I have no desire to prolong this discussion at all against the wish and the unanimous consent of the Conference, and I am not wishing to create a false impression. What we may be able to produce I do not know. I do know this, that it is something that ought to be encouraged, just as much as when the sleeping sickness in Africa killed a million of the tribes of Africa. The white man did not say, "Let them die" but rose up, as a man, the rebel in nature, and said "I will not die, but I will destroy that which is destroying me." and I am taking that position now. We are trying to see if there is not something that can be done to destroy the chestnut tree blight. I yield to the gentleman; if there is any objection, I do not wish to continue.

THE CHAIRMAN: The matter before us comprises the papers of this morning, with their various bearings, and the paper of the afternoon. There are four distinct subjects.

DR. SMITH: There has been a manifest desire that all possible information be given here of the experiments of Dr. Metcalf, whose publication has raised the hope that the dead line is to be effective. Possibly Dr. Crowell can tell us something about it, or some other member of the Department.

THE CHAIRMAN: That would be eminently proper under the rule guiding us at the presene time. We would be glad to here from Dr. Crôwell for three minutes, and extend the time, if the Conference desires; either Dr. Crowell of Professor Collins will speak.

PROFESSOR COLLINS: Mr. Besley made the remark, I do not remember whether it was this morning or not, that he would like to have some positive statements. I am prompted to say a few words about the matter. I should have said them before, only the discussion seemed to be so close on to the time limit that I thought perhaps a little more favorable opportunity might occur later.

In reply, if we can regard it a reply to the question of Mr. Besley and Professor Smith, I would like to say a few words in regard to the cutting-out experiment around Washington. You must remember that in the Farmer's Bulletin which has been published, the statement is made that those experiments were conducted chiefly by the senior writer, which is Dr. Metcalf. We are all sorry that he cannot be here to tell you more about this. Unfortunately I have visited only a few of these places personally. Here is a statement, however, which I would like to read in connection with that:

In Farmer's Bulletin 467, p. 11, we made the following statements regarding certain experiments which had been performed at that time to test different methods of controlling the disease by cutting out advance infections:

"The country within approximately thirty-five miles of Washington, D. C. was chosen in the fall of 1908 as preliminary territory in which to test this method of control. This section has since been gone over fairly thoroughly once a year. As will be seen by Fig. 1, fourteen points of infection were located and the infected trees destroyed. Most of this work was done by the senior writer. The largest infection was a group of nursery trees that had been imported from New Jersey; the smallest, a single lesion on a small branch of a large forest tree. In one case eleven forest trees in a group were infected, the original infection having been two trees, dating apparently from as early as 1907. Up to the present time (June, 1911) the disease has not reappeared at any point where eliminated and the country within a radius of approximately thirty-five miles from Washington is apparently free from the bark disaese, although new infections must be looked for as long as the disease remains elsewhere unchecked. It is therefore believed that this method of attack will prove equally practicable in other localities, and if carried out on a large scale will result ultimately in the control of the bark disease."

Since June, two new points of infection, dating probably from 1910, and a third suspicious point have been discovered within this area. This was expected, as above. If the results of legislation this winter show that an effort will be made to control the disease in Maryland, Virginia, and the District of Columbia, these points of infection and any others that may be found will be destroyed in the spring. Otherwise the experiment will be abandoned, except for keeping a record of previous cuttings.

Since Christmas six of the fourteen points above referred to have been visited. In one case where only diseased limbs were removed and the balance of the tree left standing, the tree has become infected. This was expected; we have always recommended complete destruction of diseased trees. At two points the diseased trees were cut, but the stumps left unbarked. This we believe to be bad practice, but in spite of this the stumps are still with one exception unaffected. In the other three cases the trees were entirely destroyed, and the disease has not reappeared in the vicinity. The regular inspection of all fourteen points will be made again in May and June, after the leaves are out, as has been our previous practice.

Only indicative conclusions can be drawn from the above experiment until at least six more years have passed. It should be borne in mind that this is an experiment, not a demonstration. The experiment should in any case have been duplicated in various parts of the country. It is not too late to do this now; even in States where it is too late to attempt general control, local cutting-out experiments can be made, and the end will give results of great value, on account of the difference in local conditions.

DR. MURRILL, of New York: Mr. Chairman: I wish to speak just for a moment in reply to the preceding paper, and I wish to speak very briefly and plainly, as to why the chestnut canker cannot be controlled by cutting-out method proposed:

1. It is impossible to locate all advance infections, these not being apparent even under close inspections.

2. It is practically impossible to cut and burn all infected trees after their discovery.

3. Even if these trees are cut, it is impossible to discover and eradicate the numerous infections originating from millions of spores produced on these trees and distributed by birds, insects, squirrels, wind, and rain.

4. Even if it were possible to cut and burn all affected trees, for ten or twenty years afterwards numbers of sprouts would grow up from the roots of these trees and continue to die from the disease and to spread the infection.

5. Supposing that it might be possible to eradicate all advance infections, what method is proposed that is at all feasible for combating the disease in its main line of advance? All of the foresters connected with the United States Government and the entire Army of the United States would be utterly powerless to oppose its progress.

6. Although the chestnut canker has been known and experimented with since 1905, there is not a single instance where an individual tree or a grove of trees affected by the disease has been saved. If it is impossible to combat the canker under the most favorable circumstances, how would it be possible to succeed with an extensive forest? The published account of the extermination of the chestnut canker in the vicinity of Washington, D. C., upon which experiment the requests for state appropriations are said to be founded, cannot be relied upon. The trees most conspicuously affected there have been cut and burned, so that the presence of the disease is not readily apparent, but with each season additional trees will be affected and

the attempt to stay the disease will be abondoned, especially when the main line of advance, which is now in northern Maryland, reaches the Potomac River. (Applause).

MR. CASSELL, of Philadelphia: I wish to say to Dr. Murrill that I will be glad any time to show him trees that have been treated for two years and are alive to-day and apparently quite healthy. (Applause).

PROFESSOR STEWART: Mr. Chairman: I wish to speak of two points mentioned by Professor Collins in connection with the Washington experiment. I think that he has left the impression that those points of infection discovered after June, 1911, could be regarded as new infections. Now, one of them, which we examined, Professor Collins says must have occurred in 1910, and I quite agree with him that it occurred as early as that, and perhaps earlier. That certainly cannot be regarded as a new infection. Another point: Professor Collins states that in those two cases where the trees were cut and the stumps left unbarked, that the disease has not reappeared. Perhaps he did not put it quite that way; I believe he said, "they are not now infected." Now on the 30th of December last, when we examined them (Dr. Metcalf, Prof. Collins and others being present), we found the fungus on the bark of one of those stumps, and also at the base of an adjoining tree, as stated in my paper.

MR. I. C. WILLIAMS: Mr Chairman: I wish to direct the attention of this Conference to the character of some of the scientific investigation that is going on with respect to chestnut blight disease. I think we have a right to know what some scientists are doing, what they are saying and what they are attempting to do. It is for that purpose, therefore, that I have brought before you a copy of the report of the New York State Museum, and I wish to read you a short paragraph therefrom. On page 7 of that report it is written as follows:

"While there (referring to a locality which was visited) my attention was called to a diseased chestnut tree. It was a young tree, with sickly looking foliage and a few dead branches. It was suffering from the chestnut bark disease, caused by a parasitic bark fungus. Both branches and trunk were affected by the fungus, the latter dead a few feet above the ground. It was my first opportunity to see a tree affected by this disease, about which much that appears to me to be overdrawn and needlessly alarming has recently been published in magazines and newspapers."

This is dated Albany, May 15, 1911. You will bear in mind that the writer admits having seen but one diseased tree from which he draws that conclusion; and (to Dr. Murrill), if my friend will just bear with me a moment, he will get an opportunity when I am through.

THE CHAIRMAN: The three-minute limit having expired, we will understand, unless there is objection, that Mr. Williams has unanimous consent to continue.

MR. WILLIAMS: I hold before this meeting that it is a case of ridiculous and absurd foolishness for a man to come out in a public print of that character and, as a reputable scientific man, wishing to be taken seriously, say that because he has seen one diseased tree he regards this thing as needlessly alarming, and all trumped up and in the air. If that is the kind of scientific aid we are getting, then much of our scientific work is useless. Much of it is just as useless as the conclusions that were drawn here yesterday from some of the papers read. They are simply guesses in the future, strokes in the dark; they amount to nothing. One man can guess at something as well as another. If the practical men of America are to pin their faith to guesswork resulting from the cursory examination of one tree, then I say it is pretty nearly time to call off the scientists and let us look to somebody else.

PROFESSOR CLINTON: The politicians.

MR. WILLIAMS: Yes, sir, they will help. You will find that when a politician sees something good, he goes for it and generally gets it. He, at least, has courage enough to try.

In regard to the article just read before you, I happened to have a copy of that in my hand. I suppose the gentleman who read it is somewhat mystified as to how I got it; but if he desires to know, the information may be had. It may be interesting to this meeting to know that it was one of his pre-Convention efforts in some way to cook up a sentiment, or an apparent sentiment, against what possibly might be done at this meeting, and was accompanied by such a letter as I rather expected would never be written.

The first statement is: "It is impossible to locate all advance infections, these not being apparent even under close inspection."

I deny the assertion. Advance infections can readily be found if the man looking for them knows his business. In time every tree will develop to such a stage in its infection that it may readily be detected. There is no hidden mystery about this disease. All you have to do is to know it and find it. It takes probably repeated searching, but when you go out for a thing you search until you get it. You do not look for it in a desultory way and then say "It is impossible to find all advance infections."

"It is practically impossible to cut and burn all infected trees after their discovery."

Who for a minute will believe that it is impossible to burn a tree if you cut it down?

"Even if these trees are cut, it is impossible to discover and eradicate the numerous infections originating from millions of spores produced on these trees and distributed by birds, insects, squirrels, wind and rain."

If we cannot eradicate, we may check. We may do something that will be beneficial, and if it is impossible to do as stated in paragraph 3, then let us do the next best thing. Let us not quit because some one thinks that it probably is impossible, but let us go ahead and do the best we can. I question the propriety of anyone engaged in work of this kind and in relation to this disease being ready to give up after the first effort.

"Even if it were impossible to cut and burn all affected trees, for ten to twenty years afterwards numbers of sprouts would grow up from the roots of these trees and continue to die from the disease and to spread the infection."

I would like to know whether that observation is based upon facts, or whether it is a mere guess, an assumption. An incident was cited to you this morning where a number of infected trees were cut out of a grove near Philadelphia. The bark was carefully taken from the stumps, burned, every infected portion of tree that could be found was destroyed, and the sprouts from those stumps have come up in a fine, thrifty manner. To date they show no infection. That is not complete evidence, of course, but it is an indication. It is an indication that these stumps will sprout again and they may possibly be kept free from infection. How much easier it is to go back to the stumps and cut the small sprouts than to search for the disease on tall forest trees. "Supposing that it might be possible to eradicate all advance infections, what method is proposed that is at all feasible for combating the disease in its main line of advance? All of the foresters connected with the United States Government and the entire Army of the United States would be utterly powerless to oppose its progress."

I would like to ask how that was arrived at. By what process of calculation has that statement been derived? I would like to ask what method they propose. Do they have a method? Is there any method that is worth anything at all? Now if there is, let us use it. If there is not, let us look for one. We are interested in looking for one. We claim no method that is of great virtue, but we do claim that we are interested in looking for a method, and that is the thing we want to do.

"When an appropriation is asked for, it is customary to point to some good reason for hope of success provided the appropriation is obtained." In other words, you must solve your problem before you get the money to solve it. If that is the way the States of the United States are doing business, then I think they had better reform their methods of business quickly. If that is the way the scientific men of the United States do their work, I think it is well for them to get wise.

Now Mr. Chairman, I do not want to be misconstrued. I want to be fair to these gentlemen, and I am fair. But I doubt whether it is just the thing for them, in this present uncertain state of our knowledge, to stand as they do, utterly oblivious to any decent attempt to do anything, to relegate that all to the shades and simply conclude, as a matter of *a priori* inference, that this thing cannot be done, and therefore drop the whole business.

I would like to raise another question. I would like to ask the gentlemen from around the neighborhood of New York city whether, if they had been really active and alert and on the firing line when this thing was discovered in 1904, might they not have accomplished some real thing which would have redounded to the benefit of the other States, as Massachusetts has done in her gypsy moth fight? (Applause). If instead of sitting down and nursing their hands in idleness and allowing this scourge to go on, simply because they could not originate sufficient interest in their States, they had gone out and done what they could, this thing would probably not have come upon us. The assumption is quite as valid as many we have heard from the other side.

Now Mr. Chairman, in work of this kind I think it just and right that those who are interested in it should all pull together. If we do not agree upon methods, if we are not agreed as to our conclusions, why not each work out these conclusions for himself? Why not each interested person, State, or organization, endeavor to do what he or it can? We would regard it as our everlasting shame and disgrace if we had sat down and permitted this disease to sweep on without raising a hand against it. We have the finest kind of illustrations of success in work of this kind. Did the United States Goverment cease to pursue its investigations and its practical work in the eradication of yellow fever simply because it took a hundred years to get to some tangible result? Finally they have solved the yellow fever problem. They have done it with the aid of the scientist, and we welcome his effort, but we want it to be on scientific grounds. New Jersey has been plagued with mosquitoes since time immemorial, I presume; but have the citizens of New Jersey ever failed to screen their windows against mosquitoes because the scientists of the State have not succeeded in working out a method of eradication that is effective? There is a lot of homely illustration of effort where we are engaged in doing what we can in an endeavor to find out something that will be really useful, tangible, and effective.

That is the keynote of our work here. I would like this Convention to carry away with it the idea that we are in this work just for what ever result we can accomplish, and we do not care in what direction the inquiry goes. That makes no difference whatever. What do we care whether this fungus went on a foreign trip some years ago and then came back in disguise and is now setting up business at the old stand? The thing is with us, is before us, and we want to deal with the concrete present. The other is interesting historically, but let that be as it may. The thing to do is to deal with the problems that are with us; and when we have dealt with them to the best of our knowledge and then failed, we have used our whole effort and I think we have discharged our duty to the public. (Applause).

PROFESSOR SURFACE: Mr. Chairman: I should like to direct our thoughts to a subject which I think has, in part, escaped our attention in discussing the excellent paper of Dr. Hopkins. He has brought our attention to the fact that there are four hundred and seventy-two species of insects known to attack the chesnut tree, and a great number of these are borers. He has brought our attention to the fact that those borers make two holes in the tree, one as the young larva forces its way in and one as it comes out as a mature beetle. It has been shown that the fungus germ or spore enters where the bark is injured or punctured. Thus we see that each insect boring in the tree makes two places of injury where the spore germs can enter, and thus it makes a possibility of damage at two places, although as a rule they are not far apart. Now let us remember that the natural and chief enemies by all means of these borers are the woodpeckers, and the natural enemies of these four hundred and seventy-two species of insects are the birds of the forest. It has been said that the woodpeckers carry the disease germs; but let us not infer for a minute that the woodpecker should be exterminated for so doing, for, were all the woodpeckers utterly destroyed, there would practically be just as much dissemination of these disease germs as if the woodpeckers were all present. These germs are carried readily by the wind. In the same way the robin, for example, has been accused of spreading the San Jose scale. If all the robins were destroyed the San Jose scale would be carried just as much as if the robins were present. The fact that in passing from one injured place to another there may be some germs on the bill of the woodpecker does not argue against that beneficial bird of our forest. I wish to go on record as saying that one of the most efficient methods of fighting this blight is to preserve the birds and particularly the woodpeckers, which destroy these borers. I have before me sections of branches that have been bored by insects and woodpeckers having been taken out, showing their beneficial work. It appears to me, then, that the impression should be corrected as to the possibility of preventing the spread of the germs by destroying woodpeckers. Preserve the woodpeckers and other insectivorous birds and prevent the spread of the infection. (Applause)

DR. MURRILL: Mr. Chairman: I have been accused of using "pre-Convention methods." I had no intention whatever of that purpose. I am not a politician at all. When I got back from the Pacific Coast I found there had been a Convention or a Conference, in Albany, and I found that New York State, my own State, had made certain recommendations for an appropriation. I deemed that unwise, that is, to ask for a large appropriation, so I immediately took steps to write to the Governor and to write to some of the representatives and I took the matter up, entirely as a citizen of New York State. It was my duty to the State. Later I heard something about an appropriation in the Legislature of Virginia, my native State, and at once took the matter up with the Governor of that State. It is a copy of this letter which the speaker before (Mr. Williams) had for discussion.

As to sitting down and doing nothing, for twenty years I have been working on diseases of trees. For the last seven years I have known this fungus. Immediately when I found it, when the affected trees were shown me by Mr. Merkel, I began the most industrious investigation of it, and I venture to say that many of those present have been guided to a knowledge of it through my extensive correspondence on the subject.

Now for a programme, I have that also. I do not believe in butting our heads against a wall and wasting the public money uselessly. I believe in carrying on investigations a little further and, if possible, in finding some rational method, so that we can use our funds to much better advantage. I should say, keep in touch with the disease in every stage; survey and locate it, but do not locate it with reference to eradication, because I deem that impossible. Devote this year, at least, to scientific investigation. The papers of all the delegates have referred to being on the eve of some great discovery. Now let us give them another year and let the Commission devote its best energies to scientific investigation along certain lines which I have here marked out, which may be used if you wish them. I will not read them.

(The speaker handed a paper to the Chairman, which appears later on the record of proceedings).

Let them be forest tests, and also orchard and laboratory tests. Those forest tests may embody your immune zone, your eradication of diseased trees in a section. Let that be a scientific, thoroughly scientific test, under this Commission, and, after the season is over, let us have a report and decide what further must be done with this magnificent appropriation which the State of Pennsylvania has so generously made. (Applause).

PROFESSOR RANE: I simply rise just to make this point: It seems to me that a discussion is what brings things out. Now I am sure everybody that is attending this Convention at this time feels that the State of Pennsylvania is taking a splendid stand in this work. I am also of the opinion that some have allowed the little financial end to step in, thinking perhaps that the State of Pennsylvania is throwing away some money. After all, this is insignificant. I feel that the responsibility upon a Commission that has money to expend in this work is likely to bring those men out, and put them in a position that we will all look forward to, and we cannot secure this unless that responsibility is placed in such a way. I think that is the beauty of the gypsy moth work in Massachusetts. We have had a great deal of money. When it was placed under my Department, I wondered how in the world to spend that amount of money and really derive the most benefit from it. That was the problem that worried us most, and I doubt not that is the same problem that is worrying this Commission most. I am sure we are not here in any way to criticize, and I hope at least we do not fall into that attitude of mind. I am inclined to think that some have the wrong impression. We are heart and hand with this Commission in Pennsylvania, and I believe that with money and with responsibility, they are likely to bring things about. We have brought results about in the moth work in my state in improving spraying machinery alone that I believe will be sufficient importance in the future to the whole broad United States to pay for the expenditure. Also, no one could estimate the value to the world of the use of arsenate of lead for spraying purposes, for which the gypsy moth work in Massachusetts is responsible.

Again, another point that I wish to emphasize. We are establishing positions, State Foresters and other State positions along different lines. I think that we want to get into the habit of having a well directed forest policy, so that the current may flow along well defined channels. The great trouble I think, as I look upon these forest pathologists and entomologists is that there are constantly new outbreaks in new places, and a few good specialists on each problem are better than each state working it out independently.

I should like a system, and it seems to me that the State foresters, if there is such a position in our various States, ought to be closely knit together and that this work should go along that channel and be well directed, not only, as I brought out, for these individual things but for the problem as a whole, so that in the long run we will get definite results.

MR. STEVENS, of the Lehigh Valley Railroad: Mr. Chairman, it is now three o'clock on the last afternoon of this session. I came here for two purposes: One, to get additional information regarding this fungous pest, and another, to get some idea of how we can best co-operate in combatting it. Now a large share of this meeting has been given up to one side, the analytical side of the question, and it seems to me we should give some attention to the constructive side. We are agreed in some things, and one is, that a better system of forestry, carried out through the East, will tend to control or help control this fungous disease. I think there is no dissenting voice on that at all. This has been the the history of a good many pests which we have met. I have in mind particularly such a one as the orange pockweed.

"The Devil's Paint Brush." We may not have known how to eradicate it, but the introduction of that weed has brought about a better rotation of the crops, which makes orange pock-weed a negligible quantity. So it seems to me here, if we could appoint a committee or in some way formulate a plan for a more rational control of our forests, we would be doing something upon which we could agree and work together, and thus not only control this fungous disease, but do wonders to the forests of this section.

THE CHAIRMAN: Mr. Stevens will probably be pleased to learn that the Committee on Resolutions will have something of a constructive order to suggest.

MR. STEVENS: Then may we proceed as quickly as possible, so that we may discuss that?

THE CHAIRMAN: That is the next order on the programme, and before calling for a report by the Committee on Resolutions, if you will permit a word from the Chair, I will beg your indulgence. A few moments ago, doubtless in a spirit of fun, the word "politician" was introduced into our discussion. Now I wish to say that I have made careful observations --as one may of the work in one State from another State— of the work that is being done in the State of Pennsylvania along this line. Thus far I have failed to see the first sign of what might be regarded as political methods, and I claim to be somewhat expert in detecting the presence of such methods. (Applause). I have inquired of two gentlemen of Pennsylvania who are well posted, one of them being a member of the Chestnut Tree Blight Commission, as to the political faith of these five men, and I have been unable to find out yet what their political faith is. (Applause).

The members of the Chestnut Tree Blight Commission of Pennsylvania are serving without compensation. They are men of large business interests and also altruistic interests. They are glad to give their time to the subject because they believe they can help the State to solve a great problem, and, so far as I have been able to size up the situation in Pennsylvania, from the papers and the discussions which have been offered here, I should say that the Pennsylvania plan, in a word, is to seek the truth and when the best course is found, then to follow that course. What else can we consider to be the policy in this State? Remember that the Legislature of Pennsylvania has appropriated two hundred and seventy-five thousand dollars, and we heard yesterday that only twenty thousand dollars has been expended. That money is being used, it appears to me, to determine which of various methods is the best, and the very fact that such a large balance of the money is still held in reserve is the strongest proof that the authorities of this State are waiting until they are fully satisfied as to which is the best course to pursue. It seems to me, gentlemen, that when we say there is danger of wasting public money uselessly in connection with the work which has been reported here, we are attacking a phantom and, as I think there is some little danger of the wrong impression getting out from this meeting, I desire to make these remarks to assist in clearing up the situation. Good work is being done in this State and in other States. Here the problem is perhaps greater than in any other State, and here the State has made magnificent provision for both studying the problem and carrying out effective measures. (Applause).

DR. MURRILL: I just want to concur heartily in everything the Chairman has said, and entirely disclaim any reference to the Commission in any way or any shape that the Pennsylvania State Legislature has so generously provided for. I just wanted, when called a politician, by using pre-Convention methods, to disillusionize you of that statement.

PROFESSOR CLINTON: I used that word "politician." Why did I use that word "politician?" Not because he is a Democrat or a Republican or anything of that sort—I do not care what his politics are—but for this reason: The convention at Albany and the convention here, to my mind, is called largely for a moral backing for this Chestnut Blight Commission in Pennsylvania. They want that backing and they are going to get it, and I am not going to object to it. You can pass any resolution you want, and I will not object to it. I came down here to present facts as I know them and to give them to you, and the moment Mr. Williams is speaking, he is trying to throw slurs at science, and especially at science outside of Pennsylvania. He attacked Professor Peck, and Professor Peck at Albany was the one man that—not the one man, but he was a man—that said he was in favor of their work in fighting the chestnut blight. He quotes him to disparage him, and he is the man that is backing up their work. Professor Peck is a good scientist in his way. There are a lot of good scientists that are doing good work outside of this State, as well as in it.

THE CHAIRMAN: We will now proceed to hear the report of the Committee on Resolutions.

MR. WILLIAMS: I would like to preface the report by saying that I have no intention of disparaging any man.

What I said was not with that intention in mind, but to call attention to what I claim are inadequate methods, methods not well thought out. I have no quarrel with any man whatever. I admire a good, lusty antagonist, and I respect his opinion. I am also most profoundly grateful that we have had an explanation from our good friend, Dr. Murrill, as to just what his programme is. We have wondered a long time what it might be and we are in the dark no longer, now that he has made the explanation; and we are glad for it.

In presenting the resolutions which have been drafted by your Committee, appointed for that purpose, and as the Chairman of the Committee, it becomes my duty at their direction to report as follows:

WHEREAS, This Conference recognizes the great importance of the chestnut tree as one of our most valuable timber assets, having an estimated value of not less than $400,000,000; and

WHEREAS, A most virulent fungous disease has made its appearance in wide sections of the chestnut timber region, and already many millions of dollars of damage have been sustained, and the total extinction of the chestnut tree is threatened by the rapid spread of this disease; and

WHEREAS, We recognize the importance of prompt action; therefore, be it

Resolved, That the thanks of this Conference are tendered to Governor Tener for calling it, and for the courtesies he has shown.

That we appreciate the interest of the President of the United States, as evidenced by his communication to Governor Tener, showing, as it does, that the head of the National Government is not unmindful of the great danger presented by the Chestnut Blight problem.

That the Commission appointed by the Governor of Pennsylvania be commended for the earnestness and diligence they have shown in the conduct of their work.

That we urge the National Government, the States, and the Dominion of Canada to follow the example of Pennsylvania, which is analogous to that of Massachusetts in starting the fight against the gypsy moth, and appropriate an amount sufficient to enable their proper authorities to cope with the disease where practicable.

That we favor the bill now before Congress appropriating $80,000 for the use of the United States Department of Agriculture in Chestnut Bark Disease work, and urge all States to use every means possible to aid in having this bill become a law at the earliest moment.

That we believe trained and experienced men should be employed in the field and laboratory to study the disease in all its phases.

That we believe definite boundaries should be established where advisable, in each State, beyond which limits an earnest endeavor should be made to stamp out the disease.

That we believe an efficient and strong quarantine should be maintained; and that it should be the earnest effort of every State, the Federal Government, and the Dominion of Canada to prevent the spread of the disease within and beyond their borders. In accord with this thought we strongly commend the efforts being made to pass the Simmons bill now before Congress.

That we believe strong efforts should be made in all States to stimulate the utilization of chestnut products, and in order to do so, we recommend that the Interstate Commerce Commission permit railroads and other transportation companies to name low freight rates so that chestnut products not liable to spread the disease may be properly distributed.

That we recommend the National Government, each State, and the Dominion of Canada to publish practical, concise, and well illustrated bulletins for educating owners of chestnut trees.

That we believe further meetings on the line of this Conference advisable and we hope the Pennsylvania Commission will arrange for similar meetings.

That we thank the State of Pennsylvania for its intention to publish immediately the proceedings of this Conference.

That copies of these resolutions be forwarded to the President of the United States, to the Governor of every State, to the Governor General of the Dominion of Canada, and the members of the Federal and State Legislatures, with the request that they do all in their power to aid in checking the ravages of this dread disease.

I respectfully move the adoption of the resolutions.

Seconded by Dr. J. Russell Smith.

THE CHAIRMAN: Are there any remarks?

DR. MURRILL: Possibly I have taken too much of your time, but I have a message to these delegates of the other States, and I feel sure that they are willing to listen to me for two minutes. The question is, what will you say to your States when you return? What programme will you recommend in your States? First: Survey to keep in touch with the progress of the disease, so that you may be able to acquaint timber owners just when to cut and utilize their timber to the greatest advantage. The State should have this knowledge. Then also pay heed to science and further investigation.

THE CHAIRMAN: What you are giving is undoubtedly of great value, but it occurs to the Chair that it is not directly in line with these resolutions, and the Chair would ask if you would not be willing to bring it up after we have acted on the resolutions, unless you have something in mind further than has been developed. Is there any discussion of these resolutions?

The motion to adopt the resolutions was put.

THE CHAIRMAN: The resolutions seem to have passed. They have passed.

DR. J. W. HARSHBERGER, of Philadelphia: Mr. Chairman: Just one suggestion that I want to make that has occurred to me during the proceedings, that I think is in line with suggestions looking toward some practical outcome of these meetings. We, as wise men, should provide for any contingency that may arise in future years. If the chestnut tree is doomed, then the fungus which attacks the chestnut tree is doomed with it. My suggestion is this: That the Chestnut Blight Commission send to some out-of-the-way part of the world, where the chestnut tree will grow, nuts which have been thoroughly sterilized, with a suggestion that these nuts be grown under the care of some forester; you might say in southern Germany, or eastern Germany, wherever they think proper, in case that the American chestnut tree is exterminated by the chestnut blight in America; so that we can draw upon that supply to re-forest our hillsides and our slopes with our native chestnut tree. Just as the man in the western states provides his shelter against the cyclones, so we should provide a means of re-stocking our forests with the chestnut tree, by sending these chestnuts to some out of the way part of the world, which is immune, or where the chestnut blight disease will practically be cut off from reaching the chestnut trees. That is merely a suggestion, in line with future operations connected with this blight disease.

THE CHAIRMAN: The Chair should have extended an opportunity to Professor Murrill at once, after passing the resolutions, for his statement.

DR. MURRILL: Just a minute, and I will feel that my duty will have been done: The State's programme, then, would be, first, to survey, to locate, and keep in touch with the progress of the disease, not a rigid inspection, but such an inspection as the State Forester and State Pathologist could take charge of, possibly with a slight appropriation. Second, await results of scientific investigation for one year at least. We are having a magnificent experiment here, one we are glad to have made along scientific lines, and under the leadership of a Commission above reproach in every way. Now, can we not wait a year and continue our experiments and then act upon the evidence that we get from this year's work?

Just a word to timber owners: Forest management is not a cure for the chestnut blight. The chestnut blight is a good feeder. The better the chestnut tree, the better it grows on it.

It is a mistake to say that forest management will eradicate blight. It will eradicate most other diseases, insects, and so forth, but it does not affect the blight.

Utilization is the real issue; the practical use of the lumber, and that is in the hands of those who own chestnut timber. The present is yours. You have the chestnut timber as it is; tomorrow, next generation, you may have it not. Be business like and stand for your own rights. The opinion of one man may be worth a thousand times the opinion of another. You see that in every walk of life. Take the opinion of hardheaded, scientific men, who know about this trouble, just as you would the opinions of hardheaded business men. I thank you for your at tention. (Applause).

THE CHAIRMAN: If there is no objection, a statement prepared by Dr. Murrill upon "Questions for Scientific Investigation," handed in to the desk a few minutes ago, will be including in the proceedings, together with his personal views.

The paper submitted is a follows:

QUESTIONS FOR SCIENTIFIC INVESTIGATION.

1. The viability of the spores, both summer and winter forms.
2. The vitality of the mycelium in the bark and wood.
3. The vitality of sprouts and their bearings on the question.
4. The food of the fungus; the decomposition of tannin by ferments.
5. Distribution. A large subject, involving experiments and observations over wide areas and dealing with winds, rain, insects, birds and their migration, squirrels, the transportation of wood, railway ties; rate and direction of distribution; nursery stock; trees in foreign countries; effects of coppicing.
6. Origin. Nothing is known at present. Is it native or foreign? Why was it unknown until recently, and then why so violent?
7. Will it attack other trees besides species of chestnut? Much depends on this. Trees nearest the chestnut should be used for experiment.

8. What is the future of the disease? Will it run its course and disappear? Will it become less virulent? Will resistant varieties appear? Can such varieties be made by selection, hybridization, etc.? Can chestnuts be grown with safety beyond the Mississippi river? How long after death of all our trees, may chestnuts be again planted with safety?

9. Can we expect natural enemies to arise? If it were an insect disease, this might be looked for with more hope.

10. Can a method of control be discovered by further scientific research? Most remedies suggested by unscientific persons are known at once to be valueless and need not be tried. One thing is certain, the more one knows about a disease, the more liable one is to discover a remedy. If none is possible, the sooner this fact is known, the better for all concerned.

THE CHAIRMAN: It has been suggested to the Chair from two directions that, as we have in this audience a number of men of large commercial interests, the opportunity should be extended to them to make remarks. The Chair is pleased to accept that suggestion. Mr. Thalheimer.

MR. THALHEIMER, of Reading: Mr. Chairman: In Pennsylvania, in those counties that I know, most of the farmers have five, ten, and some of them fifteen acres of timber land that has come away back from their forefathers, and I think it would be proper for this Commission to get the names of those farmers, or their representatives, and keep them posted on how to take care of their timber and caution them of the danger they are in of losing it, and let them assist you in looking after it. Attract their attention, and you will get many good points for this Commission to act on which you would not get otherwise.

If you will allow me one minute, I will tell you something which I observed myself. It may be interesting to some of you. I stopped off at a corner of a lane to wait for a car and while I was waiting, I looked on the ground and there saw gypsy moths. I never saw them as large in my life. They were yellow and blue with big horns, worse than the Massachusetts kind. They were about two inches long and about a quarter of an inch thick. They walked along the track, and I looked at them and followed them. My car came along, and I went down town and coming back, while waiting for another car, I wanted to take a seat. There was a walnut tree at the corner of the lane, and I wanted to take a seat on a bench under the tree. When I came to take that seat, it was literally covered with those gypsy moths, coming off of that tree. What I want to say to you is this: I watched and noted that there was a little fly, which is like a comparison of a guinea hen to an ordinary chicken—they were just that shape—and one or two would follow a moth and they would get on top of the moth and just sting it and jump off again. I kept on investigating, and it took me two hours to watch them. As soon as they would touch the gypsy moth at a certain place back of the neck, they would kill it every time. That was an accidental investigation. I spoke to several professors about it, and asked them to look it up, and see whether they could not propagate that fly.

MR. STEVENS: Where was that?

MR. THALHEIMER: In Reading, Pa.

MR. STEVENS: May I ask Dr. Murrill a question? He made a statement that good forest management would not help to control chestnut blight disease. I would like to ask his authority for the statement.

DR. MURRILL: My own experience about New York State, over a wide area, for several years.

MR. STEVENS: In forests?

DR. MURRILL: In forests, over dense, almost full grown chestnut forests. The disease occurs without reference to ill or well trees, and I have noticed it on vigorous trees as well as on trees diseased from other causes.

PROFESSOR RANE: In construing that term "forestry management," it seems to me it might go further than just applying it to chestnut trees. As a matter of fact, our forest management as regards the moth situation is to eliminate those trees and bring in others that would take their place. Forestry management means, therefore, the elimination of the chestnut with the idea of bringing in other species; so we can bring that thing out in a practical way, from a different standpoint than just thinning the chestnut.

DR. MURRILL: I heartily commend that.

MR. CRAMER, of Lehigh University: In reply to the gentleman at my right, Dr. Murrill said his observation was based on many years' experience of his own in and about the forests. I would like to submit the question to this gentleman as what those experiments were,—actual work, or scientific experiments, actual work in removing these infected trees, or examining them?

DR. MURRILL: Both. We tried various experiments. When the disease first appeared, we tried the cutting off and cutting out, but not the cutting of the stumps. Some of the stumps were burned, and we found that the sprouts sprung up from several inches below the ground and that the disease went into the roots some distance. It also went beneath the bark into the wood and re-appeared, so that it was impossible to cut it out. We have had a number of observations and experiments about New York to show that forest management, so far as clean culture goes, has no effect whatever on the eradication or on the control of chestnut blight.

MR. ZIEGLER: I am concerned with the management of about twenty thousand acres of forest, which is largely chestnut coppice. I want to tell you about a condition existing there, and to ask Dr. Murrill's opinion as to what should be done. We have chestnut blight in those twenty thousand acres in about ten spots, the largest of which is about ten acres, existing there for two years. The first year's attack killed merely a few trees here and there. The second year's attack shows the death of trees in a radiating direction from the central focus, you might call it. I would like to know what action should be taken; whether he would recommend cutting out these few acres at once and thereby trying to reduce the number of spores produced, to the degree of say one one-hundredth, at a very small cost, or whether he would leave those trees go a year longer and await some other measure?

DR. MURRILL: I have received hundreds of letters of that same nature, and now I must answer all of them in this way: To save, utilize, and market your timber is the first consideration, when the disease has entered a forest of that extent. Therefore, cut your timber that is likely to go to waste first. Cut it first, if favorable, and later, as the disease encroaches, cut other timber and use it and market it, so that you may not glut the market.

MR. ZIEGLER: May I suggest that that is practically along the line that is being followed by the Penna. Blight Commission, so far as I have been able to learn of it, and that is the line we hope to follow, following their advice.

DR. MICKLEBOROUGH: Dr. Murrill, have you been cutting the chestnut growth up at the Bronx Garden?

DR. MURRILL: We are now cutting down the last trees. It has cost us five thousand dollars to cut down fourteen hundred trees in fifty acres of the Bronx Park.

DR. MICKLEBOROUGH: I would like to ask Dr. Murrill another question, and that is, in the early stages of the disease on western Long Island, where it is in the most malignant form, if it was not his suggestion to the Park Commissioners in the autumn of 1907 or 1908, on account of the prevalence of the disease in Prospect Park where there were twelve or fifteen hundred chestnut trees, and if you did not also recommend to do the cutting there?

DR. MURRILL: That has been my recommendation, Mr. Chairman, until we found it was hopeless, and the area of the disease was so great as to make it practically impossible to cut these trees. We have not been able to get money enough appropriated by the Parks and public in New York City to cut out the dead wood caused by this disease.

Mr. E. A. WEIMER, of Lebanon, Pa.: Mr. Chairman and Gentlemen: I would like to address a few unscientific remarks to the owners of wood lots or forests, and if my scientific friends wish to listen, they may.

I have been interested in forestry for twenty-four years and have made a study of the chestnut blight during the past four years. I think that I have the honor, with the Hon. Mr. Elliott, who is here, and Dr. Drinker, in discovering the first entry of the blight into Pennsylvania. I have here in a jar a sample of that very first specimen, three and one-half years old. It has been sealed ever since, I am told, and it shows living or active spores. I show you this to demonstrate the care that is necessary to take in getting rid of the refuse of the trees and their bark when we go to cut them down.

To land owners I wish to say that I have myself a tract of chestnut timber in Lebanon county. The trees there are forty-one years old and they will range all the way from forty to ninety feet in height, and from ten to twenty inches in diameter. This tract of land shows every condition, you may say, of altitudes, of moisture, and of soil conditions. It has a north, south, east, and west exposure, because it is in the shape of a horseshoe. It has an altitude of eleven hundred feet at the highest part and at the lowest of seven hundred feet above sea level. It also has a stream running through it which gives you a swampy portion. Up at the top it is very gravelly; on one side it is clay, and on the other side you will find some of the best of wheat land. In every one of these sections I have found focal centers of blight, making this tract a perfect field for study.

Here I want to call your attention to one thing that has just come to my mind: Do not depend on discovering blight from surface indications only. The inspectors and myself have gone through my tract several times, and we thought we had discovered several trees only with the blight in its advanced stages, and a small number of other trees showing only traces.

Two weeks ago, however, the Forestry Department asked me to cut two carloads of blighted wood to demonstrate to the extract manufacturers that the blight had no effect on the production of tannic acid. So we went out to my tract, and Mr. Wirt and Mr. Fox of the Forestry Department, helped to locate trees. After going through the tract and locating only two focal centers of about twenty-five trees, we commenced to wonder where the two carloads, twenty-seven cords, were to come from.

I then suggested to Mr. Fox, who remained on the job, that we start cutting down the trees around the focal centers, and, if we found trees not infected, we would throw them aside. We started cutting and chopped down an acre of trees that showed few signs as viewed from the ground, but when cut down, we saw that their tops were badly infected; every one in fact. This shows that when you find a focal center, it would be advisable to keep on cutting all around the focal center until you have taken every infected tree, and not to depend on surface indications.

You may look at the stump with a microscope and you may not find any spores; for I will tell you that I have hunted for surface indications of the blight for the past few years in my tract, and never found indications of the bark splitting or spore dust at the roots or base of the stump, until last year, yet the tops of the trees, in certain sections, are all dead; they started dying several years ago.

I want to say one thing more. The farmers can help the Pennsylvania Chestnut Blight Commission by starting to do some of the work of inspection themselves, and if in doubt, may call on the Commission for advice and information. The Commission is willing to send men out to help you to locate the blight and tell you what to do. I will also try to help you, or, if you will send your foresters to my tract near Mt. Gretna, I will try to help them.

I have discovered a new way of finding the blight which I wish to present to this body for what it is worth. I want to tell you how you can see the blight even ninety feet in the air on what we call top-infected trees. You place your back directly towards the sun, half close your eyes and then look up along the top part of the tree, and if there is any blight in the cracks of the bark in a direct line with the rays of the sun, you will find the yellow spores highly illuminated. Under any other condition you would not see these spores, as they would be hidden by the shadows cast by the bark. Now, say in two hours, after the sun has illuminated another portion of the tree, you had better go through that tract again. In other words, start out going through the tract by one route so planned that during different times of the day you will have passed the same tree several times, and each time place the sun directly back of you, and you will be surprised with the results. I think Mr. Fox, (if he is here), will verify what I have said. Both of us spent three days in inspecting an area of trees, and did not find an infected tree. But, one morning, on that coldest day we had for years, two weeks ago, I got up at six o'clock, and found over seventy-five trees by this sun method in a place that we had gone over three times before, and we were truly surprised.

I notice that some of the experts are laughing, but I will wager that I will take anyone to my tract, and they will pass by the trees referred to as uninfested. I will then cut these trees down and show them the blight.

These trees are just as dangerous as the trees infected with the blight from top to bottom. If you think you do not have the blight among your trees, sacrifice a few trees that look suspicious, and the chances are that you will see it on the top branches. If it is possible to get up on some high point overlooking your forest, and you notice brown or yellow patches of tree tops, go and cut the trees down in those spots whether you see the blight or not. Take no chances, because it is a disease that you can take no chances with.

I want to tell you another thing. We may not be able to control the blight by cutting down the trees, but it is worth while taking the chances, and all these men who have property, I think have money enough to take the chances. I would advise cutting down the trees quickly in the forests. Do it tomorrow, because winter time is the best time. The spores are in their winter quarters and are less likely to be blown around. Cut them down, bark them and, if possible, try to burn up all the leaves and brush in the infected areas. If necessary, sacrifice that area. Put all the branches and bark over the stumps and spray them with coal oil or better, cheap crude oil. Buy one of those cheap sprayers, costing about six dollars, and atomize the oil. You will find that a few gallons will cover a number of stumps and enable you to burn the stump down to the ground. It will kill all the spores and borers. On the first application of the heat, the bark peels away from the stump, and that presents the spores and borers to the flame where they are destroyed at once. Burning the stumps is better than peeling them, because when you peel off the bark, you lose some of the bark or shake the spores out on the ground.

This bottled specimen which I have shows that the spores will live three and one half years. This should show you the necessity of killing all the spores possible.

Here is one benefit of the Chestnut Blight Commission's work. They propose to cut down the infected trees. It may not stop the blight, but one thing it will do. If they burn the stumps, it will produce the best possible new condition for the managing of that forest. Even if the blight does come back on the sprouts, you can work on the sprouts and cut them off the second time, if necessary. You can also spray the young growth with lime-sulphur solution for the fungus, and apply some other solution to be discovered for the borers. It will also teach us the true value of chestnut wood.

I think our chances of controlling the disease are good. I do not say or believe that we are going to kill it entirely, because, to my knowledge, no spore diseases have ever been completely eradicated. We still have the black-knot with us, as well as the peach-yellows, but they are now both so well controlled that we have almost forgotten them.

We may be able to check the blight to such an extent that nature will be able to supply a means to throw off the disease in due time, especially if we aid her by killing the borers and limiting the supply of spores. So, again I say, I believe the Chestnut Blight Commission is on the right track, and my forest preserve is open to any man interested in this work.

My address is E. A. Weimer, Lebanon, Pa., and I will say to any man who comes to Lebanon, I will show him all I can; every condition of forestry that has developed on my tracts from over twenty-four years of practice. (Applause).

PROFESSOR COLLINS: The statement was made that this specimen in the bottle had been sealed for three and a half years, and the spores are still alive, as I understood it. I think Mr. Weimer forgot to tell how he knew they are alive.

MR. WEIMER: You can see in the lower part here (exhibiting bottle), that the spores have become very active. They retain their red color, whereas, up here where they are dead or dormant, they turned black, and have fallen off. I think that is the best indication that I can offer. These indications were thought good enough for my purpose.

PROFESSOR COLLINS: I think the observations would be a little more conclusive if the gentleman would try cultures to see if they would grow.

MR. WEIMER: I agree with the Professor, and will say that this specimen is now the property of the Forestry Department, and I will kindly ask them to have a culture test made.

DR. MICKLEBOROUGH: May I make a brief statement with reference to the life of spores? I have a little vial with me in which I have the ascospores that I collected at Gladstone, New Jersey, on Memorial Day, 1908. I have examined those spores from time to time, and find they are still alive. How do we know they are alive? We can take, as I have done, a five per cent. solution of pure glycerine, and the spores will sprout in it. These ascospores will sprout and I have examined the sproutings under the microscope,—the mycelium threads. I was performing a miscroscopic test to harden spores for the microscope, to make a permanent mount, and I accidentally found that, instead of hardening the spores, my five per cent. solution of pure glycerine only was food for them and they proceeded to sprout.

Let me remind you that those little pieces of bark that I have in the vial with me in my coat pocket have been kept dry, free from moisture. If they had been out in the forest, or subjected to the climatic conditions which fungi require, heat and moisture both, I am very sure those spores would have been developed and disseminated long ago. They would have lasted perhaps but a few months; but you take them and keep them perfectly dry, and I believe that you can prolong the life of the ascospores, and probably the conidia, for several years.

THE CHAIRMAN: Would it be well, gentlemen, to agree upon a time for final adjournment, so that we may know what we are working toward? I wish also to arrange for the Governor to come in. Would it be well now to set a time for adjournment?

A DELEGATE: I move you that we adjourn at 4.15 p. m.

MR. PEIRCE: I move that the time be amended to 4:30 p. m.

MR. BODINE: I think it was announced at the beginning of the session that we were to be favored by a farewell visit of the Governor. Should we not consult his convenience before fixing an hour for adjournment?

THE CHAIRMAN: He has stated that it would be agreeable to him to come in at any time.

The substituted motion is that the hour of adjournment be fixed at 4:30.

The motion was seconded and carried.

THE CHAIRMAN: What is your pleasure with reference to appointing a committee to wait on the Governor?

PROFESSOR RANE: I so move you.

Seconded.

THE CHAIRMAN: It is moved that a committee be appointed to escort the Governor into the room before adjournment.

The motion was put and carried.

THE CHAIRMAN: The Chair will appoint as that committee, Commissioner Bodine, of the Chestnut Tree Blight Commission, Dr. Merkel, of New York, and State Forester Rane of Massachusetts, and will request them to escort the Governor into the meeting ten or fifteen minutes before the adjournment, as they find it to be convenient.

DR. HARSHBERGER, of Philadelphia: A very simple test could be made of the vitality of those spores which Mr. Weimer has, by growing them on an ordinary culture medium, and I would make the suggestion that Mr. Weimer send his specimens to the proper person connected with this Commission, and have the test made to ascertain whether those spores he has in the bottle still retain their vitality or not.

THE CHAIRMAN: The suggestion is made by Dr. Harshberger that Mr. Weimer be requested to send the spores to an expert connected with the Chestnut Tree Blight Commission for examination as to their vitality, and, if agreeable, the Chair would suggest that the result of that examination be included in the proceedings of this meeting.

MR. WEIMER: This sample is in charge of the Forestry Department, so that Mr. Williams or Mr. Wirt will attend to that. It is their privilege. I will take it up with them.

THE CHAIRMAN: We will dismiss the matter, then, with the understanding that Mr. Weimer will take it up with the Forestry Department, and if there is no objection, authority is given to include the report of that investigation in the report of this meeting.

PROFESSOR GRAVES: I would like to ask Mr. Detwiler a question about this dead line. Is that going to be delimited by cutting out all the chestnut, healthy and diseased, or is it just simply an arbitrary line? I want to know this for information.

MR. DETWILER: The dead-line which we plan to establish will be maintained by cutting out the diseased trees as located by constant control; and we have not yet considered cutting out all of the chestnut trees, unless the owners are willing to do it. If, upon an explanation of the situation, the owners are willing to do this, we have advised that it be done.

PROFESSOR GRAVES: If this sort of work is going to be taken up by the State, it seems to me it would be a good plan to delimit all areas which contain no chestnuts. I have the honor, Mr. Chairman, to be the gentleman who went through the State of Massachusetts on a motorcycle, as Professor Rane said this morning, and I found a great many areas there which had no chestnuts at all, and some such areas I am sure occur in Pennsylvania; so if you are going to take up this method, it seems to me such areas ought to be marked out and then start west of those.

PROFESSOR NORTON: I desire to make a suggestion. There may be a great deal of chestnut that must be cut and utilized which might possibly over-stock the market. Why could not the chestnut that is beyond the needs of the market have the tannin extracted from it and stored for future sales, either by corporations, individuals, or possibly by the State? I would like to mention another question of a scientific nature that has been suggested and which I think has not been brought out sufficiently. Of course, those who are familiar with fungous diseases understand this, but I believe that a good many people who are not familiar with the nature of fungi would not appreciate it, and that is the question of the difference in the opportunity for its infection where you have destroyed, say fifty per cent. of the infected material, or where you have destroyed ninety per cent. of it or ninety-nine per cent. Professor Stewart spoke of that, but I wish that someone who is familiar with statistics on that could bring it out a little better; whether there would be much difference in the opportunity for infection where you have destroyed fifty per cent., ninety per cent. or ninety-nine per cent. of the infected material? Of course, we understand that where ninety-nine per cent of it has been destroyed, there still would possibly be hundreds of millions of spores in a small area.

PROFESSOR RANE: I have some resolutions which I would like to present at this time:

"Resolved, That the delegates and others in attendance at this Conference desire to express their high sense of appreciation of the many courtesies tendered them by the officers of the Pennsylvania State Chestnut Blight Commission and the Department of Forestry."

It was moved and seconded that the resolution be adopted.

The motion was put and unanimously carried.

PROFESSOR RANE: I have another resolution:

"Resolved, That the thanks of this convention be, and are hereby tendered Hon. R. A. Pearson for his able and courteous way of handling the duties of permanent Chairman." (Ap plause).

MR. BESLEY (in the Chair): Mr. Pearson is too modest to put that resolution, so I take pleasure in putting it before this house, and if there is no discussion,—I believe it is seconded,—I suggest an immediate vote on that question.

The motion was put to adopt the resolution and unanimously carried. (Applause).

MR. PEARSON: Mr. Temporary Chairman, Ladies and Gentlemen: I sincerely thank you for this compliment. I thanked you at the opening of the conference for the honor of being your presiding officer, and I wish to assure you it has been a great privilege to me. I feel that we have really accomplished something here which is worth while, and I trust that the good that has been done will be recognized more and more as time passes.

There are two gentlemen in the room who, I am sure, everyone wishes to hear from before we adjourn. Several times during our conference mention has been made of the first discovery of the chestnut tree blight, and the name of the gentleman who discovered it has been mentioned several times. I think we ought to ask him formally to come before us, and make a few remarks. I refer to Mr. Merkel, of New York.

MR. MERKEL: I do not know what Mr. Pearson wants me to say; whether he is wishing for blarney or not. I can only say that I came in order to hear the opinions of everybody expressed. I am glad that the resolutions that were adopted were adopted, in spite of the fact that there were some people who did not agree with them. I believe that the work of this Congress to-day is epoch-making. I believe we have advanced a vast step. We have gone further yesterday and to-day by miles than we were the day before. I hope that we can save the chestnut tree. My fondness for trees in general is the only reason that brought me here; but that I should be pushed into the limelight thus,—a modest violet like I am,—was not my intention.

THE CHAIRMAN: Frequently during our discussion we have heard about the need of constructive work. The one man of the entire State, and I dare say the entire world, who has made possible the greatest constructive work against the Chestnut Tree Blight Disease is now in the room, and I must call upon the father of the measure which is responsible for the effective work in Pennsylvania for a few words, Senator Sproul. (Applause).

SENATOR SPROUL: Mr. Chairman and Gentlemen: A member of the Senate is generally safe in the House, and I did not know that anyone in any official capacity knew I had come over here.

THE CHAIRMAN: We all know you.

SENATOR SPROUL: I am very glad, indeed, to have had an opportunity of looking in on this meeting. When the bill was introduced and considered, it was regarded as largely an experiment, and it was thought that probably the State was taking rather large chances in making available so large a sum of money for carrying on a work which nobody at that time seemed to know very much about. I think that, from what I have heard of the results of this meeting, if no other good were accomplished by the expenditure of the money by Pennsylvania, the initiative taken in investigating this very serious question and in trying to devise ways and means to control the disease,—if no other good out of this meeting has been accomplished, I think that the expenditure was perfectly justifiable. I am glad indeed to hear the expressions from the discoverer of the chestnut blight and others as to the usefulness of this Convention, and I trust that the good work will go on, not only here but everywhere where this disease is threatening so much harm. (Applause).

THE CHAIRMAN: A request has been made that Deputy Commissioner Williams say a word before we adjourn, and at the same time advise you how extra reports of this Conference may be secured, if persons wish to have them.

MR. WILLIAMS: I had no intention of speaking again. All I can say is that we hope, and the Commission hopes, to have this report transcribed and published at an early date. When it is printed every person who has registered here, as visitor or delegate, who has come at the behest of his Governor or some institution which he represents, will be sent gratis, through the mails, a copy of this report. Every other person interested in having a copy of the report can make application to the headquarters of the Chestnut Blight Commission in Philadelphia, 1112 Morris Building in that city, and, so far as may be possible, I think their requests will be complied with. Just how soon it will be possible to have this record in print we do not know, but no time will be wasted in the interim.

I do not think I have anything further to say except to add this word: That the Pennsylvania Department of Forestry is interested with all other foresters and all other practical men

and all other scientific investigators, in doing what we can to produce the greatest good. What we are aiming at in Pennsylvania is to get results, and I take it that when this problem is understood by our friends and neighbors, they will equally be anxious to get results. These will be obtained through various pathways and by different means, but it is the favorable result that we are interested in. That is the great goal of all this effort. We would be very pleased to have any of the delegates and friends who are here call at the Department of Forestry. Many of you have been there; probably many have not. You will find it in the north wing of this building, and we usually have open house from seven o'clock in the morning until ten o'clock at night. Sometimes the doors are open all night, so we are ready to receive our friends at any hour of the day or night. I thank you for this final opportunity to say a word to you, and trust that your visit in Pennsylvania will not have been without some permanent result. (Applause).

MR. THALHEIMER: I would like to ask the delegates that are here whether any of them has had any communication with the Italian Government, to find out their success in raising the chestnut.

THE CHAIRMAN: We are going to refer the speaker to the Secretary of the Conference for that information, and he can give it immediately after adjournment. The Secretary is thoroughly informed on the subject.

Although I have been very positively instructed not to do so, I must at this time call for a word, at least, from the Secretary of the Pennsylvania Blight Commission, Mr. Harold Pierce. (Applause).

MR. PEIRCE: Mr. Chairman and Gentlemen: As Secretary of the Chestnut Tree Blight Commission, in behalf of the Commission, I want to thank both you, Mr. Chairman and the members of the Conference, for the close and business-like attention that has been given to the various discussions that have taken place, and while at times there has been great diversity of opinion, yet from that very diversity we trust much practical good may result.

At the request of Governor Tener, the Commission prepared the programme, but in arranging for the speakers it tried to provide for full and frank discussions by both the supporters and opponents of what is known as "the cutting out process," so that every one would have a fair chance of being heard.

If at any time any one has information of value to impart, the Commission will be only too glad to hear from such persons, and we assure you that anything which may seem likely to be able either to curb or cure the disease, will be gladly given a trial by the Commission.

The Commission considers it has been wise to make what has been called a dead line, believing the ravages of the disease can thereby be much better controlled than to allow the disease to continue to spread as it did for several years, without any attempt to keep it within bounds.

At the same time, the Commission intends to do all it can to carry on investigations both in the field and in the laboratory, hoping that in the near future some cure may be ascertained. We, however, believe that if we are to succeed, we must have the earnest co-operation of all the states, for it seems self-evident to us that Pennsylvania cannot win without such co-operation. We therefore earnestly trust every member of this Conference will go from here to his home imbued with the feeling that he will do all in his power to bring about such co-operation. Without that, I fear it will only be a short time before all the chestnut trees along the Atlantic seaboard will be in a dying state.

As far as possible, the resolutions which this Conference has passed, will be carried out by the Pennsylvania Commission, and in closing, I want again to thank you both for the close and businesslike character of this Conference and to urge earnestly that if anyone here learns of anything which may be of value, either in controlling or curing this disease, that he will at once inform us of it.

Messrs. Bodine, Merkel, and Rane then escorted the Governor to the floor of the Convention.

THE CHAIRMAN: Governor Tener, I desire to report to you that during these two days we have been discussing the various phases of the chestnut tree blight. Many valuable points have been brought out. The main conclusions of the Conference have been embodied in a set of resolutions, duly adopted this afternoon. It has been arranged, through the courtesy of your own State, to publish the proceedings of this Conference, in order that what has been said and done here may become widely known for the benefit of the fight against this terrible tree disease.

And now, Sir, our deliberations have about ended, and it is a privilege, and I deem it an honor, for me to turn back to you the duty as presiding officer of this meeting, as I received that duty from you only yesterday. (Applause).

GOVERNOR TENER: Mr. Chairman, Ladies and Gentlemen: While it has not been possible for me to attend the meetings of your Convention since its opening and to listen to the various papers that have been read or to take part in the deliberations of the meeting, yet from time to time information has come to me, and I have learned that your meeting has in every way been an interesting one and that you all will go home feeling that you have probably learned something from this meeting and from each other.

I hope that the purpose of the convention was sufficient to justify calling you here. Many of you have come at some inconvenience, I am quite sure. Pennsylvania will be very glad,—and I am particularly pleased to say it,—at her own expense, little or great as it may be, to print the proceedings of this conference and to give the report the very widest circulation. I am glad that you have seen fit to come here and to take the interest you have.

I have learned also that at times there was some spirited argument between you, and very often we know that out of a great conflict comes the greatest peace and the best understanding, and I hope that that is the case in this instance.

And now, as you go to your respective homes, I hope you will carry with you a very pleasant thought of this convention and that, in the days to come, your associations here, your deliberations, and all that you have done, will prove a most pleasant recollection to you all. We are glad indeed to have had you in our Capital City with us on this occasion. Now that you are going, I wish you Godspeed, happiness, and prosperity in all your undertakings of life. (Applause).

If there is no further business for the Convention, I will entertain a motion to adjourn.

DR. MURRILL: I move you, Sir, that we adjourn.

Seconded by Professor Rane.

The motion was put and carried.

GOVERNOR TENER: I now declare this Convention ad journed *sine die.*

ADDENDA.

Newport, Perry County, Pa.,

February 21, 1912.

To the Officers of the Chestnut Blight Convention:

I desire to submit a statement in connection with this blighted wood question which is not the professional opinion of any representative of the Chemical or Forestry Department of the State, or any scientist; but is presented merely as the thought of a layman who has had considerable experience in the chestnut wood extract business, and who has conceived the idea that it might possibly, in a way, have some bearing upon matters under consideration by the convention. It is submitted merely as an individual hypothesis, which may be entirely wrong.

W. M. BENSON.

CHESTNUT BLIGHT AND ITS POSSIBLE REMEDY.

By W. M. BENSON, NEWPORT, PA.

In discussing the causes of the chestnut blight perhaps the past experience of the extract manufacturers who make extract for tanning leather, may be of assistance in pointing out the proper remedy.

The chestnut wood received at the extract factories was at first supposed to be all alike in tanning strength, but costly experience proved that wood from good, strong lime, shale or limestone lands is far richer in tannin than wood from soils that are rocky, sterile, and which contain little lime. This difference is so marked that even the workmen in the leach house at extract plants can tell when wood from a lime shale or limestone region is being leached, simply by the unusual increase in the strength of the liquors obtained from such wood. Chemical analyses proved the same thing beyond all question, that in order for chestnut timber to attain its full tannin strength, it must grow on limestone or lime shale soil. This is not a secret of the extract trade, but a trade fact that extract manufacturers want the public to know, as it explains why the extract manufacturer will take wood from one region, but will refuse wood from some other locality, where analyses of the wood, and practical results in the leach house show a wide difference in the yield of extract per cord of wood. It pays better to pay freight for long distances to obtain wood from a lime shale or limestone region, than to buy wood that is closer to the factory, but which has less tannin.

An analysis of the ashes from the extract factory which was made at State College in the Spring of 1911 shows that there is over 40 per cent. of lime in the ashes. The analysis was made with a view of selling the ashes for the potash they were supposed to contain, but the result was surprising inasmuch as the analysis showed about one-third of one per cent. of potash, while as before stated it showed over 40 per cent. of lime. Is it not a remarkable thing to realize that a chestnut tree wants 120 times as much lime for its composition as it does of potash?

Another fact from the manufacturer's costly experience with the lime in extract liquors is the expense it costs him to keep the oxalate of lime which is leached from the wood from coating up the copper tubes in the evaporating apparatus, or vacuum pans as they are called. Oxalic acid has a powerful affinity for lime, and it is used as a test in the chemical laboratories to detect the presence of lime in a solution. In the boiling down process the lime combines with the oxalic acid in the tan liquors, and it is precipitated as oxalate of lime, and coats the 4,500 tubes of the evaporating apparatus with a coating which has to be removed by hammering it loose. Acids that will eat the lime off the copper tubes will also eat the copper of the pans, so mechanical and other means must be used to keep the tubes free. It is no small job to do this; and while the constant presence of lime in chestnut tan liquors is one of the drawbacks to evaporating liquors economically, the fact of the presence of lime in the liquors is regarded as a good sign of plenty of tannin in the wood.

Now the writer has little or no scientific knowledge of the chestnut blight, further than having seen it and being able to recognize it in the woods, but would suggest for your further thought and consideration, the supposition that it is due to a lack of lime in the soils in which such blighted wood is growing, and that a blighted tree is simply a tree that is in the process of being starved to death for lack of lime. If this is true then blighted wood will be found on soils that are known to lack in lime, and on the contrary the soils where the chestnut tree attains its greatest size and age will be found on analysis to be composed of a considerable proportion of lime.

The map shown in this convention which outlined the area in which the chestnut blight is at its worst, shows the worst affected area to be in the vicinity of New York City, Long Island, portions of Connecticut, New Jersey, and Delaware. No doubt nearly all who attend this convention know of the palisades of the Hudson, and how little lime such a weather resisting rock is likely to have. The sea sands of New Jersey, Long Island, and the clays soils of the Connecticut Valley, which are made up of the granite erosion of the White Mountains, all yield but little lime. Granite soils yield potash, but our analysis shows that our chestnut tree needs 120 times as much lime as potash. It was brought out at the convention that the place where the chestnut trees attained the greatest age was in Eastern Tennessee, where they grew to the immense size of six feet or more through. If you will take a geological map of Tennesee, and look at the rock formation in the region of Knoxville, you will be impressed with the large area of lime-stone and lime shale outcrops in that region. Please note that it was also stated in the Convention that there is no blight as far as is now known in the whole State of Tennessee. If trees can be shown there that are 500 years old and free from blight, growing on a lime shale or limestone soil, it will go far to support our supposition that the blight is not so much a dread disease that threatens to sweep away our native chestnut trees, as it is an evidence that blighted trees are merely trees that are starved for want of lime in the soil on which the tree is growing.

It will not take over six weeks or two months to collect samples of soils from every state represented at the convention, and analyze them. If the soil where the blighted trees are growing show on analysis a low lime content, as against a high lime content where the trees grow large, then we will know almost beyond the shadow of a doubt that the blight is most likely to be caused by lack of lime, but in order to fully prove the supposition, *I would recommend that solutions of lime water be soaked into the ground thoroughly around trees known to be affected with the blight, and soak the ground around the trees as far as the branches above extend out. Soak the ground thoroughly for a distance of two or three feet down, so that every root big and little will get a little lime in solution in which shape it is readily taken up by the roots. Then spray the trees above with the Bordeaux mixture as well.* The reason why I recommend lime water solution soaked into the ground, instead of scattering lime around under the trees is this: It is known that the sap in blighted trees is sour; this sourness is not the natural sourness of tannic acid, but an abnormal sourness; therefore every little fibre and rootlet must be fed lime to correct the sourness of the sap, and cause a normal, healthy sap to flow or start this spring before the leaves come out. Lime scattered on the ground under the trees would do the same thing in time, but it would take months for occassional rains to soak the lime down to the roots.

What we are particularly interested in at this time is to get positive evidence into the hands of the convention officers as soon as possible; hence I recommend the lime water test in order to get quicker and more positive results, rather than the plan of scattering lime under the trees which is less costly than the lime water plan. Water takes up only one seven-hundredth part of its weight of lime; 80 pounds of lime, costing about 10 to 12 cents wholesale, will therefore make 56,000 pounds of lime water, or 28 tons. The lime would cost less than the labor of getting the water, but for the purpose of getting positive evidence soon it is here recommended.

If the tree grows a longer set of sprouts this coming summer than it did last summer, or if the leaves are a more healthy color, then the whole case will have been fully proved that we have a specific for the blight disease, and it will no longer have any terrors for us. We will be able to preserve the trees we now have, as well as cultivate them to advantage wherever we like, if we choose to go to the expense of applying the lime artificially.

From the extract makers point of view, I would like to see the general law proved by experiment that all trees having a high percentage of tannin in their bark or wood, or both, require lime for their vigorous growth. For instance, the bark of the pear tree is known to contain a fair percentage of tannin. If the tree blights, is it due to a lack of lime in the soil? or is it from some other cause? Will the bark of the pear tree show a high percentage of lime on analysis? If this should prove to be the case then the Horticultural Department of the State will be in possession of a valuable fact, and the extract maker will know to a certainty just what localities are the best in which to locate an extract factory, by studying a geological map showing the limestone and lime shale outcrops, and locating all sorts of tannin producing trees that he may wish to utilize in the future. We already know that the bark of the rock oak which contains 37 per cent. of lime in the ashes of the bark, and there seems to be a general law in nature that tannin bearing trees must have lime in greater quantities than other trees.

The first few analyses of the soils where blighted chestnut is growing will put the Forestry Departments of the states represented at the convention in position to know in a few weeks whether this supposition of a lack of lime in the soils in blighted tree areas is borne out by facts. If it is found to be so, then the costly and irritating job of forcing reluctant owners of blighted chestnut trees into cutting them down at their own expense will have been avoided, and a policy of preservation adopted in its place. The latter policy will be much easier to put in force, as it will have the hearty co-operation of the public, in the generous efforts of the states to assist owners of blighted trees to save them. If the Forestry Departments can be put in possession of a proper remedy for the blight by this single convention, it will emphasize the value of such conventions, and demonstate the wisdom of the legislators of this State, who so far-sightedly made the convention possible by their appropriation.

FIELD WORK OF THE CHESTNUT TREE BLIGHT COMMISSION.

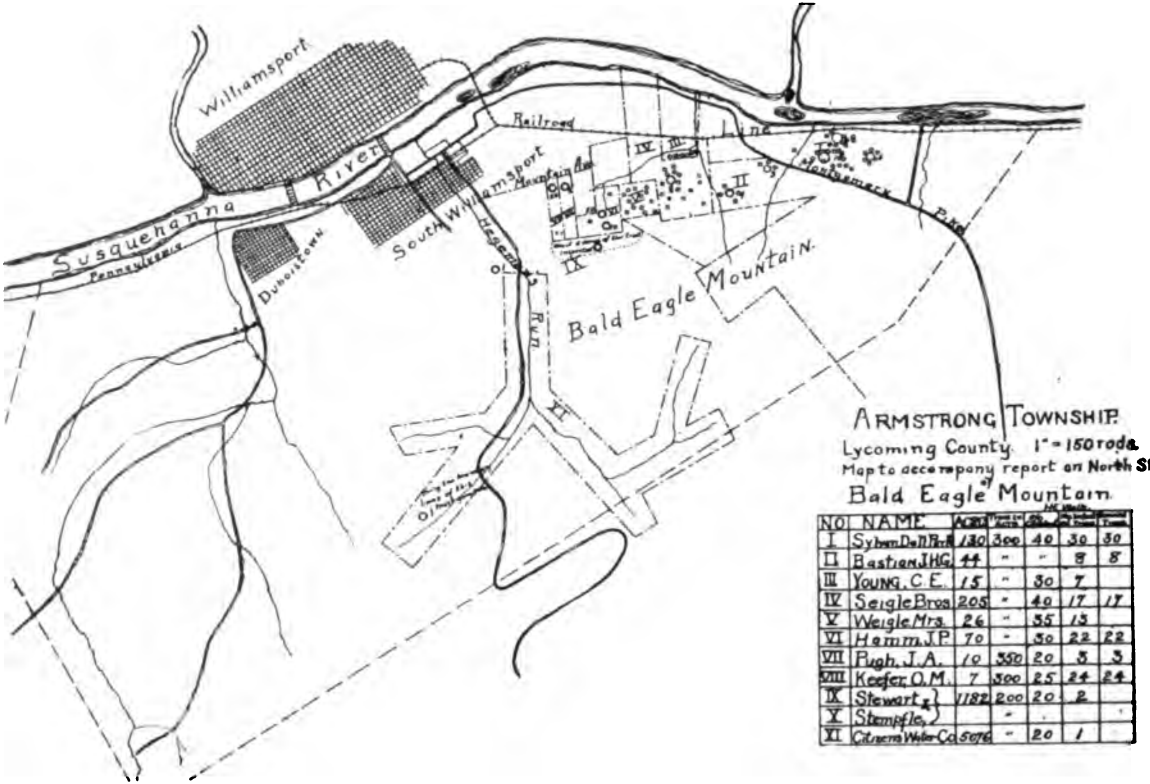
By THOMAS E. FRANCIS, FIELD SUPERVISOR.

During the six months the field force has been at work, the field agents have been trained and organized, and the general line of western advance determined. Owners of infected wood-lots, and the public generally have been warned of the existence of the disease.

The general plan which has been followed is to place one man in charge of the work in a county, under the direction of the field supervisor. The man in charge of the county usually has an assistant, and the two work out from the same head-quarters but cover different territory. When one community has been carefully scouted for the blight, the men move to an adjoining district, and in this way cover the county. In the meanwhile, timber owners are interviewed and the subject is called to the attention of the public by means of field meetings, lectures, talks before Farmers' Institutes, Grange meetings, and the like.

The work from early September until December consisted almost entirely of scouting for the disease. Later in the season, the field agents marked trees for removal and devoted much time to meetings with timber owners in the field, and general educational work. The most important result of our field work, is the interest and spirit of active co-operation we have aroused among the owners of wood-lots in areas where the chestnut tree bark disease has been found. The spirit has been aroused by the activity and honest efforts of our field men. Their inspections have been thoroughly and carefully made, and their talks at local institutes, grange, and special meetings called for the purpose of discussing the chestnut tree bark disease, have been instructive and interesting. These meetings have been well advertised locally and well attended. In Fulton, Franklin, Huntingdon, Bedford, Mifflin, Blair, Centre, and Snyder counties I have personally attended and addressed meetings called by the local field men, at which the attendance ranged from forty to two hundred and fifty woodland owners and interested persons. At these meetings a lively interest was shown, and at every meeting promises of active co-operation and help in locating and eradicating the disease, if found, have been given. Not a single instance of antagonism to our work and methods has come under my observation, and following every meeting, requests have come to us for the inspection of individual tracts, showing that the woodland owners not only approve our methods, but are anxious for an opportunity to do their part in assisting with our work. In fact, many cases of blight have been found and reported by owners as a result of instruction received at these meetings.

Judges, school teachers, ministers, farmers, business men, and prominent men interested in the welfare of the State have addressed our meetings and expressed their approval of our work. As direct evidence of willing co-operation, fifty-seven woodland owners in the previously named counties have removed and properly burned eight hundred and thirty-six infected trees and stumps from December 1, 1911 to February 15, 1912. In



NO	NAME	Acres	[illegible]	[illegible]	[illegible]	[illegible]
I	Sylvan Dell Park	130	300	40	30	30
II	Bastian J.H.G.	44	"	"	8	8
III	Young, C. E.	15	"	30	7	
IV	Seigle Bros	205	"	40	17	17
V	Weigle Mrs.	26	"	55	13	
VI	Hamm, J.P.	70	"	30	22	22
VII	Pugh, J.A.	10	350	20	3	3
VIII	Keefer, O.M.	7	300	25	24	24
IX	Stewart &	1182	200	20	2	
X	Stempfle,		"			
XI	Citizens Water Co	5076	"	20	1	

Map showing field of special investigations made in Lycoming county, Penna.

every case, an explanation of the object of our work has secured voluntary action on the part of the owners. This is the best evidence that the people of the State are interested, and will accord us the strong co-operation which is essential to carry out successfully the proposed plan of controlling the disease.

A REPORT ON SCOUT WORK ON THE NORTH BENCH OF BALD EAGLE MOUNTAIN, BETWEEN SYLVAN DELL AND WILLIAMSPORT, LYCOMING COUNTY, PA.

By H. E. WELLS, FIELD SUPERVISOR.

In order to determine as nearly as possible the number of cases of infection existing in Sylvan Dell Park and the bench land along the north slope of the Bald Eagle Mountain, a careful inspection was begun at Sylvan Dell. The park land was chosen on account of the assured co-operation of Mr. F. B. Thrall, president of the club, and the members of the Association.

The work of felling infected trees and burning the bark and brush was carefully done, and because of the nearness of the park to the road, many interested persons had an opportunity to see the blight and practical methods of control.

Seventy-five acres of park land were inspected. Twenty-five acres had been previously gone over in a very thorough manner during the last two years, and all dead, dying, or defective trees, together with brush, undergrowth, and all forest weeds, were removed. The result is an open, clean looking, thrifty stand; and, most significant of all, *but one infected tree could be found.* This tree was a large one, fifteen inches in diameter, growing close to the road through the park, and but slightly infected. The remaining fifty acres lie in the eastern part of the park and from a forestal point of view, are in a run-down condition.

No care or management has been given the fifty-acre portion of the park, and the blight, as well as many other fungous diseases, have had full opportunity to thrive unchecked. It was an admirable place in which to study the blight, for it was present in every stage of development. Sprouts, saplings, young thrifty trees, as well as old, over-mature standards were found infected. The forest floor is mostly rocks, there being little or no soil cover at all. The chestnut runs about 40 per cent. of the stand, with 25 per cent. rock oak, and the remainder a mixture of red, black, and white oak.

The majority of the infections apparently started in the tops. Some trees had to be climbed to identify the infection. In most cases the characteristic appearance of persistent leaves on girdled branches or on infected sprouts below, large lesions or blisters which have girdled the trunk, were sufficient to remove doubt as to whether the tree had blight.

It may be said here that in scout work the closest observation must be given to all suspicious trees, or trees with danger signals. The most conspicuous danger signals in summer or winter are the persistent dead leaves. In summer, these leaves are light yellow in color, in contrast with the healthy green leaves. As they are killed slowly by a gradual stoppage of sap, they remain rather flattened instead of curling and wrinkling as do leaves killed by frost in the fall. Their color is about the same in summer as that of persistent leaves in winter killed by frost and causes other than the blight. This yellowish shade tinged with a greenish hue like that of hay in the mow, often lasts long into the winter. Generally, though, the persistent leaves in winter are of a distinctly red rusty brown color, curled, twisted, frayed, and blown to shreds on the edges. On an infected or girdled branch, the leaves are persistent. In a healthy limb, when sap action stops in the fall, little corky layers are formed at the base of the leaf stem, and the leaf splits off at this point. In a diseased limb, the sap is held up and the leaf is not cut off by the corky layers.

With the leaves, small undeveloped and unopened burs are often seen. In some instances trees are found with almost every bur remaining, closed and nearly full size. The burs are dark in color and blend with the color of the leaves. If the burs are few in number and scattered, especially if open, the chances of blight being present are small.

Another characteristic danger signal is the growth of suckers or sprouts in a ring on girdle below a blister or lesion, extending around the tree. The upward flow of the sap being stopped, the tendency is to put out these laterals. These sprouts are almost always infected and quickly girdled, so in late fall or winter, a tree with suspicious persistent leaves and burs in the top and leaves on lateral shoots, is very apt to be infected.

As was said, apparently most infection started at the tops of the trees as evidenced by the appearance of the leaves, etc. Yet many large trees were found to be infected upon a careful tree to tree examination, at the base, and the only visible outward sign of the blight was the reddish yellow pustules, forming in the deep fissures of the bark, where the new inner bark is breaking through. Upon cutting into this region, the diseased, discolored inner bark next the wood was found filled with the mycelium of the fungus.

On old trees it takes more time for the disease to appear on the outer surface of the bark in the form of pustules, and often a well defined blister of mycelium is found on the inside of the bark showing no sign of its presence on the outside. For this reason the complete peeling and burning of the bark on the trunk of a tree that is going to be used is essential.

In the inspection work that was carried on, specimens showing the blight in various stages and under different conditions were found, and among them, one in particular is worth mentioning. A large blister nearly a foot in diamter was discovered and a great many of the pustules were rubbed off or destroyed. All over the surface of the lesion were numerous holes made apparently by wood-peckers, probably in search of the insect larvae that are commonly found under dead bark. Is it not possible for these birds to get spores on their feet and bills, carry them to other trees which *may not* be infected, and upon searching in that bark for more insects, thus deposit spores of the blight?

The infections found in the park numbered thirty, *twenty-nine of which are in the part that has been allowed to go without management of any kind.* In the first inspection made of the park last fall only three or four trees were found to be infected. Accordingly, on finding so much infection here it was decided to make a careful strip survey of the bench land lying between the State reserve on the north side of Bald Eagle Mountain, and the Susquehanna river. The tracts are mostly farmers' woodlots, ranging in size from a few acres up to several hundred acres. The soil is poor there and rocky, and gets poorer in quality closer to the mountain. The stands are in about the same condition as the eastern portion of the park, except where some cutting has been done, and here the brush and growth of forest weeds is very dense. The chestnut runs from 20 per cent. to 40 per cent. of the stand, and chestnut oak is present together with red, black, and white oaks.

In direct contrast with the condition found in this portion of Sylvan Dell Park is the condition observed on the Fish and Game Preserve owned by the Jay Cooke Estate. This property is several hundred acres in extent but only about one hundred acres have been inspected. This portion of the tract is located four miles northeast from Waterville in Cummings township, in the west-central part of Lycoming county. The timber is fully 90 per cent. chestnut and is a clean, thrifty young pole stand averaging six to ten inches in diamter, with 250 trees to the acre. On less than five acres fully thirty trees were found to be infected with blight. The characteristic persistent leaves of last summer were present in every case, but pustules were visible only at a height of ten to twelve feet. As was stated, the trees are unusually healthy and thrifty in appearance and no signs of insect work were found. This center is, at the present time, the most northwesterly infection known.

The map accompanying this report gives the relative size of the tracts, and shows approximately the centers of infection by a cross in a circle. The numerals indicate the number of trees in the center.

The most typical center or spot infection was found on the southwest corner of the Hamm tract (see map). There is timber all around this point, except on the west and northwest. On the west it is cut over, and a young second growth of saplings is present, while on the northwest is a cleared field. The real center of this spot was a large tree about sixteen inches in diameter, infected from top to bottom. The bark was fairly plastered with pustules and all of the young saplings (of which there were three or four growing from the base), were badly infected. It seems reasonable to suppose that this infection has been present for two or three years.

Infections of every kind were found at varying distances from this badly infected tree. Fifty feet away, two saplings, six inches in diameter, were found, upon climbing, to be infected, and the only sign of the blight at a distance was a cluster of dead leaves on a terminal shoot. On climbing, a blister about four inches in diameter was found, but pustules had not been formed, the infection having been caused probably late last summer. This lesion was about ten feet from the very tip of the leader. It was found to be girdled and pustules were present at the beginning of last year's growth.

A short distance away a little to the southeast, a small tree, six inches in diameter, was found infected only at the base. Another tree one hundred feet west in the cut-over area was badly infected. This tree was dead, having been girdled with an axe, and the ring of bark removed; but the blight was fully developed and the bark was covered with pustules above the portion of the tree girdled by the axe.

The largest center was found on the Keefer tract (see map). Here twenty-three trees, all saplings, were found on a circular spot fifty yards in diamter. Only one other tree was found outside this center, and that at the extreme southern end of the tract.

Another center less than a quarter of a mile east from the first center described, was found on the line between Hamm and Stuempfle, and the most badly infected tree was one 10 to 12 inches in diameter, to which the wires of the fence were nailed. The tree was dead, and the tunnels of borers and the larvae in them were found. This tree showed very well the appearance of the blight on old bark, and from it several good sections were obtained. Around this tree the young sprouts and two saplings, four inches in diameter, were badly infected.

The strip was worked, in the manner indicated, and when a center was found, every tree within a varying radius depending on the size of the center was carefully examined until no more trees could be found that were infected. Often at the outer limits of one center the edge of another center would be encountered, and this new spot would be studied in the same way. Here and there, scattering cases of infection were found, not in a center, though perhaps the source of the infection was one. These are shown on the map as small circles without a cross.

In the same way a careful inspection of the Fisher and Savidge tract has been carried on. Messrs. Fisher and Savidge of Williamsport and Sunbury respectively, have planned to cut off and graft with Paragon scions, the natural stock on 550 acres of land located one mile west of Essick Heights. This land is admirably adapted to the optimum growth of chestnut, and in fact, in some portions of the tract, which comprises in all 640 acres, nothing else grows. The stand is dense young sapling sprouts 12 to 15 years of age, though here and there patches of old mature timber are found. The purity and density of the stand, however, without a doubt accounts for the number of infections present, which exceeds greatly any condition heretofore found in Lycoming county.

The first spot or center was found not over 100 yards west from the house of G. H. Newman (on map), and it is definitely known that summer before last wild doves roosted here and that they flew in here whenever disturbed. Adjoining was a field of buckwheat where they were in the habit of feeding. The infection or center was entirely on a tract of less than one-fourth acre in size and the trees were nearly all thoroughly infected, mostly in the tops. Several trees showed persistent leaves in the tops, but otherwise there were no signs of the blight. Upon climbing these trees the first stages of the blight were found in a slight splitting of the bark together with a few pustules just beginning to become visible. It seems likely, therefore, to suppose that this infection was carried here by these birds, or at least that it was spread locally by them to other centers near at hand. In all nearly 400 trees were found to be infected, and these were found grouped in six or eight centers. Very effective co-operation is being given the Commission by the owners of these tracts in this region. However, there is a solid strip of chestnut timber four to five miles wide and eight to ten miles long, stretching from the Ogdonia down the Loyalsock Creek. It will be impracticable to attempt to scout this region this winter, but with the opening up of spring, by placing a crew of four or five men in here under the direction of a man familiar with the territory, the whole region will be carefully scouted.

All known infections will be destroyed and the men working in this territory cutting tannery wood, are thoroughly familiar with the appearance, spread, and danger of the disease, so that we can look for local assistance, and that in the end is the aim of our work.

In conclusion, taking everything into consideration, good results have been obtained by winter work. Persistent leaves are visible to a trained eye for long distances through the woods. However, deep snow or a covering of sleet interferes with the finding of pustules at the base of the tree. Their dying branches begin to show most prominently during late summer, hence August and early September is the ideal time for scouting work.

The strip along the river actually inspected contains 452 acres, and this was covered in about a month of actual inspection, for considerable time was used up in superintending the removal of infected trees.

A fair estimate is 4 acres per day per man for a close inspection, working the tract in 30 feet strips. In a very close tree to tree winter inspection, two men can cover four to five acres or two to two and a half acres per day per man.

LONGEVITY OF LIFE OF SPORES.

The following report is submitted in response to the request of Mr. E. A. Weimer, that an attempt be made to germinate spores from an infected piece of chestnut, collected in Monroe county in July, 1908, and continuously kept in a moist cell at the Department of Forestry since that date. Forty-four months after the time of collecting, the status of the fungus is found to be as below:

"Philadelphia, April 19, 1912.

Mr. I. C. Williams,

Deputy Commissioner of Forestry,
Harrisburg, Pa.

Dear Mr. Williams: In reply to your letter of April 18, I can give you the following report:

The fungus on your specimen made a small growth as I at first reported to you. After however, it had started to produce a small number of picnidia it ceased to grow. I then began again, and found that I could cause the spores to germinate. They in turn made but a small growth, and afterward were unable to produce any fruiting picnidia. A small part of the bark which I removed from your specimen was put in a damp chamber. I was unable to get any growth at all from this. This shows that the specimen has almost lost life. This loss of vitality may be due to the Penicillium, a fungus which has covered the surface of this specimen. I will return the specimen in the bottle to you at once.

Very truly yours,

(Signed) CAROLINE RUMBOLD."

REGISTERED DELEGATES AND GUESTS.

The following names and addresses appear on the official register of delegates and guests in attendance at the Conference. It is a matter of regret that a large number of those in attendance failed to register, although indicating their active interest by their presence at one or more sessions.

Daniel Adams, 301 Crozier Bldg., Philadelphia, Pa., (Lumbermen's Ex.)
Prof. Geo. G. Atwood, Albany, N. Y.
Dr. J. M. Backenstoe, Emaus, Pa.
Prof. H. P. Baker, Forester, State College, Pa.
Parker Thayer Barnes, Harrisburg, Pa.
Prof. Geo. L. Barrus, Albany, N. Y.

H. H. Bechtel, Cincinnati, Ohio.
George Bell, Marysville, Pa.
F. W. Besley, John Hopkins Univ., Baltimore, Md.
John Birkinbine, Philadelphia, Pa.
W. F. Blair, Waynesburg, Pa.
Rep. Bloodgood Nurseries, Flushing, N. Y.
Samuel T. Bodine, Villa Nova, Pa.
John Y. Boyd, 222 Market St., Harrisburg, Pa.
H. F. Bright, Ashland, Pa.
H. R. Bristol, Plattsburg, N. Y.
Wm. McC. Brown, Oakland, Md.
Henry G. Bryant, 2013 Walnut St., Phila.,
Geo. H. Campbell, B. & O. R. R., Baltimore, Md.
Chester E. Child, Pres. Lumber Mfrs. Assn., Putman, Conn.
Prof. W. D. Clark, State College, Pa.
Dr. Geo. P. Clinton, Conn. Agr. Exp't. Station, New Haven, Conn
S. C. Clemons, 431 Dearborn St., Chicago, Ill.
B. F. Cocklin, Mechanicsburg, R. F. D., No. 2, Cumb. Co., Pa.
Prof. J. Franklin Collins, Washington, D. C.
W. G. Conklin, Troxelville, Pa.
Hon. Robert S. Conklin, Commissioner of Forestry, Harrisburg, Pa
Dr. M. T. Cook, New Brunswick, N. J.
W. C. Coombe, Millerstown, Pa.
Geo. F. Craig, Rosemont, Pa.
J. C. Cramner, Lehigh University, South Bethlehem, Pa.
Hon. J. W. Crawford, North Bend, Pa.
H. W. Crawford, Conestoga Traction Co., Lancaster, Pa.
W. A. Crawford, Cooperstown, Pa.
Hon. Wm. T. Creasy, Master State Grange, Catawissa, Pa.
Hon. N. B. Critchfield, Secy. or Agriculture, Harrisburg, Pa.
S. L. Cummings, Dewart, Northumberland Co., Pa.
Prof. Nelson Fithian Davis, Bucknell University, Lewisburg, Pa.
Jos. W. Derrick, care of Harisen Townsend, 10th and Chestnut, Phila.
S. B. Detwiler, Executive Officer, C. B. Comm'n., Bala, Pa.
Mrs. S. B. Detwiler, Bala, Pa.
Dr. Samuel G. Dixon, State Health Comm'r., 1900 Race St., Phila.
Dr. Henry S. Drinker, Pres. Lehigh University, South Bethlehem, Pa.
Hon. John J. Dunn, Board of Agriculture, Providence, R. I.
S. B. Elliott, Reynoldsville, Pa.
Elwanger & Bro., Pottstown, Pa.
Dr. J. B. Emerson, 40 E. 41st St., New York City.
S. B. Enterline, Pottsville, Pa.
Samuel L. Eslinger, Lemoyne, Cumb. Co., Pa.
J. K. Esser, Field Agt. Chestnut Tree Blight Comm., Mauch Chunk, Pa.
Thomas Evans, Lebanon, Pa.
Hon. A. B. Farquhar, Pres. Penna. Conservation Asso., York, Pa.
P. S. Fenstermacher, Supt. Trexler Farms, Allentown, Pa.
F. R. Fertig, State Horticultural Inspector, Lebanon, Pa.
Rep. F. & F. Nurseries, Springfield, N. J.
F. W. Finger, Philadelhpia, Pa.
W. Righter Fisher, Bryn Mawr, Pa.
Dr. Wm. R. Fisher, Swiftwater, Pa.
J. W. Fisher, Newport, Tenn.

Dr. A. K. Fisher, Bureau of Biological Survey, Washington, D. C.
Amos Fleisher, Newport, Pa.
P. Hartman Fox, Austin, Pa.
James G. Fox, Hummelstown, Pa.
W. W. Frazier, 250 S. 18th St., Philadelphia, Pa.
Thomas E. Francis, Field Agt. C. T. B. Comm'n., Huntingdon, Pa.
Prof. H. R. Fulton, State College, Pa.
Blair Funk, Pequea Creek, Pa.
W. H. Gardner, Basic City, Va.
Samuel R. Gault, Harrisburg, Pa.
Dr. N. J. Giddings, Morgantown, W. Va.
J. M. Goodloe, Bigstone Gap, Va.
C. E. Gosline, Paterson, N. J.
Prof. Arthur H. Graves, Yale University, New Haven, Conn.
E. M. Green, Mt. Union Tanning and Extract Co., Mt. Union, Pa.
W. E. Grove, York Springs, Pa.
Melvin Guptill, Malden, Mass.
Dr. H. T. Gussow, Ottawa, Canada.
Miss Mary M. Haines, Cheltenham, Pa.
Robert B. Haines Co., Cheltenham, Pa.
Robert W. Hall, Lehigh University, South Bethlehem, Pa.
James L. Hamill, Columbus, Ohio.
J. Linn Harris, Bellefonte, Pa.
Dr. J. W. Harshberger, 4839 Walton Ave., Philadelphia, Pa.
D. S. Hartline, Bloomsburg, Pa.
W. Elmer Houpt, Shippensburg, Pa.
Henry Hawk, 903 16th Avenue, Altoona, Pa.
L. E. Hess, Berwick, Pa.
John K. Hibbs, Field Agt. C. T. B. Comm'n., Philadelphia.
Dr. Samuel S. Hill, Supt. Chronic Insane Asylum, Wernersville, Pa.
G. H. Hollister, Hartford, Conn.
J. E. Holme, care of England, Walton Co., 3rd and Vine, Phila.
E. A. Hoopes, Moylan, Pa.
Dr. A. D. Hopkins, Bureau of Entomology, Washington, D. C.
John Hosfeld, Shippensburg, Pa.
Hon. Josiah Howard, Emporium, Pa.
Geo. G. Hutchinson, Warrior's Mark, Pa.
F. B. Jewett, Brooklyn, Pa.
Henry C. Johnson & Co., Luzerne, Pa.
Joseph Johnston, 3940, Lancaster Ave., Phila.
Miss Florence M. Jones, Philadelphia, Pa.
Miss Martha Jones, Conshohocken, Pa.
Hon. George B. Keezell, Keezeltown, Va.
George W. Kehr, Pa. State Branch Nat. Con. Asso., Harrisburg.
George A. Kerr, care of John H. Heald & Co., Lynchburg, Va.
W. S. W. Kirby, Philadelphia, Pa.
Theodore Klein, Ariel, Pa.
William Kline, West Hanover, Pa.
H. C. Klinger, Liverpool, Pa.
Q. U. S. Krody, Lancaster, Pa.
J. Landis, Bunker Hill, W. Va.
W. J. Lawson, Andora Nurseries, Chestnut Hill, Pa.
Chas. E. Lewis, Orono, Maine.

Edw. Lienhard, Mauch Chunk, Pa.
K. Lockwood, State Chemist, New York City.
Hon. Amos F. Lunn, State Senate, No. Smithfield, R. I.
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BULLETIN NO. 1.

PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION, 1112 MORRIS BUILDING, PHILADELPHIA.

OCTOBER, 1912.

THE

Chestnut Blight Disease.

MEANS OF

IDENTIFICATION, REMEDIES SUGGESTED AND NEED OF CO-OPERATION to CONTROL and ERADICATE the BLIGHT.

GROUP OF INFECTED CHESTNUT TREES IN SOUTHERN PENNSYLVANIA

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA.
1912.

Pennsylvania Chestnut Tree Blight Commission.

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Harold Peirce, *Secretary*, ... Haverford.
Samuel T. Bodine, ... Villa Nova.
George F. Craig, ... Rosemont.
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ISSUED BY

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

1112 Morris Building,
Philadelphia.

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA
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This Commission, in collaboration with the Pennsylvania Department of Forestry, is to ascertain, determine upon and adopt the most efficient and practicable means for the prevention, control and eradication of a disease of the chestnut tree, commonly known as the chestnut tree blight. It is authorized to conduct scientific investigations into the nature and cause of such disease, and the means of preventing its introduction, continuance and further spread. The Commission has power 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 it may deem necessary and proper.

The Commission will cooperate with the owners of chestnut trees to accomplish all of the purposes of the Act in every possible manner.

TREATMENT OF ORNAMENTAL CHESTNUT TREES AFFECTED WITH THE BLIGHT DISEASE.

This bulletin is intended as a guide for the treatment of individual chestnut trees affected with blight, which on account of their value as orchard trees or for decorative purposes warrant the expenditure of considerable time and money for their preservation.

DESCRIPTION OF THE DISEASE

The blight disease is caused by a fungus which grows in the bark and also in the outer layers of sapwood. Pustules (fruiting bodies) are soon produced and grow through to the surface of the bark. On old, rough-barked trees these pustules are borne in the crevices of the bark. The pustules, of a pinhead form, are orange-yellow or saffron in color, and get darker with age, at maturity being a rusty brown. The spores are of two kinds and are produced at nearly all seasons of the year. They are disseminated through the agency of wind, insects, birds, etc. The spores must reach the inner or middle bark to cause an infection. Ordinarily they germinate very quickly, perhaps in a few hours, or at most in a few days. The mycelium then grows through the bark in all directions, developing a series of more or less concentric rings, so that the lesion, or area of infection, has a somewhat circular or oval shape. The rate of growth of the mycelium depends upon weather and other conditions. It grows at all seasons of the year, except in the coldest weather, when it is dormant. In summer, especially in June and July, it is most rapid, as a temperature of about 70 degrees and upwards seems best suited for its development, but growth is less rapid if the weather is dry. In July and August the trees bearing dead branches are especially noticeable.

FAKE REMEDIES

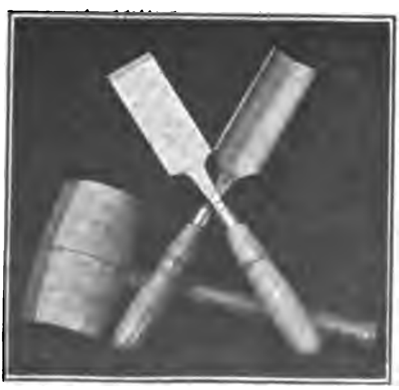
A great number of so called "cures" for the blight have been advanced. In many cases the method of treatment shows that the sponsor is either ignorant or unscrupulous, and in other cases the work is done in such a haphazard fashion that it is entirely worthless.

A spray cannot penetrate beneath the bark where the disease is working, and consequently is absolutely worthless as a remedy. It may be possible, however, to find a toxic solution which can be introduced in some way into the circulation of the tree which will kill the fungus without killing the tree. The Pennsylvania Chestnut Tree Blight Commission is carrying on a series of experiments with this end in view, and it is hoped that some such remedy will be found. It has been claimed that a proper application of fertilizers will cure the disease. While it may be that a healthy, rapidly growing tree is more resistant, observations seem to prove that soil fertilization alone is not a cure. The principal remedies and treatments advocated are being given a thorough test by this Commission, and should any of them be found successful, the public will be so informed. At the present time, however, we can recommend nothing but the treatment herein outlined, which will have to be carried out thoroughly if any considerable degree of success is to be attained.

The work can be done by the owner himself in some cases, especially if the trees are small or easily climbed. A good working knowledge of the characteristics of the disease is essential, but the owner can be sure when he does the work himself that the proper precautions are taken. The owner should also make numerous examinations after the first treatment is concluded, and should be in a position to remove the incipent infections, when this can be done cheaply and before the trees are much harmed.

TREATMENT

The treatment consists principally in cutting away the infected portions of the tree. The mycelium quickly discolors the bark and a sharp line between the apparently healthy and infected bark is usually seen. However, the mycelium penetrates into the apparently healthy bark, and if possible, the cut should be made one inch or more beyond the discolored area. The mycelium also works to some extent into the sapwood below the discolored area, and three or more annual layers of wood should be removed as well. The smaller infected branches should be cut off one foot or more below the canker, when possible. If these branches are cut off at the base, flush with the tree, the wound will heal over more quickly, and there is less danger of the trees becoming reinfected. If the infection lies near the base of a branch, care should be taken to see if any of the mycelium has grown into the trunk. A gouge, chisel and mallet are the proper tools for use in such work. The gouge should be kept very sharp, so that the tissues at the edge of the cut are not unnecessarily bruised, and the healing over of the wound thus delayed. With good work the new growth will start directly under the cut and will often be visible in less than a week, in the actively growing season. The new growth takes place at the sides of the wound. Often above and below a broad



Three handy tools in tree surgery.

wound a triangular piece of bark will die. For this reason it is advisable that the top and bottom of the scar be pointed rather than abrupt or broadly rounded. A large percentage of the bark of a vigorous, young tree can be removed if necessary, without killing the tree. Portions can be cut away from all sides, and the flow of sap will alter its course so as to follow the living bark. It has been shown that this flow of sap under extraordinary conditions will deviate from a longitudinal course fully 90 degrees.

The wounds should be painted with an antiseptic covering after all traces of the mycelium are removed. This is to prevent the development of insect or fungous diseases, as well as the infection by spores of the blight which may have lodged upon the wound, and also to act as a waterproof covering for the wound. Very thick coal tar diluted with creosote to make it readily applicable is the best combined antiseptic and cover that can be recommended and should be used wherever possible. Other substances which can be used as antiseptics only are:

Corrosive sublimate (bichoride of mercury), in the proportion of one part of the corrosive sublimate to one thousand parts of water. Tablets of this poison are sold at all drug stores with directions as to how much water to add to make the 1-1000 solution.

Formalin, 5% solution in water. This is also a poison and must be used with care.

Either of the above antiseptics will kill any of the fungus with which they come in contact. The cutting tools need not be dipped in any solution to kill any spores which may adhere to them, provided the antiseptic is immediately and carefully applied to all cut surfaces.

Waterproof coverings to follow as soon as antiseptic is dry:

1. Coal tar.
2. Lead paint.
3. Shellac, (of temporary value only unless renewed often).

Or this Solution:

4. 1 gallon pine tar.
   2 qts. rosin.
   1 qt. linseed oil. Mix thoroughly.

Extreme care should be taken to collect and burn every particle of the wood and bark which was cut from the infected parts of the tree. This is important. The fungus will live in this bark for a long time after being cut. It has been found that pieces of bark cut from trees send out living spores after lying on the ground in all kinds of weather for five months, and that fence rails and unbarked logs used for building purposes have still shown the disease in an active condition after a year or more. All underbrush, etc., should be cleared from around the tree and the entire tree and the ground directly under it sprayed with a lime-sulphur wash or other disinfectant.

After the treatment has been completed, there is danger from two sources:—1. Some of the mycelium may have been overlooked and left in the bark or wood. The edges of the wound should be closely watched for sometime after the first treatment, and if re-infected, should be promptly and more thoroughly cut away again. Unless this is done it will be unwise or useless to spend money for the first treatment. 2. The tree must be guarded against new infection. For this reason if the tree is located in a region where the disease is very prevalent, or if the tree is in an unhealthy condition and presents many wounds which serve as entrances for spores, the chances for success are smaller. All wounds should be covered during the first treatment and every precaution taken to prevent unnecessary wounds. The use of climbing irons on trees results in the most dangerous type of wounds, and their use by any so-called "tree doctors" should be sufficient reason for branding the men as incompetent, ignorant or wilfully careless.

Spraying the trees at intervals for the purpose of preventing re-infection will kill spores on the exterior and may be successful. Lime-sulphur or Bordeaux mixture may be used, and the work should be done at intervals of about two (2) weeks during the spring and summer, and, if possible, through the entire year.* Painting or spraying the trunk and larger limbs with whitewash is also of some apparent benefit, so far as tried. It is also advisable to apply a coating of tree varnish or tree tangle-foot to the base of the trees after spraying, to keep crawling insects off of the trees.

CASES WHERE THERE IS SMALL CHANCE OF SUCCESSFUL TREATMENT

No such treatment can be recommended for forest trees on account of the difficulty and expense attached to it. Even in the treatment of orchard and lawn trees there is less likelihood of success than usual in such instances as the following:

1. When the tree is very old or very large. Trees in time lose their power of recuperation, and the wounds made in the course of the work will not heal over readily. Experience has shown that trees over forty feet high are seldom treated with any beneficial results.

2. Where the disease has progressed over a large portion of the trunk of the tree so that much of the bark will have to be removed. If the trunk or a large branch is nearly girdled, the

*Complete and detailed directions for making Bordeaux Mixture and Lime-Sulphur solutions will be found in Farmers' Bulletin No. 243, which can be obtained free upon application to the Secretary of Agriculture, Washington, D. C.

Bark and refuse material piled on infected stump for burning.

Chestnut stump after burning; sprouts will develop quickly.

treatment is apt to seriously weaken the tree. Before the work begins, a careful inspection of the diseased areas should be made. Begin at the base and thoroughly examine all portions to the tips of the branches, for signs of blight unless the base is badly diseased, when it will be useless to attempt to save the tree.

3. When the tree is in an unhealthy condition, due to borers or wood rotting fungi. Trees having borer holes and bark wounds present entrances for more spores of the blight and do not respond to the treatment.

4. In localities where the blight is very prevalent and where little is being done to fight it. There is little hope of saving a tree when there are many trees in the vicinity producing millions of spores.

FERTILIZERS

It is believed that a healthy, rapidly growing tree is less liable to infection and will certainly recover better under treatment. It is advisable to apply a fertilizer to the soil about the tree. The soil should be treated a few feet further than is covered by the spread of the crown of the tree. The fertilizer to be applied should contain all the chemical elements in which the soil is deficient—nitrogen, phosphorus, and potash are the most likely to be absent from or deficient in the soil. A mixture of these three is advisable. The following formula, which contains these three elements in readily soluble form, is suggested:

Per 100 square feet:

4 oz. muriate potash	(Potash-content 50%)
13 oz. nitrate soda	(Nitrogen-content 15%)
14 oz. acid phosphate	(Phosphorus-content 14%)

Per Acre

100 lbs. muriate potash (50%)
330 " nitrate of soda (15%)
350 " acid phosphate (14%)

It has also been suggested that an alkaline condition of the soil may have some favorable influence in checking the blight. As a remedy, lump (fresh burned) lime should be used, in quantities of about 9 lbs. per 100 square feet, or two (2) tons per acre. If used with the above fertilizer, it should be applied either two weeks before or after—not at the same time.

SUSCEPTIBILITY AND IMMUNITY

All wild and cultivated varieties of American and European chestnuts seem to be susceptible to the blight, but not all to the same degree. So far as can be ascertained, pure strains of Chinese, Japanese and Korean chestnuts seem to be almost, if not quite, immune to the blight. This applies, however, only to trees grown from imported nuts or nursery stock. These trees hybridize very readily with the native trees, and trees grown from seed produced in this country appear to lose their power of immunity.

RECOGNIZING THE DISEASE

Owners of valuable chestnut trees in Pennsylvania should learn at once to recognize all the symptoms of the blight, so that it may be speedily detected as soon as it appears.

Briefly stated, the disease may be located and recognized by some or all of the following characteristics:

1. Dead branches, usually with withered leaves clinging to them. In the spring, prior to death, the leaves on the infected branches remain small and sickly looking, and gradually take on a yellowish tinge. When these leaves finally die, they have a peculiar wilted appearance. The burrs also remain small and undeveloped. On branches attacked after the leaves have fully developed, the leaves assume their yellowish or reddish-brown fall colors. On trees killed by blight during the growing season prior to September, both leaves and burrs usually remain clinging to the branches through the following winter and are of great value in helping to locate infected trees. All dead branches should be closely examined for further indications of the disease, particularly at the base of the dead parts.

2. Cankers on diseased branches or the trunk, where the bark is not thick and rough. These cankers are areas of dead, discolored, sunken bark, often more or less broken by cracks or checks into the inner bark. Old, thick bark does not change in outward appearance until a year or so after it is diseased, when it begins to peel from the tree in shreds. Prior to shredding, thick bark which is affected gives forth a peculiar hollow sound when struck with a hammer, due to a space between the wood and bark caused by the decay of the inner bark.

3. Small reddish blisters appear on cankers on smooth bark. Later the tops of these blisters burst, forming small, wartlike eruptions or pustules of a sulphur-yellow, orange, or brown color. In the deep cracks of old bark, the pustules form reddish or orange-colored lines. These pustules are the fruiting bodies which produce the spores. During damp weather bright yellow, twisted threads of the microscopic spores are sent out from the pustules. These threads are jelly-like at first but on drying become firm and brittle. They vary from one-sixteenth to half an inch in length, and are dissolved by the rain, which distributes the spores down the surface of the bark.

The mycelium or vegetative portion of the fungus shows in small, irregular, fan-shaped areas of yellowish or buff color, when the surface of diseased bark is shaved off or cut slantwise. This is the portion which produces the spore-bearing pustules, and also the part that saps the life of the bark.

5. Death of tops of entire trees. These dead trees are often conspicuous because of the reddish-brown patches of bark, due to the presence of the pustules. In case the tree has been dead for a year or more, the bark begins to peel off naturally in strips or shreds.

6. Suckers or water sprouts, which develop at the base of the cankers or at the base of the diseased tree. They are frequently very numerous for one or two seasons, after which they are usually killed by the fungus.

If in doubt as to the existence of blight in your locality, communicate with the Chestnut Tree Blight Commision, 1112 Morris Building, Philadelphia, supplying all information of importance concerning the matter.

PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION

1112 Morris Building, Philadelphia.

BULLETIN No. 3 - DECEMBER.

Field Studies

ON THE

Dissemination and Growth

OF THE

Chestnut Blight Fungus

BY

PAUL J. ANDERSON AND D. C. BABCOCK.

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA
1913

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INTRODUCTORY STATEMENT.

The work reported in this Bulletin was carried out under the direction of the Field Pathologist in two field laboratories of the Pennsylvania Chestnut Tree Blight Commission during the growing season of 1912. One of these laboratories was located at Charter Oak, Huntingdon County; the other was at Mt. Gretna, Lebanon, County.

The writers wish to acknowledge valuable assistance from the following: E. T. Kirk, J. F. Burrows, M. R. Clare, C. F. Korstian, L. S. Pearson, A. B. Bechtel, W. E. Keefer, R. D. Spencer, C. A. Gates.

DISSEMINATION OF THE FUNGUS

INTRODUCTION.

Not only must the chestnut blight fungus be destroyed where it is already found, but it must be prevented from spreading to healthy trees. The loss of the trees already infected would be a small matter if we had a way to prevent it from spreading to those that are now free. But this way will be found only after it has been determined how the fungus passes from one tree to another, and how it gains entrance to a healthy one. This is the fundamental problem and no small part of the summer's work has been directed towards its solution. The work is far from complete but a report is submitted at this time for the benefit of others, who may be working along this line.

Before entering into a discussion of experiments, a resume will be given of what others have said and done on the problem of dissemination.

A REVIEW OF THE LITERATURE.

How the fungus enters the host.—Murrill (1) in 1906 is of the opinion that the fungus could only enter through wounds but suggests the possibility of lenticels also being channels of entrance. He thinks that wounds may be made by any one of a number of agents: mice, voles, rabbits, man, insects, etc. Later in the same year (2) he believes that the fungus may enter through dead twigs, since he finds these at the center of many cankers. Metcalf, (3) in 1908 says that the spores enter through wounds, insect punctures, dead twigs or dead wood. Later in the same year Hodson (4) repeats the statements of Murrill and Metcalf. The next year Metcalf and Collins (5) state that the spores enter through wounds and possibly in other ways. In 1910, however, they (7) assert that the fungus can enter without any visible break in the bark. Still they are of the opinion that wounds are the usual channel and state that among these, the tunnels of the bark borers are the most common. They suggest also that winter injury may produce lesions that will give entrance to the fungus. The idea of the borers being responsible was evidently strengthened by further observation for in 1911 (9) after repeating their former statement, they write, "In many parts of the country where the disease is prevalent there is very direct evidence that bark borers, and particularly the two-lined chestnut borer (Agrilus bilineatus) are directly associated in this way with 90 per cent. or more of all cases of this disease." None of these writers cited give any experimental data to prove their assertions.

How the fungus is carried from one tree to another.—Whether the agent that makes the wound is the same as the one that carries the spores, is a question on which observers do not agree. The tendency in the last few years has been toward the belief that they are the same, and that when the specific agent that makes the wound is found it will also be found to carry the spores.

Murrill (1) in 1906 says that the summer spores are disseminated by wind, insects, birds, squirrels, etc., and also that mice, voles and rabbits make wounds and carry the spores in their fur. In a second article (2), he suggests the agency of rain in carrying the spores to other parts of the tree. Hodson (4) in 1908 says, "Wind is probably the principal agency, but the spores are no doubt carried by animals, birds, insects and by the shipment of infected material. The disease spreads locally through the gradual distribution of the spores from tree to tree and at a distance, chiefly through the shipment of infected material, such as a nursery stock, bark, nuts and other products. There is a possibility that long distance infection is also effected by means of migratory birds." It should be noticed that he was speaking only of the summer spores. He does not claim to have done any work on this subject himself, but has compiled his circular mostly from what Metcalf and Murrill wrote. Rane (8) in 1911 says that the spores are carried long distances by the wind but it is impossible to tell whether he was speaking of the conidia or winter spores. Exactly the opposite opinion is expressed by Metcalf and Collins regarding the spores (9): "There is no evidence that they are transmitted by wind, except where they may be washed down into the dust and so blown about with the dust." The following year Metcalf stated as follows:" Both kinds of spores appear to be sticky and there is little evidence that they are transmitted to any distance by wind except when washed down into the dust and so blown about with it." (10). To account for the spread they suggest rain and add: "There is strong evidence that the spores are spread extensively by birds, especially woodpeckers, and there is also excellent evidence that they are spread by insects and by various rodents, such as squirrels." (9). They also mention the agency of man by shipping timber and nursery stock. The general opinion of investigators up until the present about the wind, is well expressed by Collins* who in his address at Ithaca, N. Y. in December 1911, makes the following statement: "I am quite convinced that these spores are not blown broadcast, simply because they are of a sticky nature." He adds that there is no reason why birds should not carry them.

As far as any published research is concerned, the situation was well summed up by Rankin (11) at the Harrisburg Conference in February, 1912: "Concerning the means of the spread of fungus from one tree to another, we have nothing except secondary evidence. Most writers have theorized on the different methods by which the conidia or summer spores might be carried from one tree to another and new infection started. Reasoning by analogy with what is known of the behavior of many fungi, such agencies as borers, birds, ants and the wind, etc., have been suggested but in no wise proved to be responsible. It seems that the ascospore stage has not been considered by any writer in the dissemination of the fungus, yet this stage follows the conidia very quickly and is the more abundant fruiting stage." Then he adds: "Under moist conditions, the ascospores are shot forcibly out in the air, where they can be caught up by the wind and carried for a considerable distance. The speaker found the ascospores being shot from the mature pustules during every rainy period last summer. The question at once arises, why could not these ascospores once shot into the air, be carried long distances and owing to their abundance cause a large majority of the infection?" So far as the literature shows, Mr. Rankin stands alone in his views of the importance of the ascosporic stage and the agency of the wind.

Fulton (11) reports some work carried out by Mr. R. A. Waldron, which has an important bearing on dissemination. At-

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*Collins, J. F., The Chestnut Bark Disease. Reprint from Proceedings of the Second Annual Meeting of the Northern Nut Growers' Association, Ithaca, N. Y., December, 1911.

tempts were made by a strong blast from an electric fan to blow the conidia into the air. The results were such as to lead Mr. Waldron to believe that at best the conidia could be blown only a short distance even in a strong wind. His opinion, expressed to the writer, is that the wind has very little to do with the dissemination of the conidia.

CHANNELS OF ENTRANCE TO THE HOST.

Much confusion has arisen in the past by not making a distinction between the agent that carries the spores, and the one that produces the wound by which the spores may enter. Some writers have proceeded on the assumption that one and the same agent is responsible for both, i. e., that this agent carries the spores to a healthy tree and there makes the wounds where it deposits the spores in a favorable place for growth. That such is not the case, can positively be demonstrated in many cases and the evidence is strongly against it in the majority of cases.

Necessity of a wound.—Murrill (1) failed to get an infection except where a wound was first made. Metcalf and Collins (7) however, state that the parasite may enter without a visible abrasion in the bark. In our experimental plots all attempts to get an infection by placing the spores on sound bark have failed. The following experiment, however, may be not without significance in this respect. Diseased bark taken from a young canker was placed closely around small branches, where no abrasions could be detected and then the whole wrapped with cotton. The cotton served first to exclude insects and other agents; second, to keep the bark moist. Seven branches were treated in this way on June 29th and on September 5th,—a little less than ten weeks, cankers were formed on three of them. There was no sign of an infection, however, one month after the experiment was started. On account of the unusually favorable conditions for infection that are offered and the tardy appearance of the cankers, not much practical importance has been attached to these results. All other experiments indicate that the cases where the fungus enters through sound bark are so rare as to be entirely negligible.

The value of observation of natural infections.—The questions that have been asked hundreds of times are: Can't you tell by looking at young cankers, how they were started? What is the use of making inoculations when you have the wounds right there at the center to show you where the canker started? The problem is apparently very simple. If you find a canker with a larval gallery at the center, then the fungus must have entered through that wound;

if a sapsucker hole is there, then it is plain that the infecting spore was deposited in that hole, etc., etc. It is safe to say that ninety-nine per cent. of the statements that have been made concerning the infecting agent are based on data collected in this way. Some extensive lists of the kinds of wounds in the canker have been carefully compiled and put forward as indicating that certain specific agents are responsible for a certain percentage or the infections. The fallacies of such data are so obvious that they hardly need comment. It is almost impossible to tell, except in the very youngest cankers, whether the wound preceded the canker or the canker preceded the wound. Very few old cankers are free from larvae and it is not uncommon to find them in cankers less than an inch in diameter in our experiment plots and yet the wounds were produced by a knife and not by the larvae. Woodpeckers and other birds pick at the cankers to get the larvae. The holes that they make, often lead the uninitiated to believe that the canker started in them. Many have stated that the natural cracks in the bark are a favorite means of entrance because they found these at the center of the canker. Yet it has been noticed all summer, that it does not matter by what method the inoculation is made,—a crack will almost invariably be formed at the center on account of the drying out of the bark and soon it is almost impossible to tell by what method the inoculation was made. In our observations on natural cankers, dead twigs have more often been observed at the center than any particular wound. But did the canker start from the dead twig or did the twig die as a result of the canker forming around it? Very young cankers are not often noticed and when they are, they usually contain no spores, so that it is impossible to state whether or not they were produced by Endothia unless cultures are made or they are put in a moist chamber for further development. Many cankers have been ascribed to this fungus, but when sent in to our laboratories for examination proved to be only the natural dying of the bark around insect galleries.

Observations on the natural cankers are not altogether without value, but it is certain that data collected from these observations alone are not reliable in determining the cause of infection.

Inoculations of various kinds of wounds.—The only way then to find out what agents are responsible for giving entrance to the fungus is to find the wounds produced by these agents (in uninfested territory), inoculate them artificially and see if cankers are developed from them, at the same time keeping plenty of wounds not inoculated as checks. In some cases where wounds cannot be found where wanted, it is necessary to make artificial wounds as near like the natural ones as possible. The following kinds of wounds have been inoculated and the results given in Table 1.

1. Slits in the bark, longitudinal, diagonal, etc., to imitate axe wounds, knife wounds, etc.
2. Gouges to imitate climbers.
3. Artificial borer holes.
4. Natural insect holes.
5. Peeling down the bark.
6. Scraping off only the outer cork layer.
7. Cut stubs.
8. Broken down branches.
9. Natural cracks.
10. Gimlet holes to imitate sapsucker holes.
11. Holes made by a hypodermic needle.

It will be noticed in this table that a fair percentage of infection was secured in all but three kinds of wounds. One of these was natural cracks. Indications from later experiments, not yet reported, lead us to believe that this kind of a wound also can become infected. It is worthy of remark that out of all the natural insect holes that have been inoculated with both kinds of spores and with cultures, not one has produced a canker up to date.

The results of all the inoculation experiments of the summer, certainly warrant the following conclusion: Any kind of a wound in the bark deeper than the outer green cortex may furnish an entrance for the fungus. In other words, it is not necessary to have a wound of any specific character or made by any specific agent.

Before leaving this subject, mention should be made of another mode of entrance, which although as yet not sufficiently investigated, may prove to be of some importance. It was commonly noticed in thick young coppice in eastern Pennsylvania that many of the young sprouts of this year's growth were dying from the tip downward. The disease seemed to start in the leaves, the midrib especially being blackened by the invasion of a fungus. All stages could be found from leaves with dead tips to the entirely deadened twig. In a very large number of cases the blight fungus was growing around the base of the twig, where the blackening had run down to the larger branch, in such a manner as to lead one to believe that it had entered by means of the twig. Isolations both from the leaves and from the twigs showed the presence of a fungus which we have repeatedly demonstrated to be the cause of "die back" on the twigs in western Pennsylvania. This fungus was isolated too late in the season to carry on inoculation experiments this year. That its attack may have some relation to the entrance of the blight fungus is at least possible.

TABLE 1

Showing the comparative value of different kinds of wounds for infection.

Character of wound.	Inoculation material used.	Number of inoculations.	Percentage successful.
Longitudinal slit,	Diseased bark,	568	93.6
Longitudinal slit,	Mycelium from culture,	454	89.2
Diagonal slit,	Mycelium from culture,	25	96.0
Diagonal slit,	Dry spore horns,	16	93.7
V-shaped cuts,	Conidia in water,	97	93.8
V-shaped cuts,	Ascospores in water,	88	94.3
V-shaped cuts,	Ascospores shot in dry,	1238	82.5
Artificial borer holes,	Mycelium from culture,	68	54.4
Natural insect holes,	Mycelium from culture,	18	0.0
Natural insect holes,	Conidia in water,	23	0.0
Natural insect holes,	Ascospores in water,	22	0.0
Peeling down bark,	Mycelium from culture,	25	88.0
Stab with knife	Ascospores in water,	347	36.9
Stab with knife	Conidia in water,	81	86.8
Stab with knife	Dry spore horns,	96	79.1
Scraping off outer cork layer,	Mycelium from culture,	26	0.0
Cut stubs,	Mycelium from culture,	22	81.8
Broken branches,	Mycelium from culture,	45	71.9
Natural cracks,	Mycelium from culture,	26	0.0
Gimlet holes,	Ascospores in water,	135	52.6
Hypodermic needle,	Ascospores in water,	54	75.9

Having thus disposed of the agents which furnish a means of entrance to the new host, let us next consider some of the agents, which have been suspected of carrying the disease from tree to tree.

MAN AS THE DISSEMINATOR.

The shipment of nursery stock.—This has proved to be an efficient means of carrying the fungus by long jumps to regions free from blight (Cf. (5) p. 49; (4) pp. 5 & 7.) This phase no longer calls for experimental proof, but four interesting cases which have come to light in western Pennsylvania are worthy of mention because they were all far beyond the main line of advance of the disease. The first of these was near Connellsville, Fayette County, a county in which blight has never been found on the native trees. Twelve

Paragon trees had been purchased from a Philadelphia nursery in the Spring of 1911. These were grafted trees about two or three years old. When the disease was discovered about a year afterward, six of the trees were dead or in a dying condition from cankers on both the stocks and the scions. Fortunately no native trees were close to these and the fungus had no chance to spread further. A second case at Warren was similiar. Out of twelve trees, eleven were dead at the top and on the majority of the trees Endothia was plainly the cause of death. A very similar condition was found in Elk county. Here however, it had gone further and one native tree close by was badly infested. These trees were brought from Rochester, New York. The fourth case is between Somerset and Berlin in Somerset County, and here it has been left long enough to demonstrate the awful destructiveness of the disease. About four years ago some Paragon grafts were brought from Lancaster County, a badly infested county, and top grafted on native trees. There are now thousands of diseased trees within a radius of two miles from the grafted trees. Since the disease has gone so far and since there were no records of it up to the present year, it is only fair to state that it cannot be definitely proved now that this infection started from the Paragon grafts. The fact that the scions were from an infested orchard indicate that these were the source of infection.

The spread of the disease by tools.—To determine whether the disease can be spread by tools in cutting into a diseased tree and then into a healthy one, the following experiment was tried:

On July 25th, 13 cuts were made in trees with an axe, each time after chopping into a diseased log several times. Within six weeks cankers began to appear around the cuts and on October 1st, when the trees were cut down and burned, 12 of the 13 cuts had decided cankers about them. There is then little doubt that the disease can be carried in this way.

Shipment of logs and wood.—Can the disease be spread by shipping logs and wood into uninfested territory? This resolves itself mainly into the question of whether the fungus lives and grows and produces spores on the dead bark and logs, under the conditions in which they are usually kept. How long will it live there? Will it pass from one log to another or from one piece of bark to another? Supposing that the spores were already formed, how long would they continue to live on dead logs or on bark? How long would the perithecia retain their power to shoot spores into the air? To answer these questions, the following experiments have been started and the results up to date are given below:

Experiment: To determine how long mycelium will remain alive in logs, peeled and not peeled. On July 1st, 104 logs were cut and left on the ground where they fell; 18 of these were peeled and the remainder left with the bark on them. Three months afterward the mycelium was found still alive in 22 per cent. of the peeled logs and 66 per cent. of those not peeled.

Experiment: To determine whether bark after being taken from the log and thrown on the ground can become infected. Pieces of bark were inoculated and thrown on the ground in various situations to see if the fungus would develop on them. Table II gives results.

TABLE II.

Showing results of inoculation in removed bark.

Date.	Method of making inoculations.	Where kept.	No. of incubators.	Percentage successful.
June 1,............	Mycelium from culture in slit,.........	Dry ground where sun was shining.	14	0
June 1,............	Conidia put in slit in bark,...............	Dry ground where sun was shining.	12	0
June 1,............	Ascospores put in slit in bark,...........	Dry ground where sun was shining.	15	0
July 23,............	Mycelium from culture in slit,...........	Shady place but rather dry ground.	6	100
July 23............	Ascospores in water,.........	Shady place but rather dry ground.	3	100
July 23,............	Piece of diseased bark tied on,.........	Shady place but rather dry ground.	3	100
Aug. 21,............	Piece of diseased bark tied on,.........	Low wet ground in shade,...	12	100
Aug. 21,............	Washed with water containing ascospores.	Low wet ground in shade....	7	100
Aug. 21,............	Mycelium from culture in slit,...........	Low wet ground in shade....	21	85

From this table it appears that the condition under which the bark is kept will determine whether or not it can become infested. If piled in a moist and shaded place, it is certain that the fungus will spread through it, if any spores are present, to infect it. Also if diseased and healthy bark are piled together, the fungus will run from the diseased bark to the bark that is uninfested. It has often been noticed during the past summer that where diseased trees were cut and the chips left in a pile about the base of the tree, that the fungus will grow luxuriantly in the bottom of the pile. Not only will it grow on the dead chips, but also on leaves and dead chestnut burs, as proved by the following experiments:

Experiment: To determine whether Endothia will grow on dead leaves. Dead chestnut leaves were sterilized in a moist chamber on July 23rd and then a few drops of water containing ascospores washed down over them. On August 24th numerous pycnidia were formed on the leaves.

Experiment: To determine whether Endothia will grow on dead chestnut burs. On June 14th, three dead chestnut burs were sterilized and placed under a bell jar. Afterwards a few drops of water containing ascospores were washed down over them. On July 24th pycnidia had been developed on all of them.

Experiment: To determine whether the fungus can grow on seasoned chestnut wood. On September 13th, nine small pieces of a rail that had been seasoned for several years, were put in tests tubes with moist cotton, sterilized and inoculated at one end. On October 6th, scattered pycnidia had formed at various points on the surface of all of them. That it can also grow on twigs of other species will be brought out later.

The fact that this fungus, besides being a virulent parasite, is also an excellent saprophyte seems never to have received sufficient attention. It will grow more rapidly through dead tissue than through living tissue, and will live there for a long time and continue to produce its spores. Some interesting examples of this have been noticed. In an infested tract previously mentioned, in Somerset County, in June of this year, diseased trees were burned so near healthy ones, that the latter were scorched on one side and the bark cracked open. A reinspection of the injured trees four months later showed that the fungus had gained entrance through the cracks and had spread entirely over the burned sides of the trees, growing in some cases a distance of six inches from the point of infection. Comparisons with the rate of growth as determined by inoculation experiments show that this is a great deal faster than it grows through healthy tissue. At St. Marys, Pennsylvania, trees with scattered cankers were cut in the spring of this year and permitted to lie without further attention. In October a reinspection showed the fruiting pustules of the fungus spread more than a foot from the edge of the canker during the summer. Trees in the same condition were felled during the spring at Anderson, Pennsylvania. The trunks were utilized but the tops and branches were left on the ground. Six months later, hardly a branch or stump or top could be found which was not fairly covered by the fungus. In the saprophytic condition no canker is formed and the bark looks no different from ordinary dead bark except for the reddish pustules. Another peculiarity of the fungus under these conditions is that the mycelium does not advance in fan-shaped mats, but by single strands so that it is not readily visible to the unpracticed eye.

Spores that are already formed live for months (see below under "Longevity of the Spores") and that the perithecia will still retain their power of ejecting the ascospores into the air is proved by the following:

Experiment: To see how long after being dried the perithecia can eject the spores. Bark with perithecial stromata was kept in the laboratory for 14 weeks. Five pieces of this were then tested and ascospores were shot out on slides from two of them.

Then there is no reason why the disease can not start in a new locality to which the logs are shipped, if in that locality they are placed near where chestnut trees are growing. If the logs are peeled, however, the chances of spreading are much reduced since the logs will dry out more and in any case only pycnidia will be produced. The shipment of unpeeled wood is evidently a more prolific way of spreading the disease since the perithecia are developed on the bark.

The only recommendations about the shipment of chestnut products that can be made at this time are in regard to the moisture conditions under which they are shipped or stored. It has been demonstrated that water is necessary first for the ejection of the ascospores; and second for the germination of either form of spores. Shipment should be made in closed cars and the wood, if it cannot be stored inside, should at least be piled up off the ground in such a way as to admit all the air and sunlight possible.

BIRDS AS CARRIERS OF THE FUNGUS.

The fact that birds pick at the cankers in search of larvae has been previously mentioned. Then they would get the spores or bits of mycelium on the feet, bills and feathers and carry them away to other trees and deposit them there seems a plausible theory. During the early spring, on the experimental plats at Mt. Gretna, Mr. Clare observed several species of woodpeckers and the blue jays picking at these cankers, and in some cases large areas were picked away. At that time, however, none of these were shot and tested for the presence of spores. A set of experiments was planned to determine whether any of the birds carried the spores, but on account of unfortunate delays, could not be carried out until the middle of the summer. By that time the birds were very scarce around the trees. It seems that during the summer they live mostly on berries and other fruits and do not pick at the trees. Nevertheless some of them were shot in the plots and tested. The method and results are given below:

Birds found on the infested trees were shot during the summer and their feet, bills, and tail feathers washed separately in sterile water. This water was then centrifuged to bring down the spores that might have been washed from the birds. Part of the sediment was then examined under the microscope and the other part plated out in dilution plates. When colonies of fungi appeared, they were isolated to determine whether they were Endothia. Another method used, was to make direct imprints on sterile chestnut bark agar plates with the feet and bills of the birds. Three blue jays, eight downy woodpeckers, three creepers, four flickers and two hairy woodpeckers were treated as above, but all results were negative. To determine whether this method was at fault, the feet and bills of birds were brought in contact with both conidiospores and ascospores and then treated as above. Colonies of Endothia developed in abundance.

Birds may be instrumental in spreading the disease but up to the present we have no experimental data to prove it. These experiments will be resumed during the winter and spring with a better chance of obtaining conclusive results.

That such a wound in the bark as that produced by a sapsucker could become infected by ascospores is indicated by the following:

Experiment: One hundred and thirty-five wounds of about the same diameter and depth as the holes made by sapsuckers were made with a gimlet. These were inoculated by putting the ascospores in water and dropping the water from a pipette into the holes. All of these had cankers formed about them six weeks later. No cankers appeared on the forty-five uninoculated gimlet holes used as checks.

HOW THE RAIN SPREADS THE DISEASE.

The rain dissolves the mucilaginous matrix of the spore horns and the conidia are carried down the trunk, where they probably find lodgment in wounds and produce cankers. This is the usual explanation of the fact, that most trees with cankers on the upper trunk or large limbs, later become diseased at the base and on the exposed roots. As an actual fact, there are no experimental data which prove that the rain is responsible for these basal cankers. Insects might just as well carry the spores there, and several other agents might be suggested but the rain theory is the most plausible

Some very interesting data were collected along this line at Charter Oak on the naturally infested tract. The diseased trees were blazed April 1st of this year, the blaze being cut in healthy bark in most cases. On August 14th eighty-four of the blazes were examined and sixty-six of them had developed new cankers at the base of the blaze, while only eight had cankers at the top. Now a remarkable thing about the Charter Oak infection is that all through the summer no ascospores could be found, but there has been an abundance of conidial tendrils since the middle of May. Taking these facts into consideration, therefore it seems probable that the cankers in the blazes were started by the conidia washed down from above.

To determine that the spore horns are washed off by the rain, it is only necessary to watch the water running down the trunk during a rain. That they would wash into wounds below is certain, if there were wounds there at the time of the rain. Then to duplicate these conditions, it is only necessary to make a suspension of conidia in water and spray trees so that the conidia run down into wounds, or to put the water with the spores directly in the wound. This was done successfully in various sorts of wounds as reported in Table III.

A still more convincing experiment was carried out at Mt. Gretna as follows:

Experiment: Isolated trees were selected which had cankers on the trunks producing conidial tendrils, but having no ascospores in them. Wounds were made at various distances below the cankers. Water was sprayed with an atomizer on the cankers and allowed to run down the trunks into the wounds. Of the twenty-three wounds treated in this way, sixteen developed cankers later.

TABLE III.

Showing the value of conidia in water for producing infection.

Date.	Plot.	Method of inoculation.	Number of inoculations.	Percentage successful.
June 5,	6	Sprayed with atomizer in V-shaped cuts,	57	89.4
June 17,	15	Dropped into stab in the bark,	53	54.7
June 11,	12	Dropped into stab in the bark,	96	55.00
July 7,	36	Dropped into V-shaped cut,	40	92.5

A much more important part played by the rain in the spread of the disease is in soaking up the bark and the perithecial stromata, thus bringing about the proper conditions for the ejection of the ascospores. This will be treated under "Wind Dissemination."

Sometimes it has been observed that the ascospores, instead of shooting, merely ooze out, and in this case, the rain would wash them down and produce basal infection, just as with the conidia. To determine the power of ascospores to produce infection when carried down by the drops of rain water, a set of experiments was carried out very similar to those with conidia. The rain might also splash the spores for short distances or carry them to trees that are directly under cankers on the higher trees. The results are given in Table IV. On the whole there is need of further experiment in regard to the relation of the rain to the disease.

TABLE IV.

Showing the value of ascospores in water for producing infection.

Date.	Plot.	Method of inoculations.	Number of inoculations.	Percentage successful.
June 10,	10	Dropped into stabs in bark,	184	29.3
June 11,	13	Dropped into stabs in bark,	144	34.7
June 17,	15	Dropped into stabs in bark,	59	40.7
July 17,	36	Dropped into V-Shaped cuts,	88	88.9

THE RELATION OF INSECTS TO THE DISEASE.

From the time that the disease was discovered, insects have come in for a large share of the blame for its spread. The main reason for this theory seems to be that they are found so abundantly on and in the bark of chestnut trees and that their galleries are common in the cankered areas. But one will look in vain through the literature for any convincing experimental data to prove that they are responsible. Since this was considered a problem for the entomologist, and since there were several entomologists working on it in Pennsylvania, very little work bearing on the relation of insects was done in our laboratories.

The insect most often found in this state, working in the bark is the little larva of the "bast miner." When it emerges it leaves a neat little hole less than 0.5 mm. in diameter. Since these appeared to be excellent places for the fungus to gain an entrance, inoculations were made in them, with mycelium, ascospores and conidia and introducing them in various ways and at different times during the summer. No infection was ever secured.

There seems to be a general idea abroad that insects are in the habit of boring into diseased bark and then going to another place, and boring another hole there, thus carrying the disease from one tree to the next. Competent entomologists assure us, however, that it is doubtful if any insects with such habits live on the chestnut. Larvae do not leave their galleries until they come out as adults, and then they come out leaving the old pupal case behind them, or else they come out and go into the ground to pupate, in which case also they would not carry the spores to other trees. There is also an idea current that when the adults deposit their eggs they sting or puncture the bark and lay the eggs on the inside. Now as an actual fact we are informed that such is not the case but that the eggs, as a rule, are deposited on the outside of the bark, and when the larvae hatch, then enter the bark through microscopically small holes and at so slow a rate, that it is doubtful if very much fresh bark is left exposed at any one time. The cicada is an exception to this rule, since it does deposit its eggs on the inside and make a large wound in doing so, but has never been demonstrated that a cicada will oviposit in a diseased area, so that it would be hard to see how the spores could get on the ovipositor in the first place. Nor are the cicadas sufficiently numerous in this part of the State to account for the infection. The writers have had occasion to examine several thousand cankers during the summer, but have never seen one that was suspected of having started from a cicada wound. However, cases have been reported by field men in which as high as thirty per cent. of the lesions were found in or about cicada wounds.

Ants have been accused and some observers state that they have actually seen them eat the spore horns and pustules and also carry them about with them. Even at that, this is only secondary evidence that they produce new infections with these spores.

Experiment: On May 8th, eighteen ants were dug out of a canker and each transferred to a sterile plate of potato agar and permitted to run over the plate for several days. No colonies of Endothia developed on the plates. This experiment was duplicated later by R. D. Spencer in the laboratories at Charter Oak, but with negative results. Mr. Spencer is of the opinion, however, that this method is at fault.

Experiment: On August 7th, five vials of insects were sent to Charter Oak from eastern Pennsylvania by P. H. Hertzog, to be tested to see if they had spores of the fungus on them. These were tested by putting them, one at a time, in tubes or melted agar, kept just warm enough so that it would not solidify. The tube was then shaken and the agar poured into sterile Petri dishes. Ants from three of the vials proved to have the spores on them. The spores had been artificially placed on the ants in one of the vials, however. The ants in the other two had been taken from the bark of the diseased chestnut trees after a rain. This indicates that the ants can carry the spores.

Experiment: To find out how long spores will remain on ants. On August 28th, fifteen large ants were caught and immersed in water, which was milky with conidia. Then these were allowed to run in a bottle of earth and at regular intervals two were taken out and tested for the presence of spores. The last test was five hours and sixteen minutes afterward and spores were still on the insects. The technique used was the same as in the preceding experiment. This shows that ants may retain the spores long enough to carry them some distance.

Experiment: To determine whether ants eat the stromata of the fungus. On August 28th, fifteen ants were placed in a bottle, containing moist bark with perithecial stromata. Air was admitted through cheesecloth at the top. They were kept in there until all but two of them starved to death. Examination showed that they had not eaten the pustules. No similar experiment with spore horns has been tried.

Many observers have noted the fact that the stromata at times are found to be all eaten out of the bark. This has been attributed to various agents, such as birds, squirrels, ants, etc. This has been especially noticed during the past summer and trees have been found covered with cankers, but with not a pustule remaining. It was thought that the agent that removed the stromata might be responsible for spreading the disease, by carrying the spores to healthy trees. Mr. Spencer worked on this problem and found that although several insects occasionally work at the pustules, by far the greater part of them in this locality, were eaten out by *Leptostylus maculata*,—one of the Cerambycid beetles. These insects were repeatedly put in cages, with pieces of the bark containing stromata, and it was a matter of only a few days when not a pustule remained on the bark.

The question next to be answered was, whether the disease was further disseminated by the ravages of this insect or whether the beetle was beneficial since it ate such a large number of spores.

Are the spores digested and thus destroyed in the stomach of the insect or do they pass out in the excreta to germinate on the other hosts? Two sets of experiments were run to determine this point.

Experiment: The beetles were fed on the stromata for five days then taken out and sterilized with phenol on the outside. Then the viscera were removed with sterile needles, put in melted potato agar and plated out by the usual poured plate method. Numerous colonies of bacteria developed but no fungi at all. The bacterial colonies are explained by the fact that bacteria thrive in the intestines of insects, as well as higher animals. This experiment was checked by the following:

Experiment: After being fed for a day on the ascosporic stromata five of these insects were removed and caused to excrete the fecal material by a light pressure with the forceps on the abdomen. This fecal material was caught in sterile potato agar tubes and plated out with the same negative results as in the preceding experiment. These experiments indicate that this insect may be really beneficial.

Mr. Spencer and the writers are of the opinion that the insects are not important agents in the spread of the blight, except in so far as they produce wounds by which the spores may enter.

THE RELATION OF THE WIND TO THE SPREAD OF THE CHESTNUT BLIGHT.

Murrill in his first publication on the blight (1) in June, 1906, states that the summer spores are disseminated by the wind. Outside of mentioning the fact that the winter spores are matured in late autumn, this stage of the fungus is entirely ignored. From that time until 1911 almost every writer on the chestnut blight who mentions dissemination at all, follows Murrill in stating that the conidia are blown by the wind and in ignoring the ascospore stage. The disease does spread in a way that would lead most observers to suspect that the spores are carried by the wind; therefore their conclusions are not remarkable. It is much easier to imagine the wind blowing the spores off these exposed tendrils of the summer spores, than out of the perithecia, which are deeply imbedded in the stromata. Besides, the ascospores were thought to be developed in the winter, while the disease spreads most in the summer. But when it was discovered that the conidia are very sticky when wet, and are cemented together in a mass as hard as horn when dry, the wind dissemination idea had to be discarded. The general opinion concerning conidia as expressed by Metcalf and Collins (9) in October, 1911, was as follows: "As both kinds of spores are sticky, there is no evidence that they are transmitted by wind except where they may be washed down into the dust and so blown about with the dust."

The results of a series of experiments during the last summer, have led us to believe that the ascospore stage is the important stage in the dissemination of the fungus and that the wind is largely responsible for its spread. The observations and data upon which these conclusions are based are given below.

Occurrence of the ascospore stage.—The ascospores are commonly called winter spores but this name is misleading. There has never been a time during the past summer when ascospores could not be found maturing in any number of localities in Pennsylvania. On the other hand there were "spot infections" in the western part of the State, where nothing but the summer stage could be found, although the infection apparently was of several years standing. A comparison of a large number of these "spot infections" showed that in general, where the fungus was all in the summer spore stage, young cankers were scarce and were mostly confined to the young growth about the older infested trees, while in the localities where the winter stage was common, they were more numerous and much more widely spread in the surrounding woodland. These were the first observations that led us to believe that the ascospores are of primary importance in spreading the disease from one tree to another.

Ejection of the ascospores.—These spores are enclosed in a tough leathery flask, the perithecium, which in turn is deeply imbedded in the stroma. In order to get to another tree and to reproduce the disease there, they must be removed from this flask and get out into the air. The question at once arises: How do they get out? In the summer of 1911, W. H. Rankin (11) discovered that the spores are forcibly ejected from the ostioles of the perithecia. That such is the case can very easily be demonstrated. After a heavy rain or after making the bark very wet by spraying water on it, fasten a glass side on the bark over mature perithecia, so that the surface of the slide is only a few fillimeters from the ostioles. In a short time white blotches will appear on the slide over certain of the ostioles which are active. Examination under a microscope will show these to be little heaps of ascospores sticking to the slide. The course of the spores after leaving the ostioles can be watched under the low power of the microscope or better under a binocular dissecting microscope. The writer has also often observed them with only a hand lens. A still better method of watching them in quantity and one which has been used successfully in our laboratories is the "light-beam" method, which is described by Buller in his "Researches on Fungi." By this method they can be watched with the naked eye, shooting out into the air by thousands.

The relation of the rain periods to the ejection of spores.—The spores are ejected only during periods of rain since the bark must be well soaked. To see how often they would shoot during the month of August under natural conditions, slides were suspended over 30 groups of pustules on a clump of trees. All of them ejected spores, at least once during the month, and four of them at five different dates; others, less often. The fact was noticed that even after a heavy rain, the spores would often be ejected only from the stromata on one side of the tree, the other side not being sufficiently drenched to start the perithecia.

Time required for perithecia to begin shooting spores after the bark is soaked.—This, of course will vary with the moisture content of the bark before the soaking begins. To make conditions uniform, specimens of bark which had been dried for three weeks in the laboratory were used in a number of experiments. They were drenched, then put in the bottom of Petri dishes, into which had been poured a little water to keep the bark continually moist. In all, 35 pieces of bark were used. Of these 22 had shot spores within two hours; 5 began shooting in 45 minutes. The average time for the 22 was 1 hour and 28 minutes. In another set of experiments, fresh bark was brought in from the woods and tested. The variation was greater due to the different conditions under which the bark was used. Several specimens ejected the spores in less than three minutes after they were brought into the laboratory.

The duration of the shooting period following a rain.—The following experiment gives data both for answering this question and also additional data on the one just discussed: Sixty pieces of ascospore bark were soaked for 15 minutes and then slides suspended over them to detect the spores that were shot. Ninety per cent. of them ejected spores: The first one started in 22 minutes, the last one in 1 hour and 55 minutes, the average being 1 hour and 3 minutes. Records were taken of the time they continued to shoot. The shortest time was 1 hour and 20 minutes; the longest, five hours and two minutes; the average, 3 hours and 7 minutes.

In another experiment a canker was drenched with water in the woods and after it started to shoot, it continued for 2 hours and 35 minutes.

In a third experiment, a well infested small log was brought into the laboratory and sprayed with an atomizer. It began shooting in 44 minutes and was still shooting in places after 3 hours and 30 minutes. In this experiment it was noticed that, whenever the surface of the bark and pustules became dry, the spores ceased shooting. We may say then in general that as long after a rain on the surface of the bark remains wet, the spores will continue to shoot. This leads us to the next question.

Duration of shooting, if the bark remains wet.—On August 18th, five pieces of bark about 1 cm. square, were started to shooting in a moist chamber in the usual way. Records were taken three times a day of whether they were still shooting. One of them became covered with Pencillium and stopped shooting after six days. Of the others, one continued shooting 17 days, one 14 days, another 22 days and the last one, 25 days. Each of these, however, occasionally missed a day or part of a day. Later experiments gave similar results although no longer record than 25 days was ever obtained. Since it is not likely that a period of continuous rainy weather would be longer than 25 days, we may say in general, that the spores will continue to shoot as long as the bark is wet.

Effect of dessication on resumption of shooting.—On July 23rd, two pieces of bark were started to shooting spores in the regular way. After it was determined that they were shooting well, they were removed and thoroughly dried for a day, then tested again for shooting, after which they were dried for two days and tested, etc., being dessicated alternately for one and two days. For 27 days this experiment was continued, and on wetting each time, they continued shooting. The experiment was discontinued on the 19th of August because of contaminations.

In a similar experiment, allowing the bark to dry, however, one day between each test, spores were ejected on every test for 14 days. In a third experiment they were dried a week between each test. This experiment was in progress four weeks and at each test spores were ejected.

Distance to which spores will be ejected.—W. H. Rankin reports that they will be ejected with sufficient force to throw them 5 mm. straight upward. Numerous tests have been made in our laboratories. In general they will easily shoot from 4 to 7 mm. and often much higher. The highest record secured as yet is 22 mm. A more important question is: How far will they shoot horizontally? One is surprised in watching the course of the spores, by the "light beam" method to find that the majority follow a rather regular "sporabola," as Buller has named it; some of them seem to be lighter and float off further afield than the others. The following experiment will give some idea of their power to shoot horizontally when all air currents are excluded as far as possible. A piece of shooting bark about 5 mm. square was supported 1 inch above the edge of a sterile plate of agar, so that the ostioles pointed out horizontally over the plate. All this was done under a bell jar. After allowing the perithecia to shoot five minutes, the plate was covered and stored to see how the colonies of the fungus would show up. At the end of three days 508 colonies of Endothia appeared. From the region below the bark, diverging lines of closely crowded colonies appeared for 30 mm. Beyond this the colonies were irregularly scattered over the plate. The farthest one was 89 mm. from the point where the bark was placed.

These experiments show that without doubt, the spores are shot far enough into the air so that the wind will have abundant opportunity to catch them up and carry them to other trees.

Rate of ejection of spores.—The following experiment was carried out to determine the rate of shooting from a single ostiole. A piece of shooting bark was mounted on the stage of a microscope and a single ostiole found, from which spores were shot on to the slide. The spores on the slide were counted and the following data secured:

Slide Number.	Time of Exposure.	Perithecium A.	Perithecium B.
1,	30 seconds,	212	127
2,	30 seconds,	109	118
3,	30 seconds,	103	63

This gives us the further data:

The greatest number of spores per second,	7.1
The smallest number of spores per second,	2.1
Average number of spores per second,	4.06

Using the average as the basis of our calculations, this would give us 14,000 spores per hour or at the rate of 345,600 per day for one ostiole. By watching the ostioles under the microscope each discharge can be noted by the breaking of the film of water over the ostiole. It has been determined that with each discharge 8 spores are ejected. Taking the average in the table above, this would give us one discharge for every two seconds.

Another experiment which will give an idea of the rate of discharge was as follows: A canker on a small trunk was drenched with water and as soon as it began discharging spores a 10 cm. plate of sterile agar was exposed horizontally under it for five minutes. Nine thousand seven hundred and thirty-three colonies developed on the plate. The actual number of spores, of course, would be much greater than this.

Length of time required for germination of ascospores.—In favorable weather, ascospores will begin to germinate usually within five hours after ejection. The shortest record obtained in a long series of tests was 1 hour and 25 minutes. At most a spore would have to be kept moist only a few hours to become established in a new tree.

As to the mechanics of the process of ejection, very little is known and nothing has been done as yet in our laboratories. That it is connected with the life of the organism and not a mere physical process, is indicated by the fact that when the spores are killed by a treatment of four minutes with formaldehyde gas, they are no longer ejected from the perithecia.

Spore content of the air.—To determine whether the spores of the blight fungus were really floating about in the air two methods were used. Both of these methods were first used in badly infested tracts during dry weather, i. e. while the trunks of the trees were dry. Over one hundred plates were exposed and 500 liters of air were tested with the aspirator but since not a spore of Endothia was detected, it was decided that if there were any in the air in dry weather, they could not be detected by the methods used. Since it had previously been determined that the spores are ejected only after rains, all other tests were made while the trunks of the trees were wet. Since, however, it was inconvenient to have to wait for rains, the trunks were usually drenched with water by hand.

The aspirator method was the first one tried. A 15 liter flask was filled with water and a sterile sugar tube put in the opening at the top. The water was then permitted to run out slowly through a faucet at the bottom. The water in the bottle being replaced by air, which passes through the sterile sugar in the tube, any spores that were in the air, would be retained by the sugar. The sugar was then plated out and the number of spores per liter of air calculated from the number of colonies that developed on the plates and the number of liters of air drawn through the tube. The result of a number of tests made in this way are given in Table V. In general, this method was not found so satisfactory as the next one described, but was more accurate in giving more exact figures as to the number of spores per unit quantity of air.

TABLE V.

Showing the number of Spores contained in the air as determined by the aspirator method.

Number of liters of air.	Distance out from canker.	Distance below the canker.	Number of spores detected.
30,	2 ft. and 5 in.,		20
30,	1 ft. and 11 in.,		12
8,	4 ft.		
15,	2 ft.		10
15,	6 in.,		33
15,	5 in.,		
15,	2 in.,		40
15,	6 in.,	6 in.,	
15,		22 ft.	50
15,		14 in.,	250
15,		6 in.,	110
15,	1 ft.	1 ft	75
15,	2 ft.	2 ft.	85
15,	1 ft.	1 ft.	60
15,	5 ft.	5 ft.	180
15,	3 in.,	5 ft.	210

Summary: Two hundred and sixty-three liters of air taken from distances varying from two inches to two feet out from and from six inches to twenty-two feet below the canker gave a total of 1135 spores, an average of 4.3 spores per liter.

The second method was as follows: Badly infested trunks of small trees were brought into an open place near the laboratory and induced to shoot spores by drenching with water. Sterile plates of chestnut bark agar were exposed for varying lengths of time, mostly so that the wind blew from the cankers to the plates and at various distances. The number of colonies of Endothia was counted, usually after three days. If there was any doubt about the identity of a colony, it was transferred to agar slants until identified by further growth. By this more convenient method, we were able to catch spores at a distance of more than 50 feet to the windward from the logs, but never more than a few inches against the wind. No effort was made to catch them at greater distances than 51 feet, but since they could easily be detected at that distance in a moderate wind and on a level with the canker, it would not be hard to imagine them carried for miles if they were on mountains, as we have often found them, and with a strong wind blowing. The results of a series of exposures is given in Table VI.

TABLE VI.

Showing the results of exposure of sterile agar plates near infested trees. Plates exposed so that the wind blew from the infested trees toward the plates.

Number of plates.	Distance from log.	Distance below canker.	Time exposed.	Plates discarded.	Average colonies per plate.
16,	1 inch	....	3-5 min.	4	3932
15,	1 inch	2-4 inches	3-5 min.	....	466
13,	1 inch	6-36 inches	3-25 min.	7	78
23,	2-6 inch	....	2-30 min.	7	890
40,	6-24 inch	....	3-30 min.	21	23
16,	2-36 inch	6-36 inches	15-60 min.	9	51
51,	3-9 ft.	....	10-80 min.	46	3
85,	9-30 ft.	....	20-60 min.	77	5
46,	30-51 ft.	....	60-90 min.	44	5

Exposed to side and Back of the Trees.

	Back of log.	To side of log.			
13,	....	12-90 inches.	10-25 min.	3	....
14,	1-26 in.	....	5-60 min.	7	4

A similar series of exposures with only 12 plates, however, at distances of only a few inches was tried with logs on which were numerous conidial tendrils but the results were entirely negative.

Inoculations by wind-borne spores.—Having demonstrated then that the spores are carried in great abundance by the wind, the next thing to be demonstrated was that these spores, falling into a wound in that condition, could produce infection. In order to duplicate more nearly natural conditions the following plan was followed in making the inoculations: Various kinds of wounds were made in the bark of healthy trees. Then ascospore bark taken from cankers and which had been determined to be shooting spores was suspended so that the spores were ejected toward the wound in the healthy tree. There was no way for the spores to get from the diseased bark to the healthy tree, except to pass through the air. After exposing it for a time, as given in the table, the wound was covered with cotton to prevent spores entering from any other source. The wounds were always made with a sterilized instrument and the bark was previously sterilized by washing with mercuric chloride or formalin. That this method was entirely successful is demonstrated by the results given in Table VII.

TABLE VII.

Showing results of inoculating with naturally ejected ascospores.

Kind of wound.	Distance of bark from wound.	Length of exposure.	Number of inoculations.	Number successful.
V-cut,	¾ inch,	15 min.	86	68
V-cut,	1 inch,	1½ hrs.	313	286
V-cut,	½ inch,	15 min.	22	12
V-cut,	1 inch,	1 hr.	391	370
V-cut,	¾ inch,	1 hr.	152	135
Broken branches,	½ inch,	45 min.	188	25
Tangential slice,	¾ inch,	1 hr.	28	27
Bruises from stone,	¾ inch,	2 hrs.	49	49
V-cut,	¾ inch,	1 min.	59	47
Longitudinal slit,	¾ inch,	1 hr.	19	2
Jagged knife cut,	¾ inch,	2½ min	68	55
V-cut,	¾ inch,	1 hr.	65	59
V-cut,	1 inch,	2 hrs.	19	19

In another series of inoculations the ascospore bark was placed at a greater distance from the wound and a draft created toward the tree by a hand bellows. These inoculations were also successful as indicated by Table VIII.

TABLE VIII.

Showing results of bellows inoculations.

Kind of wound.	Distance of bark from wound.	Length of exposure.	Number of inoculations.	Number successful.
V-cut,	8-12 in.	10 min.	19	15
V-cut,	1-4 ft.	10 min.	88	16
V-cut,	1-2½ ft.	15 min.	128	65

Another method of inoculating with dry ascospores was to crush the ascospore stromata in a mortar and then blow the fine dust into the air and let it settle down into wounds which had been made in healthy trees. The results of this series are given in Table IX.

TABLE IX.

Showing results of inoculations made by blowing crushed ascospore stromata into the air.

Character of Wound.	Number of inoculations.	Number successful.
Jagged hole,	230	47
Shot hole,	19	14
Breaking off dead limbs,	120	7
Hitting tree with blunt axe,	100	72
Jagged knife cut,	200	64

Check wounds were made in all the three preceding series but no cankers developed about them.

Another experiment to demonstrate the agency of the wind in carrying the spores was carried out as follows: Clumps of coppice growth chestnut were selected in each one of which was one or more trees with ascospore-bearing cankers. Wounds were made on the trees surrounding the cankered one, these wounds facing the cankers of the diseased tree. Sterile implements were used in making the wounds and the bark was previously sterilized for 25 minutes with mercuric chloride. These wounds were then covered with fine meshed wire (50 meshes to the inch) which was tacked down with a layer of cotton at the edge to insure it against the entrace of insects. A piece of cotton was tied very tightly just above the wired area to insure against any spores being washed down from above. The intention of this experiment was to exclude every possible agency for transport of spores except the wind. The cankered trees were drenched with water once a day for ten days. The wounds were at a distance of from one to five feet from the cankers. Of the 559 wounds made and protected in this way, 114 had developed cankers when the screens were removed at the end of three months. The wounds which were facing the central canker showed the greatest per cent. of infection. This is undoubtedly the most convincing of all the inoculation experiments with wind-borne ascospores.

Summary. The following demonstrated facts then lead us to believe that the wind is an important factor in the spread of the disease.

1. Mature ascospores can be found at any time of the year.
2. After every rain these are thrown out into the air in countless millions.
3. They are readily carried about by the wind.
4. Dry ascospores thus carried produced a high per cent. of infection in almost any kind of a wound.
5. Wounds are very common on chestnut trees.

LONGEVITY OF THE SPORES.

In studying the methods of dissemination of the fungus it is important to know how long the spores will retain their power to germinate and produce new infections. During the summer the writers began three sets of experiments to answer the three following questions: How long will ascospores retain their vitality after being ejected from the perithecia? How long, if they remain dry in the perithecia? How long will the conidia retain their vitality? None of these have been completely answered yet but the results up to date are given below.

1. **Ascopores after ejection.**—Clean slides were suspended over active ostioles and when clumps of ascospores had been deposited on them, they were stored in boxes in the laboratory to be tested at intervals for germination. The tests were made by covering the clump of spores with a drop of water and keeping the slide in a moist chamber over night. On the opposite end of each slide was placed a drop of water containing fresh ascospores to serve as a check. The percentages of germination were counted on the following day. As far as possible all slides for each series were secured from the same pustules. The first tests were made as soon as the spores were ejected and the percentages thus obtained may be considered as additional checks on the later tests. The results of two series are here given, the first being at Charter Oak and the second at Mt. Gretna:

Charter Oak.

At time of ejection (July 11),	test 90%	check 90%
After four weeks,	test 15%	check 85%
After six weeks,	test 10%	check 95%
After eight weeks,	test 10%	check 87%
After thirteen weeks,	test .03%	check 89%

Mt. Gretna.

At time of ejection (August 2nd),	test 96%	check 96%
After two weeks,	test 95%	check 96%
After four weeks,	test 50%	check 97%
After seven weeks,	test 25%	check 82%
After seventeen weeks,	test 14%	check 81%

2. **Ascospores in the perithecia.**—Bark containing mature ascospores was stored in open boxes in the laboratory. The results of three series, in which the same technique as in the preceding series was employed, are as follows:

Ascospores from bark collected at Charter Oak, June 25th, germinated to the extent of 40 per cent. after fifteen weeks (October 8th). Checks gave 95 per cent. germination.

Ascospores from bark collected at Mt. Gretna on June 28th, germinated to the extent of 65 per cent. after twenty-three weeks (December 6th). Checks gave 83 per cent. germination.

Ascospores from bark collected at Charter Oak May 10th germinated to the extent of 64 per cent. after 29 weeks (December 3rd). Checks gave 69 per cent. germination.

3. **Conidia.**—To test the longevity of conidia kept dry an experiment was carried out as follows: Spore horns were collected from trees in the woods on June 27th and stored in the laboratory in vials with cheese cloth tied over the tops. On July 25th they gave a fair per cent. of germination in rain water acidified with sulphuric acid. Since, however, this method was not reliable and since they could not be germinated in ordinary water, the next test, four weeks later, was by making streaks on agar slants. Six streaks gave successful cultures. On September 13th (11 weeks) they were tested by placing bits of the spore horns on sterile twigs in test tubes. Five inoculations made in this way gave just as good cultures as the checks made with fresh conidia. Similar results were obtained by this method at the end of 15 weeks and again at the end of 19 weeks. There is no doubt then that conidia can produce infection after being kept dry in the spore horn stage for 19 weeks.

All of these experiments are still in progress and much longer records are anticipated.

INOCULATION AND GROWTH EXPERIMENTS

Many important questions in regard to the life history of ***Endothia parasitica*** have never been answered. Too many statements have been based on mere casual observations on natural cankers. We have very little actual data on the rate of growth for various months of the year, how soon after inoculation the pycnidia appear, when the perithecia develop, what parts of the host can be infected, etc. Several thousand inoculations have been made at different times and under different conditions to settle some of these points.

RATE OF GROWTH OF THE CANKERS PER MONTH.

After inoculation the canker usually begins to show in two weeks if the inoculation is made with canker tissue or with mycelium from a culture. If, however, it is made with ascospores or conidia it shows very little, until from three to five weeks. Often no growth seems to take place for several months, then it suddenly begins to grow. Such cases are the exception, however, and not the rule. After the inoculation had been made from two weeks to a month, depending on the method, a white line was painted around the edge. At the end of each succeeding month, the canker was again outlined. Thus at the end of the year we will have a complete monthly record of the increase in the size of the cankers. The growth up and down the tree is more rapid than that around the tree so that, no matter how the inoculation is made, the canker soon becomes oval in shape. The rate of growth up and down the tree also varies greatly,—much more than that around the trunk. It seems to depend a great deal on the nature of the wound and the condition of the tree. This factor, however, is not so important. What we wish to know is: How fast does it grow around the tree? It is the girdling that kills and not the longitudinal growth. Up to the present we have the records for six months. These are given in Table X.

TABLE X.

Showing the monthly rate of growth of cankers in summer of 1912. Using transverse diameter of the cankers.

Month.	Number of cankers.	Average growth per month in centimeters.
June,	81	1.887
July,	200	2.779
August,	186	2.834
September,	140	1.846
October,	58	1.92
November,	93	---------

These are averages for a large number of cankers. Individual cases showed growth sometimes more than twice as great, but in general, the variation was slight. It will be noticed that the greatest growth was during the months of July and August, which were very warm months with an abundance of rainfall, while September and June were much cooler. There is an impression abroad that a canker will girdle a large tree in one year. A table is given showing the length of time it would take for a canker, growing all the time at the rate they did in August of this year, to girdle a tree of a given diameter (Table XI). However, it is very doubtful if the cankers will grow at this rate during the winter, so that it is likely that it would take much longer than this.

TABLE XI.

Showing the time it would take a canker to girdle a tree at the rate they grew in August, 1912

Diameter of tree.	Time required to girdle tree.
1 inch,	2 months and 12 days.
2 inches,	5 months and 19 days.
3 inches,	8 months and 12 days.
4 inches,	11 months and 9 days.
8 inches,	22 months and 15 days.
12 inches,	34 months and 0 days.

TIME OF APPEARANCE OF THE FRUITING STAGES.

There has been much dispute as to whether the winter or ascospore stage was developed on cankers during the first year, also as to the time it takes for the two stages to appear. Records have been and are being kept on over two thousand cankers to determine these points. The records of average plots which have completed the cycle, are given in Table XII.

TABLE XII.

Showing the stages of development of the fungus during the summer of 1912. From artificial inoculations.

Plot.	Date of inoculation.	Method.	Number of inoculations.	Appearance of spore horns.	Appearance of perithecia
4,	May 29,	Diseased tissue in slit,	31	July 11,	Oct. 3
8,	June 9,	Diseased tissue in slit,	76	July 5,	Sept. 8
10,	June 9,	Ascospores in stab,	184	July 23,	Oct. 1
12,	June 11,	Conidia in stab,	90	(No data)	Oct. 2
23,	June 26,	Diseased tissue in slit,	35	July 25,	Sept. 5
27,	June 27,	Diseased tissue in slit,	47	(No data)	Oct. 3
33,	July 12,	Diseased tissue in slit,	20	Sept. 6,	Oct. 4

In general it may be said that under natural conditions in the summer time the spore horns will be developed in from three to six weeks, and that the winter or ascospore stage will develop in ten weeks or more. The fact that the perithecial stage on all these plots appeared in September and October should not be interpreted as indicating that the approach of winter had any influence in bringing about this stage. There has been no time during the summer when developing perithecia could not be found in some localities. In cultures on agar the conidia are produced more quickly. On potato agar, they are almost always developed in less than two weeks from conidial streaks. They have been developed in six days from ascospores caught on chestnut-agar plates after being naturally ejected from the perithecia.

COMPARATIVE GROWTH OF THE FUNGUS ON YOUNG AND OLD BARK.

In order to determine whether the fungus grows as rapidly on the heavy barked-trunks, as on the thinner-barked younger trees and branches, twenty inoculations were made in old trees with heavy rough bark. At the same time, 78 inoculations were made close by in thin-barked trees. Since the bark on the old trees did not show any depressions where the cankers were, they could not be outlined, and the monthly growth of the two plots compared. Therefore at the end of twelve weeks the bark was peeled from the cankers on the old trees and the cankers measured on the cambium. It was noticed, however, that the fungus spread somewhat more rapidly in the bark of the heavy barked trees than in the cambium, so the figures are a little less than the real dimensions of the cankers. The average for the twenty cankers was 13.22 x5.58 cm. The average for the 78 cankers on the thin barked trees was 14.3x9.7 cm. According to these figures the growth is a little more rapid on the thin barked trees.

GROWTH OF THE FUNGUS ON LEAVES AND BURS.

Up to the present, it has never been found growing on either of these, and all attempts to inoculate green leaves and green burs have been unsuccessful. Dead burs and dead leaves, however, in moist chambers have been sucessfuly inoculated as given under the heading, "Man as the Disseminator." Seasoned dead wood was also inoculated and the fungus successfully grown on it.

GROWTH ON THE ROOTS OF THE CHESTNUTS.

That it will grow on exposed roots just the same as on the bases of the trees is a matter of common observation. Inoculations made on exposed roots were just as successful as those on the trunks. To determine whether it would also grow on subterranean roots 18 inoculations were made on June 27th, and the roots again covered with earth. The parasite appeared to grow in all cases, but did not produce typical cankers. The invaded areas became soggy and the growth was apparently very slow. Isolations from the soggy areas however, gave pure cultures of Endothia.

GROWTH ON THE GREEN SHOOTS OF THE CURRENT YEAR.

Murrill (1) does not believe that the shoots of the first year become infected. So far as the literature shows, no one has ever found blight on them, or successfully inoculated them. The following experiments give the results obtained at Charted Oak on this point.

Experiment: Inoculation of sterilized first year twigs. Fifteen fresh pieces of first year twigs were sterilized in test tubes by washing in a 0.5 solution of mercuric chloride and inoculated as follows:

Five with conidia. Four were successful.

Four with diseased bark. Three were successful.

Six with agar culture. All were successful.

The growth on all of these was characteristic for Endothia and differed very little from cultures on older twigs under the same conditions. This proved that failures to produce infection of first year twigs were not due to any injurious substance in the twigs themselves.

Experiment: Inoculations of first year sprouts in the woods. The methods of inoculation and the results are given in Table XIII. The cankers produced were typical in every way. Some of the sprouts had already died from the cankers when the plot was destroyed. This proves beyond question that cankers can be produced on first year twigs, but offers no explanatior of why they are so rarely found there in nature.

TABLE XIII.

Showing results of inoculation in first year shoots.

Date.	Plot.	Method of inoculation.	Number of inoculations.	Percentage successful.
July 27,	48	Ascospores in slit protected with cotton,	25	4.0
July 27,	48	Ascospores in slit not protected with cotton,	24	37.5
July 27,	48	Diseased tissue in slit protected with cotton,	13	100.0
July 27,	48	Diseased tissue in slit not protected with cotton,	6	33.3

COMPARISON OF SUSCEPTIBILITY OF TREES IN THE OPEN AND IN DENSE WOODS.

One would naturally expect that trees in dense woods would be more easily attacked on account of better moisture conditions. Plots were therefore selected in dense coppice and check plots in open places, where the trees were trimmed high and were far apart and no underbrush around them. Here they would have plenty of opportunity for air currents and abundance of sunlight. These were inoculated on the same day. The results are given in Table XIV. This summer has been very moist and the results might be different on an average year, but certainly the results here do not argue for much advantage of either location over the other. One fact however was observed in this series of inoculations which is worthy of notice. Where the inoculation wound is made in a tree in the open, a callus begins to form at once and for several weeks one is tempted to believe that the tree has succeeded in excluding the invader. There is evidently a continued struggle between the host and the parasite and if we were dealing with a less virulent parasite, the struggle would undoubtedly result in favor of the former. But the fungus gradually works in under the callus and soon becomes too strong to be resisted. On the other hand it is very rarely that a callus is formed where the tree is in dense woods.

TABLE XIV.

Showing the difference in susceptibility of trees in the open and trees in dense woods.

Open Woods.

Date.	Plot.	Method of inoculation.	Number of inoculations.	Percentage successful.
June 28,	31	Mycelium from culture in slit,	35	88.5
Aug. 5,	30	Conidia in water in V-cuts,	56	76.8
Aug. 5,	30	Ascospores in water in V-cuts,	72	55.5
Aug. 15,	53	Ascospores in water in V-cuts,	36	44.4
Aug. 15,	53	Diseased tissue in slits,	42	100.0

Dense Coppice.

Date.	Plot.	Method of inoculation.	Number of inoculations.	Percentage successful.
June 27,	29	Mycelium from culture in slit,	40	75.0
June 27,	29	Diseased tissue in slit,	40	100.0
Aug. 5,	51	Conidia in water in V-cuts,	30	50.00
Aug. 5,	51	Ascospores in water in V-cuts,	30	90.0

THE EFFECT OF ALTITUDE AND WATER CONTENT OF THE SOIL ON THE GROWTH OF THE FUNGUS.

Some observers have noticed that the blighted trees are always on low land; others have observed that they are always on the side of the slope; others that they are always up high on dry ground. The theory that the water content of the tree determines its susceptibility, has also been advocated. The laboratory and experimental plots at Charter Oak are admirably located to test out these theories. Along Shavers Creek, below the laboratory, there are marshy places where the roots of the chestnut trees have not been out of the water all summer. The woods is dense and conditions could not be invented where the water content of the trees would be higher. Back of the laboratory, Lead Ridge, a dry rock ridge of Tussey Mountains, rises about 1200 feet above Shavers Creek and is covered with chestnut trees. They grow under very dry conditions at the summit and there are all intermediate conditions on the slopes. Plots were inoculated under all these conditions. The methods and results are given in Table XV.

The results of the experiment indicate that the altitude and soil drainage have very little to do with the susceptibility of the host or rate of growth of the fungus.

TABLE XV.

Showing the effect of moisture and altitude on the growth of the fungus.

Plot.	Date of Inoculation.	Number of inoculations.	Location.	Percentage infection.	Growth per month.		
					July.	August.	September.
29*	June 27, ...	40	Summit of dry ridge 1200 ft.,	100.0	1.66	2.58	2.14
29†	June 27, ...	40	Summit of dry ridge 1200 ft.,	82.5	1.55	2.28	1.82
29‡	June 7, ...	54	Half way up the ridge, ...	96.3	2.66	3.10	2.78
16*	June 18, ...	80	Half way up the ridge, ...	86.3	2.55	2.69	2.78
16†	June 18, ...	44	Half way up the ridge, ...	95.5	2.21	2.66	2.90
19*	June 21, ...	32	Marsh near creek, ...	93.7	2.21	3.10	2.46

*Inoculations made by placing canker tissue in longitudinal slit.
†Inoculations made by placing mycelium from culture (No. 31 Charter Oak) in longitudinal slit.
‡Inoculations made by placing mycelium from culture (No. 32 Mt. Gretna) in longitudinal slit.

ENDOTHIA PARASITICA ON OTHER HOSTS.

NATURAL OCCURRENCE.

This fungus is known to cause a serious disease only on chestnut. During last summer, however, a fungus which was in all outward appearance the same, has been collected and sent to us or has been found by the writers on the following hosts:

Quercus velutina (Black Oak).
Quercus alba (White Oak).
Quercus prinus (Chestnut Oak).
Rhus typhina (Staghorn Sumac).
Acer rubrum (Red Maple).
Carya ovata (Shag-bark Hickory).

The fungus was isolated from all of these except *Quercus prinus* They were cultured on various media and as far as their culture characters are concerned, they cannot be distinguished from the regular *Endothia parasitica,* on chestnut.

In most of the cases where it was on other hosts it was growing as a saprophyte, seeming to prefer fire-scorched or lightning-killed trees. In two cases, however, on the white oak, it had all the appearance of a parasite, plainly pushing out into the living tissue. So many of these specimens were sent in and there was such general interest in them, that it was decided to run a set of experiments to determine whether the fungus was the same on all these hosts, whether it was the same as that on the chestnut, whether they would infect chestnut and whether the regular Endothia would infect the hosts from which each was isolated. These experiments and the results are given below.

GROWTH ON STERILIZED TWIGS OF VARIOUS SPECIES.

Experiment: To determine whether the chestnut blight fungus would grow on sterilized twigs of other species than chestnut. Twigs of the following species were used:

Castanea dentata (Chestnut).
Quercus alba (White Oak).
Quercus prinus (Chestnut Oak).
Quercus macrocarpa (Burr Oak).
Quercus velutina (Black Oak).
Quercus rubra (Red Oak).
Quercus coccinea (Scarlet Oak).
Rhus typhina (Staghorn Sumac).
Nyssa sylvatica (Sour Gum).
Acer rubrum (Red Maple).
Liriodendron tulipifera (Yellow Poplar).
Juglans nigra (Black Walnut).
Carya ovata (Shagbark Hickory).

Pieces of these twigs, about three inches long, were put in test tubes with wet cotton in the bottom, plugged and steam sterilized. Six tubes of each species were used, two inoculated with conidia, two with ascospores, and two with mycelium from culture. The fungus grew on all of them and also produced pycnidia regardless of how they were inoculated. The growth on all the oaks, on sour gum and on sumac was just as rapid and as vigorous as on the chestnut twigs. On the others, however, the growth was much slower and not so luxuriant. This experiment was duplicated in two laboratories with the same results. Twigs of other species were not tried, but in all probability it would grow on other twigs besides those mentioned.

INOCULATIONS ON CHESTNUT WITH STRAINS FROM OTHER HOSTS.

Experiment: To determine whether the strains isolated from other hosts would produce typical cankers on chestnut. The isolations were made in each case from the original host, either from spore horns or from the diseased tissue, which was transferred to potato agar. Pieces of this agar were then introduced into slits in the bark as in our regular inoculations. The strain from hickory has not been used since it was isolated too late in the season. The results of the inoculations are given in table XVI.

The cankers produced were in every way typical, and grew with a vigor and rapidity equal to that of the strains isolated from the chestnut. There is therefore, no doubt that these strains are the

TABLE XVI.

Showing results of inoculations on chestnut with strains of the fungus from other hosts.

Date.	Strain.	Host from which isolated.	Number of inoculations.	Percentage successful.
July 20,	5	Black Oak,	22	95.5
July 20,	6	White Oak,	27	85.2
July 20,	26	Sumac (Staghorn),	20	95.0
Aug. 14,	52	Red Maple,	16	75.0

INOCULATIONS WITH ENDOTHIA ON HOSTS OTHER THAN CHESTNUT.

Experiment: To determine whether *Endothia parasitica* can be inoculated into other hosts and made to produce typical cankers there. The mehods and results of these inoculations are given in Table XVII.

TABLE XVII

Showing the results of inoculation with *Endothia parasitica* on hosts other than chestnut.

Date.	Plot.	Host inoculated.	Method.	Number of inoculations.	Percentage successful.
June 10,	11	Chestnut oak,	Diseased tissue in slit,	34	41
June 27,	29	Red maple,	Diseased tissue in slit,	33	....
June 28,	31	Black oak,	Mycelium from culture in slit,	20	....
June 13,	14	White oak,	Ascospores in stab protected,	51	78.4
June 13,	A14	Sumac,	Ascospores in stab. Unprotected.	56	....
July 12,	34	Sumac,	Diseased tissue in slit,	32	71.9
July 12,	35	Yellow poplar,	Diseased tissue in slit,	22	....
July 19,	37	Chestnut oak,	Ascospores in V-cut,	38	....
July 19,	37	Chestnut oak,	Conidia in V-cut,	30	....
July 19,	37	Hickory,	Conidia in V-cut,	22	....
July 19,	37	Hickory,	Ascospores in V-cut,	27	....
July 19,	37	Hickory,	Mycelium from culture in slit,	16	....
July 19,	37	Hickory,	Diseased tissue in slit,	12	100
July 19,	37	Scarlet oak,	Ascospores in V-cut,	18	....
July 19,	37	Scarlet oak,	Conidia in V-cut,	12	....
July 19,	37	Scarlet oak,	Diseased tissue in slit,	6	100
July 19,	37	Black oak,	Diseased tissue in slit,	12	100
July 19,	37	Black oak,	Conidia in V-cuts,	12	....
July 19,	37	Black oak,	Ascospores in V-cuts,	19	....
July 20,	40	White oak,	Mycelium from culture,	10	....
July 20,	41	Black oak,	Mycelium from culture,	9	....
July 26,	42	Sumac,	Mycelium from culture,	26	100

The figures representing the percentages of successful inoculation in this table do not accurately represent the results of the experiments. In no case were typical cankers produced as on the chestnut. The inoculation was judged to be successful, when the spore horns of the fungus were produced on the bark of the inoculated tree.. This in all cases did not mean that it was growing there as a parasite. A wound is always necessary in making an inoculation, and there is abundant opportunity for the fungus to grow as a saprophyte on the injured tissue about the wound. This condition was especially noticed in the case of the hickory, black oak and scarlet oak. The growth on the white oak and chestnut oak was nearest like that on the chestnut. The fan-shaped areas of mycelium were found plainly advancing into the healthy tissue and there was an abundance of spore horns. The outline of the cankers continued to advance slowly for from eight to ten weeks. After that the fungus was apparently holding its own, but ceased to advance. As yet no oak tree has been found killed by the fungus. The growth on the sumac is entirely different from that on chestnut or on oak. No fan-shaped areas were found, but an abundance of spore horns, and also superficial pycnidia were produced on the edges of the inoculation wounds. The rate of growth varied with the condition of the host. Where the host was apparently in poor condition the growth was very rapid. Two trees of this kind were killed during the summer.

The ability of this organism to live as a saprophyte on other hosts is well illustrated on the infested woodlot previously mentioned at Anderson, Pennsylvania. This mixed stand of chestnut and chestnut oak was cut in the early spring of 1912. When the writers inspected the tract the following October, the characteristic reddish, flattened pycnidia were found on the top of almost every stump, irrespective of whether it was chestnut or oak. Many of the dead tops of the trees also had an abundance of the pustules of the blight fungus on them.

SUMMARY.

The results of these experiments indicate that the fungus is a weak parasite on white oak, chestnut oak and sumac. It has not shown any parasitic tendencies on any of the other species tried. Its attacks on the other trees is of practical importance, only in that they may be the means of keeping the fungus over in a locality where the diseased chestnut has all been destroyed.

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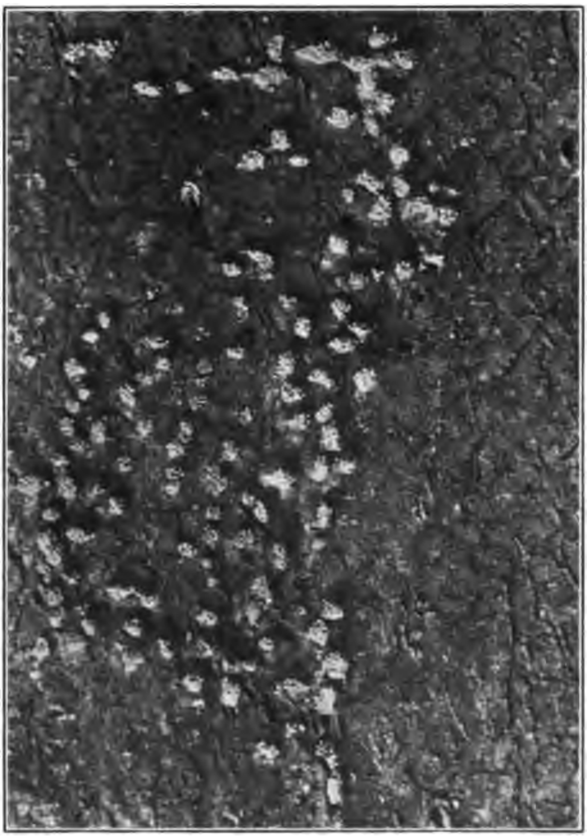
(11) '12 Pennsylvania Chestnut Blight Conference, Rept. published by the State. February 1912.

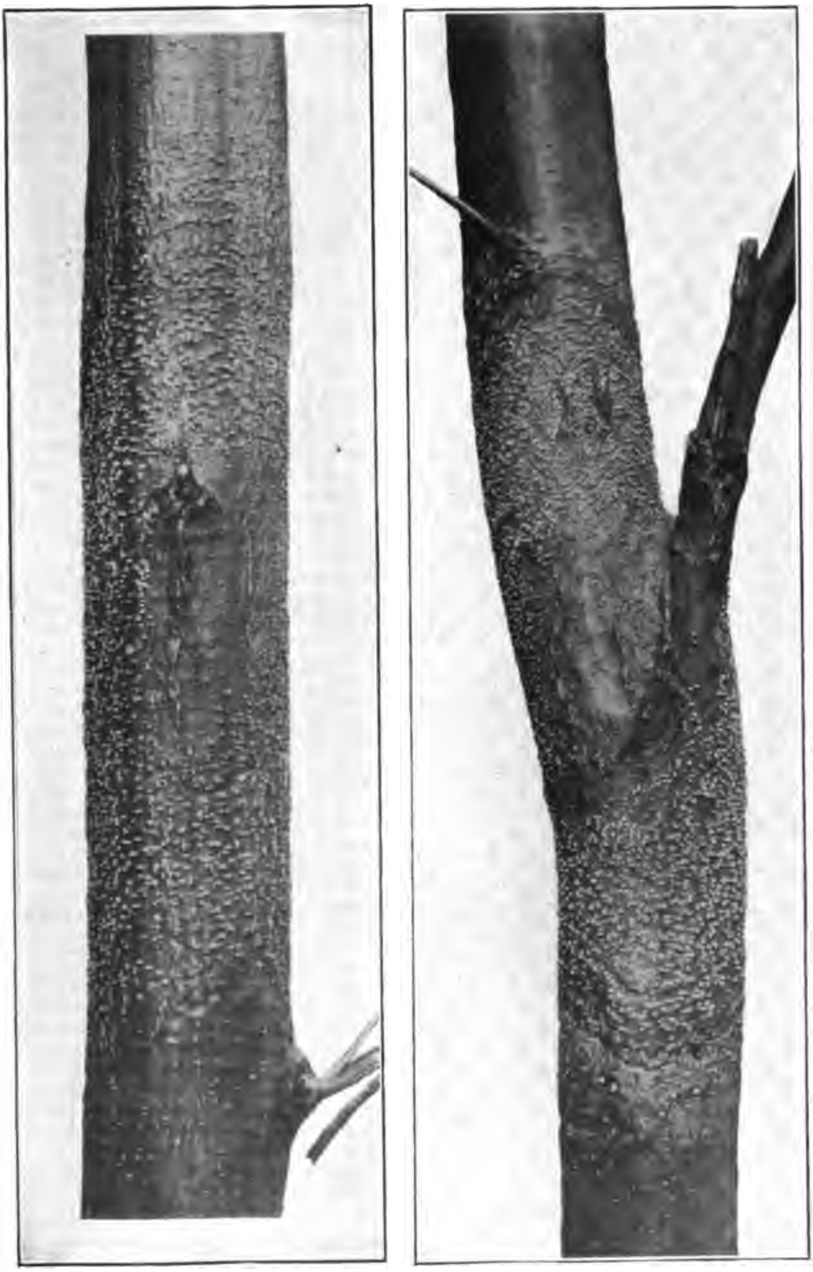
Fans or mats of mycelium of the chestnut blight fungus in the cambium and inner bark.

Colonies of the blight fungus on agar plate resulting from naturally ejected ascospores. Bark with active perithecia placed one inch above the plate over the dark line at bottom of plate. Each black point indicates one colony.



Stromata showing the necks of the perithecia.

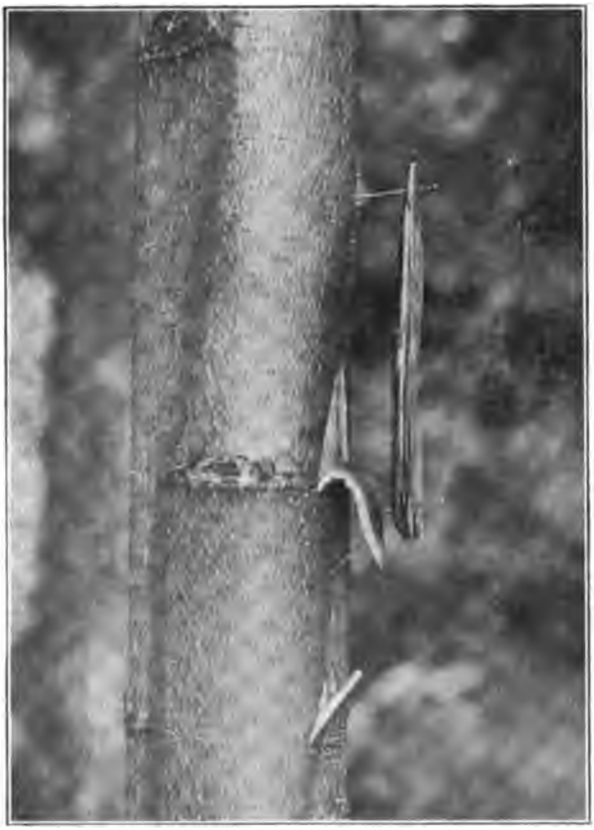
Hypertrophy type of canker.



Cankers showing stromata.

Painted outlines showing monthly growth of a canker, one-half natural size.

Inoculation with ascospores in stab in the bark.



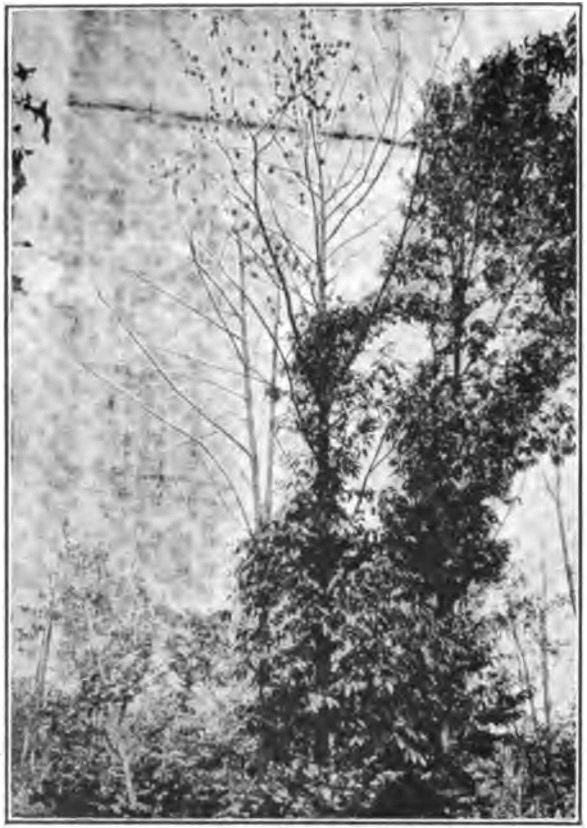
Inoculation with naturally ejected ascospores at close range.

Inoculation with diseased bark.

Inoculation at the base of broken twigs.

Artificial wind inoculation with bellows.

Testing the carrying power of the wind. Sterile plates exposed on tripod at the right. Active perithecia on the upright logs at the left. Wind blowing from the logs toward the plates.



Blighted and healthy chestnut tree in summer. Notice the small, undeveloped leaves on the diseased tree.

Blighted trees in summer, showing undeveloped leaves and water sprouts. The leaves came out in the Spring on the top of the tree in the centre, but remained undersized and died about the middle of the summer.

Logging experiment at Mt. Gretna, Lebanon Co., Pa.

PENNSYLVANIA CHESTNUT TREE BLIGHT COMMISSION.

1112 Morris Building, Philadelphia.

BULLETIN No. 4. OCTOBER, 1913.

(Manuscript Submitted December, 1912.)

The Chestnut Blight Fungus

AND A

Related Saprophyte

BY

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TABLE OF CONTENTS

THE CHESTNUT BLIGHT FUNGUS AND A RELATED SAPROPHYTE

By P. J. and H. W. ANDERSON

INTRODUCTION.

When the Pennsylvania Chestnut Tree Blight Commission undertook to determine the extent of the blight disease in Western Pennsylvania, they were confronted with a puzzling condition of what was apparently the blight in a few of the extreme south western counties. In these localities a fungus was found quite commonly on the chestnut trees, which superficially, could not be distinguished from the true blight fungus, but it was apparently causing no serious injury to the trees. Aside from the fact that this fungus was usually found only on stumps and dead parts of the trees, one other peculiarity was noticed. One of the most characteristic features of the true blight is the presence of fan-shaped areas of fungous mycelium in the bark on the scalloped advancing edge of the canker. These areas are entirely absent in the bark of the trees infested by the "Western or Connellsville Fungus"—by which name we shall designate the fungus occurring in these southwestern counties. Mr. J. K. Hibbs, supervisor of this southwestern district, being in doubt as to the identity of the fungus, submitted specimens to all the leading pathologists who have concerned themselves with this disease. They uniformly agreed that this fungus was the true blight organism, *Diaporthe parasitica,* as we shall call it in this paper. Microscopic examinations were made, but if any differences were noticed, they were ascribed to local conditions, immaturity of the specimens or various other causes. Many theories were advanced to explain its peculiar behavior in this district. Some believed that it was due to the large amount of coal smoke in the atmosphere of that region. Others thought the trees there were more healthy and therefore more resistant. Still others considered it a saprophytic strain of *Diaporthe parasitica,* while some advanced the theory that this was the saprophytic progenitor of the deadly eastern parasite. No light was thrown on the relation of these fungi at the Harrisburg conference in February of last year, although the existence of a so-called saphrophytic strain was mentioned by several speakers.* The uncertainty about the relation of these forms has given rise to much confusion as to the extent of the blight.

With this puzzling condition of affairs confronting the Commission, it was thought best to make a careful study of the western problem and for this purpose a field laboratory was located at Connellsville, where the so-called western fungus was quite common. The results of the investigation carried out at this laboratory are set forth in the following pages.

OBSERVATIONS ON THE NATURAL HABIT AND HABITAT OF THE FUNGUS.

In external macroscopic appearance this fungus resembles *Diaporthe parasitica* in all its stages and there seems to be no way in which it can be distinguished from this fungus in the field, except by the absence of the areas of fan-shaped mycelium. On young bark the western fungus develops small, scattered orange pustules under the epidermis. Areas of orange colored mycelium are often found throughout the thin bark. The pycnidia are formed in the pustules beneath the epidermis and the spore horns develop singly, pushing out from the top of the conelike pustules. The pustules on older bark are much larger, often reaching three or four millimeters in diameter. These occur as a rule in the crevices of the bark but are not confined to this region, being especially well developed on the bark of the callus at the edge of a rotted area or at the base of the stump on the exposed roots. The pustules vary greatly in color from a light yellow to almost black, a deep orange being the most common color observed. In the coke-oven region, old pustules are usually black externally on account of the smoke. The stroma is a light yellow color and pulverulent in the young condition, darkening and hardening with age. A number of pycnidia may be formed in each of these stromata. Perithecia may be found at any season of the year and are developed in the same manner as in *Diaporthe parasitica*. On the inner surface of the bark which has separated from the wood and on the wood protected by the bark, single pear-shaped pycnidia are found, in general appearance similar to the eastern fungus. Small reddish, flattened, single pycnidia are also developed on the top of stumps or on the end of logs several inches in from the edge of the bark. They are also formed on the cut edge of thick bark, especially when this is somewhat shaded.

*Report of the Chestnut Tree Blight Conference, Feb. 1912, pages 47 and 80.

Special attention was given to the habitat of this fungus since the question of its parasitism would be largely based upon these observations. It was usually found growing on stumps from which the trees had been removed one or two years, or upon fallen logs of about the same age. It was seldom found on trees or stumps which had been dead for a longer period. Many careful examinations of the coppice at the base of an infected stump were made since this was a common point of infection by *Diaporthe parastica,* but always with negative results. Die-back conditions and cankers produced by other fungi and insects are common on the coppice in this section of the State. The western fungus was often isolated from such areas, but was never found to be the primary cause of the diseased conditions. It was also found on thick bark of old trees where no injury could be found, but in no instance had it penetrated into the cambium. Very often when it was found on the apparently healthy trees, cutting into the bark would show that the borers had been at work and had killed the tissue below the area infected with the fungus. There has been no case during all the investigations where the western fungus was found causing the death of a tree. Aside from the chestnut it has been found on several species of oaks, among these the chestnut oak being its most common host.

MICROSCOPIC EXAMINATIONS AND COMPARISON WITH THE EASTERN FUNGUS.

A microscopic examination of the western fungus revealed a number of striking characters by which it could readily be distinguished from *Diaporthe parasitica.* On account of the small size of the conidia, no effort was made to find in these a basis for differentiating the two species. A large number of conidial measurements indicated that the difference between the two species is very slight in this respect.

The examination of the perithecia, asci and ascospores revealed a number of differences, the most marked of which were the size and shape of the ascospores. There was also a very pronounced difference in the length of the asci. In the following table is given the measurements of the asci and ascospores of *Diaporthe parasitica* and the western fungus taken from a number of sources. The measurements here recorded are only a portion of those actually made but indicate the range of the material used.

The Connellsville specimens were collected from various localities about this city and no two of them were obtained from the same tract. The measurements of the Virginia and Tennessee specimens were included under the Connellsville fungus since it has been shown from our cultural and microscopic examinations that there is no difference between the fungi collected from these various localities. All measurements were made with a 1-12 oil immersion objective.

TABLE I.

Showing the relative size of the ascospores of the Connellsville fungus and Diaporthe parasitica.

Connellsville Fungus.

Locality.	Diameter.		Length.	
	Number of measurements.	Average diameter.	Number of measurements.	Average length.
Connellsville No 50,	55	2.93	55	6.78
Connellsville No. 51, on oak,	61	3.2	61	6.9
Connellsville No. 52,	57	2.91	57	6.0
Connellsville No. 55,	63	2.93	63	6.5
Connellsville No. 56,	30	3.1	30	7.22
Greene Co., Pa.,	39	3.0	39	6.8
Lynchburg, Va.,	50	3.1	90	6.9
Erwin, Tenn.,	40	3.1	40	6.9
Fauquier Co., Va.,	81	3.1	81	6.86
Albermarle Co., Va.,	50	3.0	50	6.88
Morgantown, W. Va.,	50	2.4	50	6.98

Diaporthe parasitica.

Mt. Gretna, Pa.,	62	4.54	50	8.52
Highland, N.Y.,*	75	4.40	75	8.8
Somerset, Pa.,	60	4.4	60	8.2
Connellsville, Pa. M. Gray orchard, imported,	25	4.6	25	8.4

*Measured by W. H. Rankin.

TABLE II.

Showing the relative length of the asci of the Connellsville Fungus and Diaporthe parasitica.

Connellsville Fungus.

Locality.	Number of measurements.	Average length.
Connellsville No. 50,	50	33.21
Connellsville No. 51, on Oak,	30	35.73
Connellsville No. 52,	51	32.1
Connellsville No. 55,	43	32.0
Connellsville, No. 56,	56	38.05
Greene Co., Pa.,	30	34.7
Lynchburg, Va.,	40	36.7
Erwin, Tenn.,	40	32.4
Fauquier Co., Va.,	60	34.29
Albermarle Co., Va.,	51	32.52
Morgantown, W. Va.,	50	34.72

Diaporthe Parasitica.

Mt. Gretna, Pa.,	35	51.7
Somerset, Pa. No. 77,	60	48.6
Highland, N. Y.,*	75	52.0
Connellsville, Pa. M. Gray orchard, imported,	18	53.6

*Measured by W. H. Rankin.

In general, it will be seen that the ascospores of the Connellsville fungus average 7x3 mikrons, while those of Diaporthe parasitica average 8.5x4.5 mikrons. The maximum and minimum sizes are as follows: Connellsville fungus, 8.8-5.7 mikrons; Diaporthe parasitica, 9.94-7.1 mikrons. The average length of all asci measured gave 34 mikrons for the western fungus and 51.3 mikrons; for Diaporthe parasitica. The maximum and minimum sizes are as follows: Connellsville fungus, 45.5-28.4 mikrons; Diaporthe parasitica 58.2-42 mikrons. The contrast in the size here given is striking but even more striking is the difference in the shape of the ascospores.

As shown by the measurements the Diaporthe ascospores are much wider in proportion to their length than those of the Connellsville fungus. The relation is about 1:1.9 in the former, and 1:2.7 in the latter. Furthermore, the septa in Diaporthe are very evident and a distinct sinus may be seen on the mature spores, while an indistinct septum and a very slight, if any, sinus is the rule in the Connellsville fungus. These characteristics are so evident that a glance at the spores under the microscope by one familiar with the two fungi, is sufficient to distinguish them, provided the ascospores are mature.

Aside from the difference in length, the asci of the two fungi are similar, except that the wall is usually more evident in the western fungus. The perithecia of the western fungus are much smaller than those of Diaporthe parasitica. A number of measurements made from specimens collected at Connellsville and from various points in Virginia, gave an average measurement of 346 mikrons in contrast to 490 mikrons, obtained from perithecia of Diaporthe parasitica from Mt. Gretna. It was also noticed that the walls of the perithecia of the western fungus were much darker in color than those of the blight fungus.

Since the blight is not found in the southwestern portion of the State where the western fungus is found, there might arise the objection that the measurements obtained above are not comparable, in that local conditions might influence the size of the spores. On a farm a few miles northeast of Connellsville were found some chestnut trees badly infected by the real blight. These were nursery trees which had been planted two years previous, and had not shown signs of the disease until last summer when the winter stage was found. Asci and ascospore measurements from these are given in the tables and show no variation from Diaporthe parasitica measurements although taken from the center of the locality where the western fungus flourishes.

ISOLATIONS.

The most successful method of isolating Diaporthe parasitica which has been used in the field laboratories of the Pennsylvania Chestnut Tree Blight Commission is this: The outer bark is peeled with a sterile scalpel from over the advancing edge of a young canker and a small piece of tissue just on the line between the healthy and diseased inner bark is transferred to a potato agar slant. One hundred per cent. of pure cultures by this method is the rule in these laboratories. Such a method, however, could not be used to isolate the western fungus since it was rarely found advancing on the healthy tissue and even where it was found in close proximity, a transfer usually gave several bacterial and fungal contaminations besides the desired organism. In many instances, however, successful isolations were made in this way, since the fungus is a rank grower and the edge of the colony is apt to be pure. Usually, however, other methods had to be used. The most successful of these was the conidial streak. If the specimen showed the fungus to be in the pycnidial stage—summer stage— it was placed in a moist chamber for a few days, and invariably spore horns were pushed out from the stromata. These horns were detached with a wet sterile needle and the free end of the horns streaked on agar slants. Where only the perithecial stage was present, however, the culture had to be made from the ascospores. Two methods of making isolations from the ascospores were used. In the first, the stroma with the enclosed perithecia was removed and the bottom cut off with a sharp sterile scalpel, thus exposing the contents of the perithecia. Then a very minute drop of water was touched to the gelatinous mass of spores and the water containing the spores drawn into a fine capillary tube from which it was blown into a sterile petri dish. Agar was added and the developing colonies isolated. A more successful method, however, was by inducing the perithecia to shoot the ascospores upward on to a sterile agar plate inverted a few millimeters above the ostioles. This method was found to be the most convenient of all. With these four methods it was found possible to isolate the fungus from any kind of a specimen sent in, provided the spores and mycelium were not entirely dead. Isolations were made from specimens collected in over fifty different localities. Most of these were in southwestern Pennsylvania, but a few of them—as elsewhere mentioned—were from Virginia, West Virginia and Tennessee. All of them were identical, however, and need not be discussed separately, i. e., they all showed the same cultural characters. Nor did it seem to make any difference whether the isolation was made from mycelium, ascospores or conidia; they all grew alike. Isolations were made from dead stumps, logs, die-backs, on coppice and apparent cankers on living trees, but all proved to be the same. Neither did the isolations from the oak stumps and logs give different results.

INOCULATIONS.

The final test of the pathogenicity of a fungus is its ability to produce the disease in its typical form when introduced into the host under normal conditions. The importance of making a large number of inoculations controlled by proper checks was realized early in the work. The methods of making these inoculations were those which had proved most successful in the inoculations with Diaporthe parasitica at other laboratories.

When mycelium, either from the tissue or from culture was used, a slit was made under the bark and a piece of the tissue or a portion of the agar with the mycelium growing on it, was introduced into this slit. These are called slit inoculations. When conidia or ascospores are used, these are shaken up in a quantity of water and introduced thus, or the dry spore horns may be used. The point of a heavy knife is thrust obliquely into the bark with the broad side of the blade facing the tree, without removing the point, the knife is pulled downward and away from the tree. Several drops of the spore-containing liquid are then dropped from a pipette into the exposed wound back of the knife blade. The tree quickly sucks up these drops, so that this has proved a very effective method of introducing spores into the living tissue. Between 80 and 100 per cent. successful inoculations have been secured with the true blight fungus by these methods. The following series of inoculations were made at Connellsville.

1. Mycelium of western fungus from tissue.
2. Mycelium of D. parasitica from tissue.
3. Mycelium of D. parasitica from culture.
4. Mycelium of western fungus from culture.
4. Conidia of western fungus.
6. Conidia of D. parasitica.
7. Ascospores of western fungus.
8. Ascospores of D. parasitica.

Nearly a thousand inoculations with the western fungus were made at Connellsville together with a few with Diaporthe parasitica as checks. On account of the danger of introducing the disease a very limited number of inoculations were made with the eastern fungus, and these were carefully guarded and cut out after they had advanced to the stage where there was no longer any doubt of their power to produce the typical disease. Our inoculations with Diaporthe parasitica gave 100 per cent. infection with mycelium from culture and from the tissue and also from ascospore inoculations. The conidial inoculations had given over 80 per cent. infection when they were cut out. In all cases a definite canker with the typical scalloped edge and the invading fan-shaped mycelial areas developed within a month after the inoculations were made. In a few older cankers left for two months, the infected area extended nearly an inch beyond the edge of the inoculation wound.

The western fungus developed in the dead tissue above the inoculation wound, and within a month had developed pustules upon which spore horns were frequently found, but the growth of the fungus was limited to the area in which the tissue was killed by the inoculation. If it spread beyond this area, it was in the dead bark above the living cambium. There was always a definite even line between the dead and living tissue and no fan-shaped areas of mycelium were present. In all inoculation wounds a healthy callus had formed and in those made three months previous, this growth had almost cloved over the wounds. In some cases bacteria and insects delayed the formation of a callus in some parts of the inoculation, but when these were removed the callus quickly developed.

Inoculations made with ascospores of the western fungus on chestnut oak developed as on the chestnut, forming spore horns on the dead area above the wound. Reisolations were made from these spore horns, proving the fungus to be the same as that used in the inoculations.

These inoculation tests were confirmed by the results obtained at the Charter Oak laboratory where they were duplicated. The checks were more plentiful there since several hundred trees had been inoculated with Diaporthe parasitica. In a few cases we have found the western fungus spreading beyond the edge of the wound, i. e. apparently parasitic, but its development was so slow that it could be called at best, a weak parasite.

From these inoculation tests and from observations in the field, there is no longer any doubt but that the western fungus is a saprophyte and that it cannot develop into an active destructive parasite like Diaporthe parasitica. While we have not found it occurring in the same region, where the eastern fungus is common, yet the inoculations made at Charter Oak, show that it will not develop parasitic tendencies in a region where Diaporthe parasitica flourishes. Furthermore, by inoculations and by observations of natural infections, it has been proved that the true blight fungus develops normally about Connellsville.

CULTURAL COMPARISONS.

Shortly after isolating the western fungus, it was noticed that its development in culture was markedly different from Diaporthe parasitica. Further study of these differences resulted in securing certain kinds of media upon which the two fungi showed very marked contrasting characters. Both of these fungi produce conidial spore horns in much the same manner. If these spore horns are streaked on a potato agar slant, Diaporthe parasitica will produce an orange streak within four days at room temperature. This orange streak broadens, keeping pace with the growth of the fungus until the entire surface of the slant is covered with a deep orange growth. On the other hand no orange color is noticeable on the streak from the conidia of the Connellsville fungus even after a period of ten days. A lighter orange sometimes develops on these slants after a week or so but is never so marked as in Diaporthe and often fails to develop at all. Conidial streaks on other media, especially chestnut bark agar and corn meal agar, show a recognizable difference between the two fungi but this difference is not so marked as that of the color on potato agar.

On potato agar cultures from mycelial transfers a fan-shaped or irregular wavey growth is noticeable at the edge of the advancing mycelium in the case of Diaporthe, while the Connellsvillle fungus has an even unbroken edge. Furthermore, there is a marked contrast in the amount of aerial mycelium developed—Diaporthe developing scarcely any, while the Connellsville fungus has a fluffy appearance, due to a white mycelial growth above the surface of the agar. Also the contrast in color between the growths on potato agar is evident; especially in cultures about three weeks old. Diaporthe develops an orange brown color while the Connellsville fungus has at first a sulphur color which deepens as the culture becomes older.

Next to the conidial streaks on potato agar, we have found the growth on sterile twigs in test tubes to be the most accurate distinguishing character. The Connellsville fungus within ten days develops a fluffy orange mycelial growth which almost completely fills the tube. This mycelial growth is at first white, but turns to the orange color within a few days after its development. On the other hand, Diaporthe does not develop this heavy aerial mycelium but only a short white, web-like growth over the surface of the twig with heavier bunches of mycelium, which later become orange colored, where the pycnidia are to develop.

On the cut end of the twigs, Diaporthe develops a thick felt-like orange mycelial growth but this never extends out on the bark and is much denser than the growth of the Connellsville fungus. We have made these cultures on black oak, chestnut oak, white oak, chestnut, maple and sumach, but find very little difference in the nature of the growth. We have used these tests on fungi from over fifty different sources and have never failed to get these characteristic reactions. These tests are always checked when possible by ascospore measurements and often by inoculation on live trees. No doubt many other cultural differences could be discovered by further tests, but these given have proved to be so reliable that no further effort was made to find media which would show additional differences.

In culture the fungi collected at various points in Virginia, West Virginia and Eastern Tennessee, show no variation from the Connellsville type of the fungus. This conforms with the results from the spore measurements. These fungi are evidently the same.

DISTRIBUTION OF THE CONNELLSVILLE FUNGUS.

Up to date this fungus has been found in Pennsylvania only in the four southwestern counties—Greene, Washington, Fayette and Westmoreland. Many specimens were examined from other parts of the State, which were thought to be the same, but in all cases they were found to be Diaporthe parasitica. The fungus probably occurs in other parts of the State but has so far not been reported. Since it was found as far down as the West Virginia line, visits were made over into this State and the same conditions were found there. Early in the investigation, it had been suspected that this Connellsville fungus was the same as that which had been reported from several points in Virginia. A visit to that State revealed the same condition of the chestnut timber as about Connellsville. As reported on a previous page the microscopic and cultural characters were found to correspond, so that there is no doubt as to the identity of the two fungi. Specimens were also sent, by Mr. J. K. Esser, from various parts of Eastern Tennessee, and these were found to be the same as the Connellsville fungus. As indicated by the collections then, we may say that this fungus is distributed throughout Southwestern Pennsylvania, West Virginia, Virginia and Eastern Tennessee. It is not at all improbable that further search will show that it occurs in several other States.

There is another fungus found in the extreme south—Florida, Alabama, South Carolina and Mississippi—which is very similar in external appearance both to the Connellsville fungus and to Diaporthe parasitica. This is the fungus found in Ellis and Everhart's N. A. Fungi (No. 1956), where it is labelled Endothia gyrosa. It is also found in a number of other North American collections under this name. The ascospores of this fungus measure 8.2x1.90 u, being much longer in proportion to their width than the Connellsville fungus. They are cylindrical in shape and are very well represented in Ellis and Everhart's North American Pyrenomycetes. Besides the exsicicati we have also received specimens of this fungus from several points in North and South Carolinia.

TAXONOMIC RELATIONS

What is the Connellsville fungus? There is no question but that it is very closely related to Diaporthe parasitica and should be placed in the same genus. Following Saccardo's system of classification it undoubtedly falls in the genus Endothia and fits well his description of Endothia gyrosa, in so far as the spore measurements and microscopic characters are concerned. It is certain, however, that it is not the same as the long-spored southern form.

The synonomy of Endothia gyrosa given by Saccardo is misleading since it is certain that Schweinitz and Fries had in mind two very different species when they wrote of Sphaeria gyrosa and S. radicalis. Furthermore, if the genus Endothia was founded by Fries on Sphaeria gyrosa, as Farlow (1.) believes it was, then the generic name Endothia is not correct when applied to this fungus—provided we go back to Fries (2) for the definition of the genus. Schweinitz (3) in 1822 described S. gyrosa as No. 24 of his Syn. Fung. Car., but so far as we have been able to find, there is no specimen in the Schweinitz collections corresponding to the number of this description. It is probable that the specimens of this collection were included in his North American Fungi and in this collection there is a specimen of this species (No. 1431) which fits very accurately his description of S. gyrosa. in Syn. Fung. Car. In fact, in looking at this specimen under a powerful lens one is struck with the extreme accuracy of his description and one cannot doubt that he had this or a similar specimen under his lens. This fungus is entirely different from Diaporthe parasitica or the Connellsville fungus and one would not think of placing it in the same genus or even in a related genus. The most noticeable character macroscopically is that the entire surface of the stroma is covered with very regular hemispheres (sphaerulae of Schweinitz.) The perithecia are enclosed in each of these separate sphaerulae and their walls do not differ in color from the surrounding stroma. No neck is evident and the ostiole is inconspicuous or wanting. The conspicuous black walls and long necks of the perithecia of Diaporthe are entirely lacking. The perithecia are entirely within the knobs or spheres of the stroma, i. e., they do not extend down into the stroma. The ascospores are often slightly curved and the septa very indistinct. The average size of the ascospores was 15.82x4.37 u. The asci have very distinct walls and are not shaped at all like the asci of Diaporthe. They average 54 u. in length.

Schweinitz's Sphaeria radicalis (N. A. Fungi No. 1269), is an entirely different fungus from the above and although the perfect stage is not present, it resembles very closely the imperfect stage of the Connellsville fungus, or Diaporthe parasitica or the long-spored southern form. Any one who has worked with the above species will be convinced that Schweinitz (4) was writing of the perfect stage of one of these forms when he says, "Ostioles cylindrical, very black within, orange red externally, everywhere elevated on the surface, easily falling off—*whence the exposed surface shows black points, on account of the black shining ducts by which the ostioles are connected with the perithecia.*" But which of the three he had in mind would be hard to say unless the perfect stage is examined. Fries (2) places S. gyrosa in the tribe Confluentes and S. radicalis under the tribe Versatiles, thus widely separating the two, since the characters of these tribes are quite distinct. His descriptions of the two species follow closely those of Schweinitz. His distinction between the two is best brought out in his Elenchus (5) where, in describing S. radicalis, he says, "A wonderful little fungus—certainly comparable only with S. gyrosa but very *different from this in the position of the perithecia and the ostioles.* Ostioles numerous, conical elongated. fragile. spinelike. Perithecia minute, black globose, sunken, also continuous through the spine-like ostiole by a little black duct." Under S. gyrosa he says, "There is no distinct ostiole," and does not mention the beaks so noticeable in S. radicalis. This agrees well with the specimen of Schweinitz, where no ostioles are to be seen and the small knobs on the surface of the stroma contain simply the perithecia with no distinct necks.

It is, therefore evident that Fries had clearly in mind the distinction between these two species when he created the genus Endothia in 1846. In the meager and incomplete description he does not mention S. radicalis but he does mention S. gyrosa and it is to be presumed that he intended this species to be the type of the genus Although he promised later to describe the characters of this genus more fully, we find no further mention of it in his later publications. If we admit that he used S. gyrosa as the type for erecting this genus and if we wish to include under it only species resembling it, then it is evident that the present Endothia is an entirely different genus from what Fries intended. As further evidence that he did not intended to place S. radicalis in this genus we may turn again to his descriptions where he speaks of the perithecia being light colored (pallidus) and yet he distinctly mentions the dark walls of the perithecia in his description of S. radicalis.

In 1863, however, De Notaris (6) without any explanation, put the two in the same genus, and in the same year we find them combined by Tulasne (7) under the genus Melogramma. Since that time all authorities without further investigation have considered that Schweinitz gave these two names to one and the same species.

If the generic name Endothia is to be retained for those species resembling S. radicalis of Schweinitz and Fries and the more recently described Diaporthe parasitica, then we believe that the Connellsville fungus would fall in the genus Endothia. If, however, we wish to retain under this name such species as that on which Fries erected the genus, the Connellsville fungus would certainly not fall in this genus, and a new one will have to be erected to include Diaporthe parasitica, the Connellsville fungus and the long-spored southern form of Ellis and Everhart. According to our present system of classification, the form on which Fries erected the genus Endothia would easily fall in a previously established genus and this name is now left without any significance whatever. Besides we are not certain that Fries meant to give a generic description in this short note since he states that he expects to describe the genus more fully later.

The simplest way out of this taxonomic tangle then, it seems, would be to retain the name Endothia for the forms such as Saccardo includes under it. Then we would have in our territory (1) the long-spored Southern Endothia, (2) the true blight fungus—E. parasitica—and (3) the Connelsville fungus, for which we proposed the name E. Virginiana and for which we have published a description.*

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*Phytopathology 2:261-262, Dec. 1912.

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Fig. 1. Fans or mats of mycelium of chestnut blight fungus in the cambium and inner bark. Photo by E. T. Kirk.

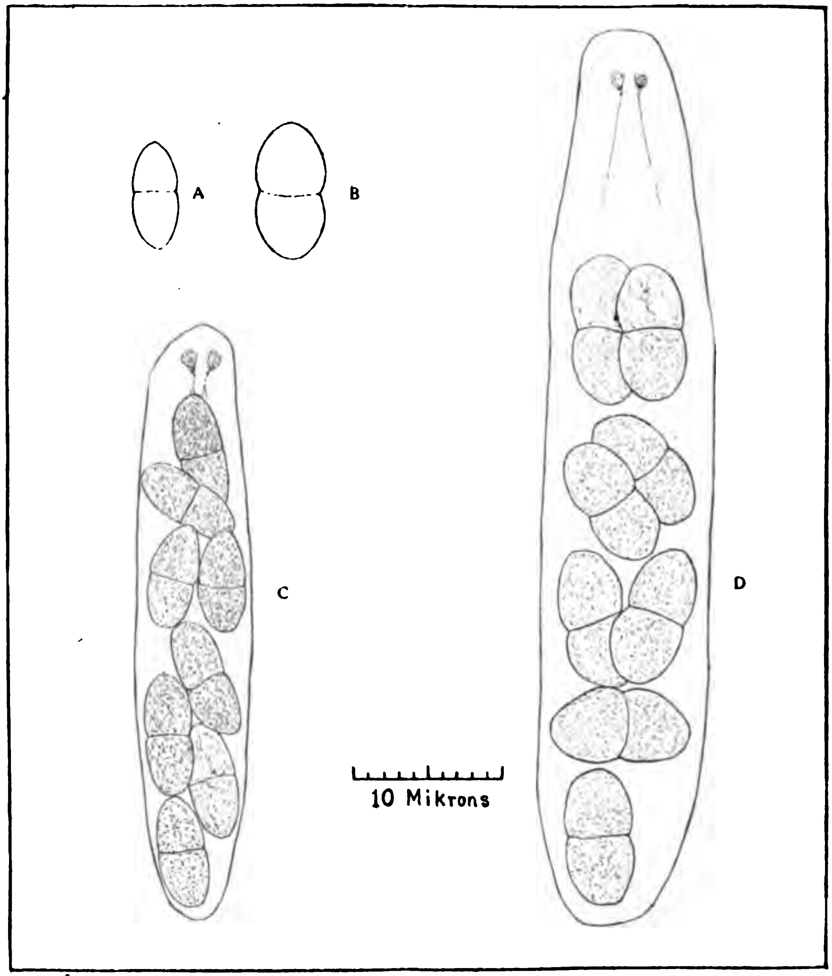

Fig. 2. A. Singlel ascospore of the Connellsville fungus. B. Single ascospore of the chestnut blight fungus. C. Ascus of the Connellsville fungus. D. Ascus of the chestnut blight fungus.

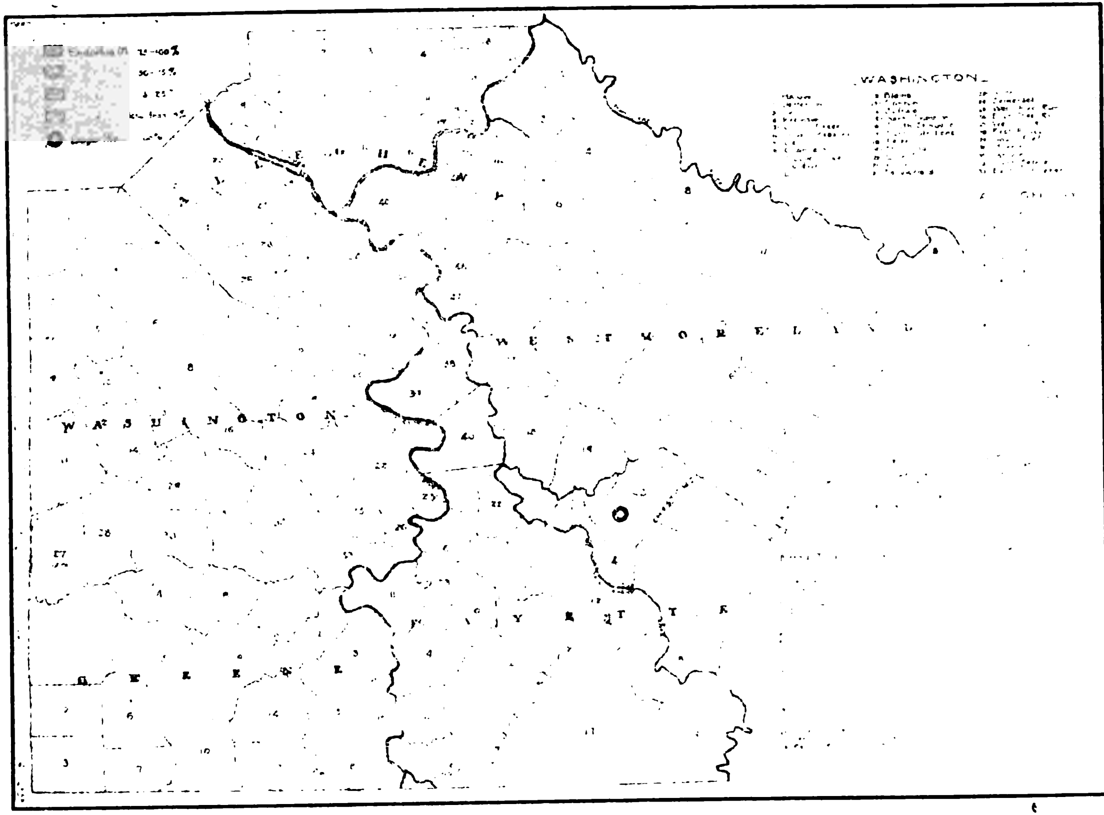

Fig. 3. Map showing the distribution of the Connellsville fungus in Pennsylvania. Drawn by J. K. Hibbs.

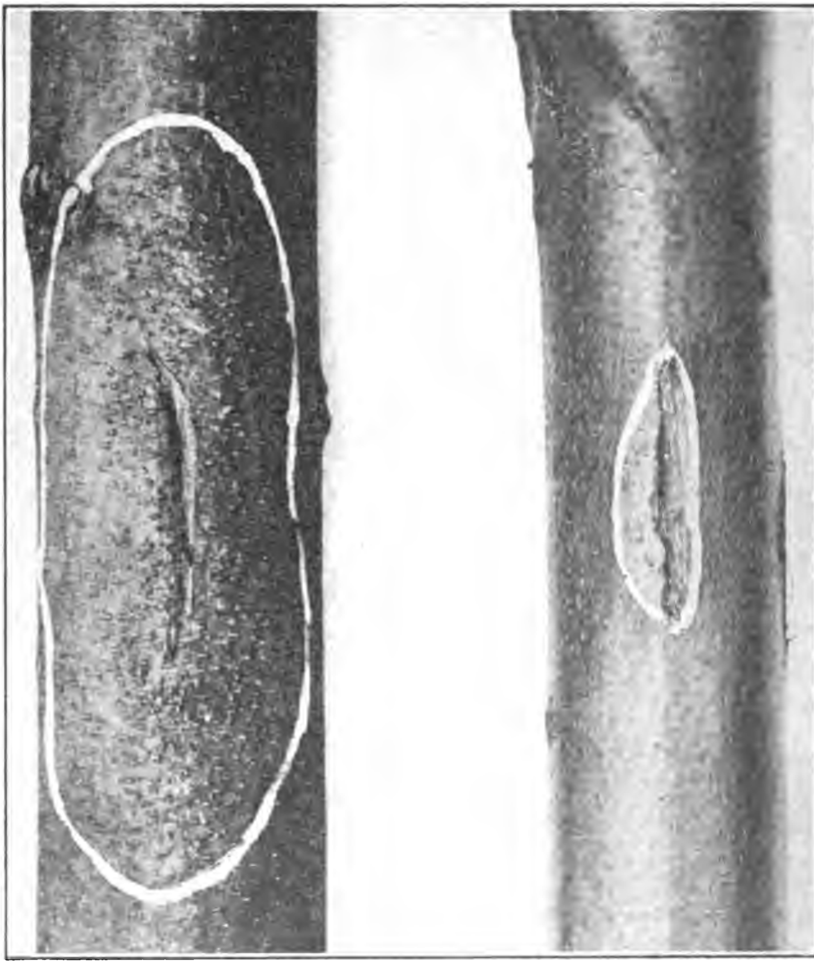

Fig. 4. Inoculations of 1 1-4 inches tree with Connellsville fungus, after five months (right); inoculation of 1 1-2 inches tree with blight fungus, after three months (left). Both outlined with paint to show extent of growth. Photo by E. T. Kirk.

Fig. 5. Bark cut away from inoculation with the Connellsville fungus, showing the even outline. Photo by E. T. Kirk.

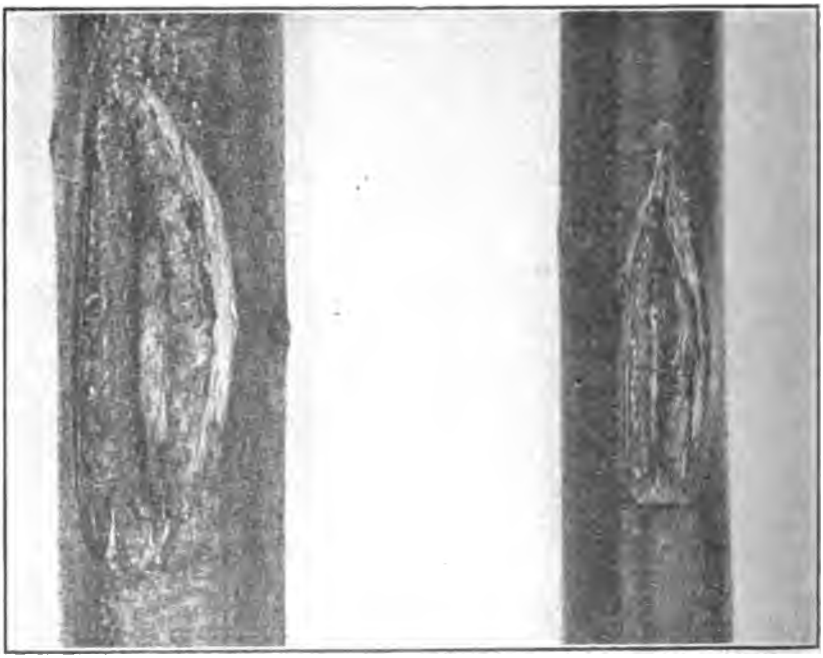

Fig. 6. Two inoculations with the Connellsville fungus showing callus formed around each. Trees 1 inch and 1 1-2-inches in diameter. Photo by E. T. Kirk.

PENNSYLVANIA CHESTNUT TREE
BLIGHT COMMISSION

1112 Morris Building, Philadelphia

Bulletin No. 5 MAY 15, 1913

The
Symptoms of Chestnut Tree Blight
and
A Brief Description of the Blight Fungus

by

F. D. Heald, Pathologist

1913

Pennsylvania Chestnut Tree Blight Commission

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Introduction

INQUIRIES are constantly being received by this Commission for more detailed information about the chestnut tree blight fungus. On the other hand, certain erroneous ideas exist in regard to the nature of this fungus. This circular is written with the hope that it will supply some desired facts and assist in correcting false notions. Investigations on the dissemination and life-history of the blight fungus are in progress at the present time and new facts are constantly being determined. Our knowledge being far from complete, it is only advisable to present the facts which appear to be fairly well established.

Symptoms and Effects

Young infections of chestnut blight on smooth-barked vigorous shoots (two to six or more years old) can be easily recognized by the presence of yellowish or yellowish brown patches, slightly raised, and standing out in marked contrast to the olive-green healthy bark. The area invaded by the fungus may be fairly regular (Figs. 4, 23) or very irregular in outline, the latter showing what has been designated as the amœboid type (Figs. 1, 2, 3). In young infections of this type there are no fruiting pustules, but these make their appearance later. If the external brown layer of cork cells is removed from the advancing edge of the invaded area, the whitish or buff-colored mycelium, or vegetative body, of the blight fungus is exposed (Fig. 24). Infections of this type may spread until the shoot is completely encircled (Fig. 4), and fruiting pustules will be formed later.

Young infections on slow-growing twigs or on the smooth bark of older branches or trunks are not as evident, but they generally show as somewhat discolored, dead areas, sometimes slightly depressed, and occasionally with a raised margin. The area invaded may be nearly circular, giving a so-called "target" infection, but it is more frequently elongated in the direction of the long axis of the shoot or branch. The invaded area gradually enlarges until the shoot or branch is completely encircled. A small shoot may be completely encircled before the appearance of fruiting pustules, but on larger limbs or on the main trunk the fruiting pustules begin to make their appearance long before complete girdling has taken place. These fruiting bodies show as small yellow, orange or reddish brown pustules (1/16 inch or slightly more in diameter) which break through the bark some distance back from the advancing edge of the lesion.

The interior tissue (inner bark invaded by the fungus) is changed to a yellowish brown color, which is in marked contrast to the bright fresh color of the normal healthy tissue, and a careful examination by cutting away the bark will show the buff-colored fans of the fungus which may have penetrated as deep as the cambium layer (Fig. 12).

During damp weather following rains, or in moist situations, long, irregularly twisted threads varying in color from buff to bright yellow may be extruded from some of the pustules (Fig. 13). These are masses of conidia or summer spores, and have been designated as "spore-horns" or tendrils. The spore-horns when first formed are soft and sticky, but when dry they become hard and brittle and are frequently darker in color.

Young infections on old trunks or large limbs with thick fissured bark cause little change in the appearance of the bark itself and the fungus may have gained considerable headway before there is any external evidence of its presence. Sometimes the first indication of an infection on large limbs or trunks is the appearance of abnormal longitudinal splits or fissures. The orange or yellow fruiting pustules appear in the deep crevices or cracks, and spore-horns may be developed from these under favorable conditions of moisture and temperature. In case of doubt as to whether a given discoloration is caused by the blight fungus the following test may be used: Place the twig or piece of bark in a closed vessel so it is supplied with plenty of moisture and will be retained in a moist atmosphere. In all cases if the fungus is present and is alive, bright yellow or orange, cottony tufts will make their appearance upon the surface, and in many cases spore-horns will also be developed.

An infection with the blight fungus is sometimes the cause of a pronounced enlargement, or hypertrophy. This enlargement may involve the entire invaded portion (Figs. 6, 7) or it may be more pronounced at the upper end of the lesion (Fig. 5). Enlarged lesions are apparently the most frequent on vigorous shoots. Longitudinal splits or fissures in the bark are very characteristic of hypertrophied lesions (Fig. 7). In many instances the lesion may show a marked sunken area (Fig. 8) due to the killing of the invaded bark, while the surrounding tissues have continued to grow at the normal rate. This dead tissue may be more or less cracked or fissured and a typical canker developed (Fig. 8). In the old lesions which have completely girdled a limb or branch the bark becomes cracked and fissured and begins to peel away (Fig. 9). The branch shown in the cut referred to had been killed by this lesion and had been dead for a year. On old rough-barked trunks or branches the bark over old lesions will give a hollow sound when tapped, due to the fact that the inner bark has been destroyed by the fungus. The bark may be readily peeled away and the inner fibrous portion is more or less shredded.

Aside from the discovery of the actual lesions there are various other symptoms which indicate the presence of blight. *Dead leaves* hanging in characteristic drooping clusters are an indication of blight-killed twigs or branches. If the twigs or branches were not killed until late spring or summer, that is, prior to the first of September, the leaves reach normal size, and these clusters of dead leaves will generally remain clinging to the tree during the winter period after the normal leaves have fallen. This affords one means of detecting blight-killed branches in the winter. In blight-affected branches there is an indirect effect upon the *size and persistence of the burs.* If the girdling is completed early in the growth of the burs, they are likely to remain small and undersized, but with later completion of girdling they may attain full size. These burs of blight-killed branches commonly remain hanging upon the tree during the winter, constituting another evident symptom for the detection of blight during the leafless period.

In case the girdling of a branch is not completed until late fall, the normal shedding of the leaves occurs. In the spring, however, the leaves from these branches remain undersized and assume a yellowish or pale color, and soon wither and die (Fig. 11). If girdling is completed later in the spring or not until midsummer, the leaves of the affected branches develop to full size, but later turn yellowish or assume a characteristic reddish brown color. Later when the leaves die they assume more of a brownish tinge, and some fall from the tree while many remain hanging for a considerable time.

The development of sprouts or "suckers" is another evident symptom of blight which can be noted at any period in the year. As soon as a branch or the main trunk has been girdled by blight, there is a marked tendency to the production of vigorous, rapid-growing shoots from a point just below the girdled area. These sprouts may be few in number or they may be so numerous as to make a conspicuous clump (Fig. 11), and they may occur on the branches, the main trunk, or at the base of the tree. These sprouts may be killed in turn by the blight, but they sometimes persist for several years. When they persist their age serves to tell the time at which the girdling was completed. The general effect of blight is to kill the part of twigs or branches beyond the lesion. The occurrence of trunk lesions is most serious, since with the completion of girdling the entire tree must succumb. In trees which have suffered from top infections for several years, the occurrence of the blight-killed branches sometimes gives rise to an effect called "stag-head." The wood of blight-killed trees is injured but little as a direct result of the disease, but if left standing it soon begins to deteriorate as a result of the work of insects and various species of wood-destroying fungi.

The Blight Fungus

The chestnut blight is due to a definite species of fungus which grows as a parasite in the bark and to some extent in the wood of the infected tree. This fungus was first described as *Diaporthe parasitica* Murrill, but has since been referred to *Endothia parasitica* (Murr.) And. It is possible to grow this fungus in artificial cultures (Fig. 25) and it has been repeatedly demonstrated by inoculations into healthy trees to be the cause of the disease.

1. *The vegetative body or mycelium.* The blight fungus grows within the bark and to some extent in the wood of the affected parts, where it produces strands or mats of closely appressed filaments, known as the mycelium or vegetative body of the fungus. In young infections on smooth-barked shoots this mycelium is located just below the brown, outer, or corky bark, and is cottony white at the advancing edge but assumes a buff tinge in the central or older portions of the infection (Fig. 24). As the infections become older, the mycelium penetrates deeper and spreads out at various depths in the bark, where it produces characteristic fan-like aggregates. The fans of buff or yellowish mycelium are especially well developed in the layers of inner bark, and finally in the cambium or growing layer between bark and wood, which is thus destroyed by the growth of the fungus (Fig. 12). After the mycelium has reached the cambium and spread out in that region, it enters the wood and grows throughout the outer layers of sapwood. It is known to penetrate at least as far as five annual rings of wood.

2. *The pycnidial stage.* After the mycelium of the blight fungus has been growing for a time in the bark it begins the formation of fruiting pustules for the production of spores. The first kinds that are produced are known as *pycnidial pustules* or stromata, and they appear as minute raised papillæ scarcely larger than a pin-head, and showing a yellowish or orange color when they break through the bark. Each pycnidial pustule shows a smooth or slightly uneven outer surface and is a dense aggregate of fungous tissue, generally containing one (rarely more) large, lobu-

lated cavity (Fig. 14) lined with innumerable vertical filaments by which large numbers of minute rod-shaped bodies, the pycnospores, are produced. With the accumulation of these in a pycnidium, the external wall is ruptured and the accumulated mass of spores imbedded in mucilaginous material oozes out in the form of a thread-like or flattened irregular coil, the so-called "spore-horn" or tendril (Fig. 13). A single spore-horn of average size has been found by actual analysis to contain as many as 115,000,000 pycnospores (Fig. 21).

The pycnospores have frequently been designated as summer spores, but the development of pycnidia depends largely upon the age of the lesion rather than on the time or season of the year. Pycnospores are produced in abundance at all times in the year when temperature and moisture conditions are favorable, and are washed down in large numbers from diseased branches even during the warm winter rains, when the spore-horns are rarely observed.

The production of pycnospores is not confined to pustules which break through the bark of diseased areas. Smaller orange or reddish superficial pycnidia may be produced in large numbers on the cut end of the inner bark or the outer layers of sapwood (Fig. 18) of fallen logs, stumps, or wood previously affected with blight, or on the inner surface of inner bark where it has split away from the wood. Peeled posts and poles previously affected with blight will frequently show many of these minute pycnidia on the diseased spots, but these pycnidia are generally rather scattered. Pycnidia producing large numbers of viable spores have been obtained from a wood-pile two years old. Chips or fragments of diseased bark or wood that fall in damp locations will produce pycnidia, so that material of this sort is always a possible source of infection.

3. *The perithecial stage.* Following the production of pycnidia and pycnospores, a second type of fruiting pustules containing the perithecia makes its appearance. Superficially these perithecial pustules can be readily differentiated from the pycnidial pustules, since each one shows upon

its surface either a number of minute raised papillæ or a number of minute black dots, the ostioles or openings of the *perithecia* or flask-like bodies buried deep in the stroma (Figs. 16, 17).

Each perithecial pustule is a dense aggregate of fungous tissue containing 1 to 60 distinct flask-like cavities, the perithecia, each of which communicates with the exterior by means of a long black neck which opens at the top of a surface papilla (Fig. 15). The wall of each perithecium is lined with small club-shaped cells or spore-sacs, which are produced in enormous numbers (Figs. 15, 20) and give rise to the second type of spores or ascopores. There is one perithecium for each superficial papilla.

The perithecial pustules show some differences in color and external appearance depending upon their age and the conditions under which they have developed. The papillæ and the stroma may both be yellowish or orange, or the papillæ may be yellowish brown to brick-red on a lighter ground, or in old pustules the stroma may be nearly black, with slightly lighter papillæ. In most cases when the perithecia are mature the ostioles or mouths of the necks will show as dark spots at the ends of the surface papillæ. There is considerable variation in the length of the surface papillæ, the difference being due to varying amounts of moisture, those which develop with an abundance of moisture showing especially long necks, while with scarcity of moisture the papillæ remain short.

The spore-sacs formed in the perithecia contain the ascospores. Each sac produces eight two-celled spores arranged generally in two irregular rows (Fig. 20). These spores have a volume about fifty times as great as that of the pycnospores (Fig. 21). They are not extruded ordinarily in masses from the perithecia, but under favorable conditions of moisture and temperature the spore-sacs rise to the ostiole and explode, forcing the spores into the air. If a glass slide is suspended 1/8 inch or slightly more above the surface of some mature perithecial pustules moistened in water and kept at a temperature not under 65° F., large numbers of ascospores will be expelled and will adhere to the slide. Such a spore print of ascospores is shown in Fig. 22. A similar expulsion of ascospores takes place in nature whenever conditions are favorable.

The ascospores have been designated as "winter spores." Their time of maturing, however, appears to depend more upon the age of the lesion than upon the season of the year. Maturing perithecia may be found at any season of the year, although they are perhaps more abundant in the fall and winter than at other seasons. Successive crops of perithecial pustules may be found on a single lesion which has persisted for a number of years. The blight fungus may spread throughout the bark of a blight-killed tree and continue to produce fruiting pustules, or perithecial pustules may be produced in abundance in the crevices of the bark of fallen logs (Fig. 17).

The Spread of the Disease

The cause of infections. New infections, whether in sound trees or in those already diseased, are caused by the establishment of the vegetative body or mycelium of the fungus in the tissues. This mycelium originates from either pycnospores or ascospores. Successive stages in the germination of both kinds of spores are shown in Fig. 26. If this germination takes place in some wound which penetrates the outer brown bark, the fungus readily establishes itself and begins to grow through the tissues of the bark in much the same way that it is growing in the culture medium shown in Fig. 25. An infection can be caused then by either a single ascospore or a single conidiospore if they are carried and lodged in a favorable location. A large percentage of the new infections appear to be definitely related to some mechanical injury, but there are some evidences that natural cracks and fissures may also be the avenue of entrance.

Natural agencies in dissemination. The pycnospores or the ascospores must be carried from one part of a tree to other parts, or from tree to tree, if new infections are to result. Present investigations point to the fact that ascospores which are forcibly expelled into the air during the moist and warm periods of the year play a very important part in the spread of the disease, since they can be carried by the air currents. It can also be definitely stated that conidiospores are washed down during every rain, even the cold rains of winter, in countless numbers from every lesion that has reached the spore-producing stage.

It seems probable, then, that conidiospores play a very important part in the spread of the disease throughout a tree after it once becomes infected. Rain and wind are undoubtedly the most important natural agents in the dissemination of spores.

The part which birds, insects and other animals play in the scattering of spores is at the present time somewhat problematical. The few tests reported up to date have given only negative results. (See Bulletin No. 3 of the Pennsylvania Chestnut Tree Blight Commission.) From investigations now in progress it may be definitely stated that a single downy woodpecker has been found to be carrying as many as 657,000 pycnospores.

Artificial agencies. It has been definitely shown in numerous cases that the shipment of infected chestnut nursery stock has been responsible for the introduction of blight into a new region. After it is once introduced, natural agencies may be responsible for the scattering of the spores.

The shipment of chestnut products of various kinds, such as logs, wood, posts, poles etc., made from blight-affected trees may also be responsible for spreading the disease, since the mycelium may retain its vitality in blighted bark or wood for long periods and produce new crops of pycnidia very soon after moisture is supplied, or spores may be scattered from pustules formed previous to shipment of the products. (See also Bulletin No. 3.)

Explanation of Plates

All photographs are by Wm. Currie, except Fig. 12, which was made by E. T. Kirk.

PLATE I

Fig. 1. Amœboid infection on two-year-old shoot. Bark has been removed and spread out flat.

Fig. 2. Amœboid infection on three-year-old shoot.

PLATE II

Fig. 3. Characteristic amœboid infection on two-year-old shoot.

Fig. 4. Basal infection on two-year-old shoot. The fungus has completely encircled the shoot.

PLATE III

Fig. 5. Characteristic hypertrophy of two-year-old shoot.

Fig. 6. Characteristic hypertrophy of two-year-old shoot.

PLATE IV

Fig. 7. Characteristic hypertrophy of vigorous shoot.

PLATE V

Fig. 8. Lesion that nearly surrounds the branch. Sunken on one side, and a slight enlargement on the other.

PLATE VI

Fig. 9. Old lesion in which the bark has become somewhat shredded and the wood exposed. The branch had been dead for a year.

PLATE VII

Fig. 10. Characteristic position of drooping leaves on blight-killed shoots. Shows also a small bur.

Fig. 11. Water sprouts produced at the base of a tree recently girdled by the blight fungus. Tree also shows few small leaves, giving the characteristic appearance of a blight-killed tree.

PLATE VIII

Fig. 12. Fan-shaped mycelium from bark of a rough-barked tree. (After Anderson.)

PLATE IX

Fig. 13. Pycnidial pustules with spore-horns developed in a damp chamber in the laboratory.

PLATE X

Fig. 14. Vertical section of a pycnidial pustule. The filaments lining the lobulated cavity produce the spores that ooze out as "spore-horns."

Fig. 15. Vertical section of a perithecial pustule. Several of the perithecia are cut so as to show the full length of the necks.

PLATE XI

Fig. 16. Perithecial pustules enlarged (x 3).

Fig. 17. Perithecial pustules in the crevices of rough bark. From a fallen log.

PLATE XII

Fig. 18. Pycnidia on the end of a fallen log. Three zones are shown, one for each of the three outer rings of wood.

Fig. 19. Vertical section of pycnidia shown in Fig. 18.

PLATE XIII

Fig. 20. Spore-sacs or asci, each containing eight spores.

Fig. 21. Diagram showing relative size of pycnospores (left) and ascopores (right). Maximum and minimum sizes of each are shown.

PLATE XIV

Fig. 22. Photograph of an ascospore print on an object slide. Made by inverting a slide over perithecial pustules that have been soaked with water and kept for a time at a temperature favorable to the expulsion of ascospores.

PLATE XV

Fig. 23. A young lesion of the chestnut blight fungus on a vigorous two-year-old sprout.

Fig. 24. The same lesion as above with the brown outer bark removed to show the white or buff-colored mycelium.

Fig. 25. Isolation culture made from the above lesion before the removal of the bark. A minute portion of the mycelium was planted at three different spots in the culture plate.

PLATE XVI

Fig. 26. Photograph showing successive stages in the germination of both kinds of spores. (a) ascospores series from 8 to 22 hours, at hourly intervals; (b) conidiospores series from 8 to 22 hours, taken every two hours.

Plate I

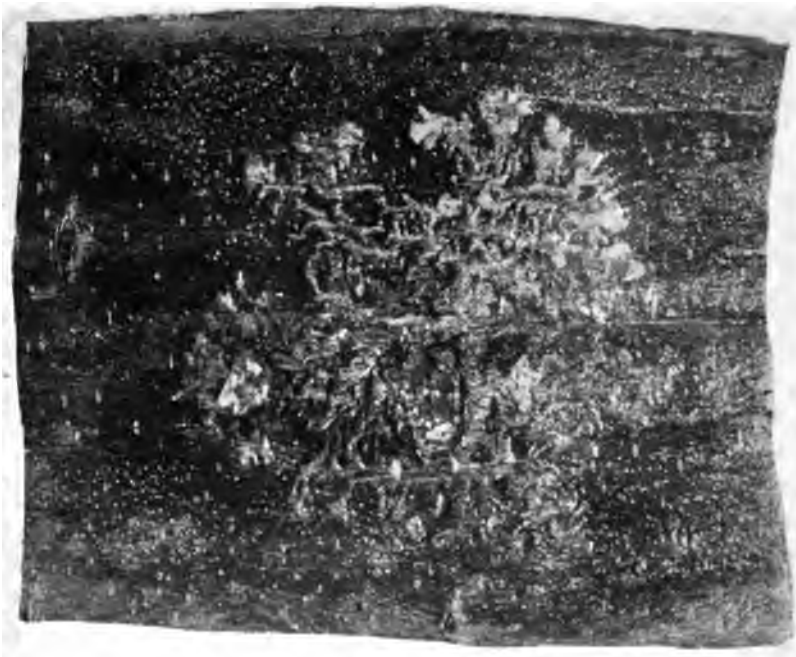


Fig. 1

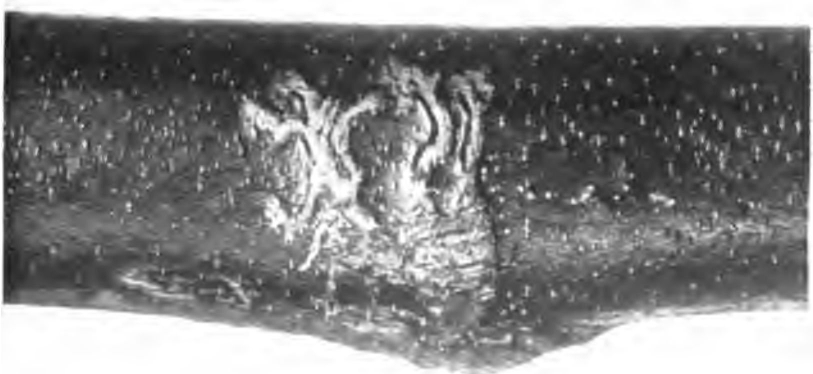


Fig. 2

Plate II

Fig. 3

Fig. 4

Fig. 5 Fig. 6

Plate IV

Fig. 7

Fig. 8

Plate VI

Fig. 9

Plate VII

Fig. 10

Fig. 11

Plate VIII

Fig. 12

Fig. 13

Plate X

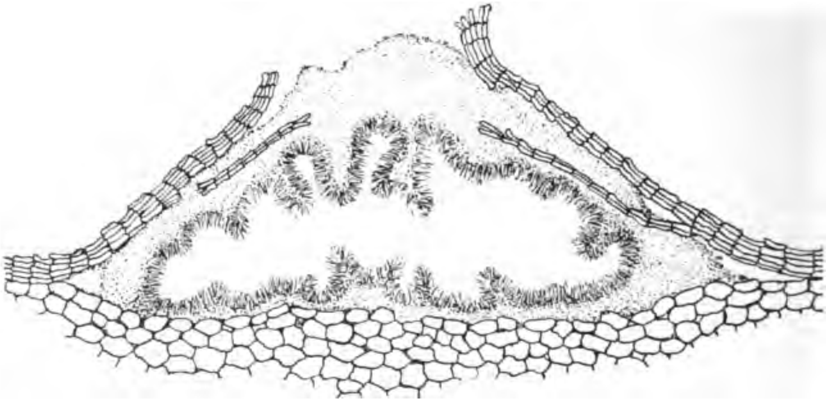


Fig. 14

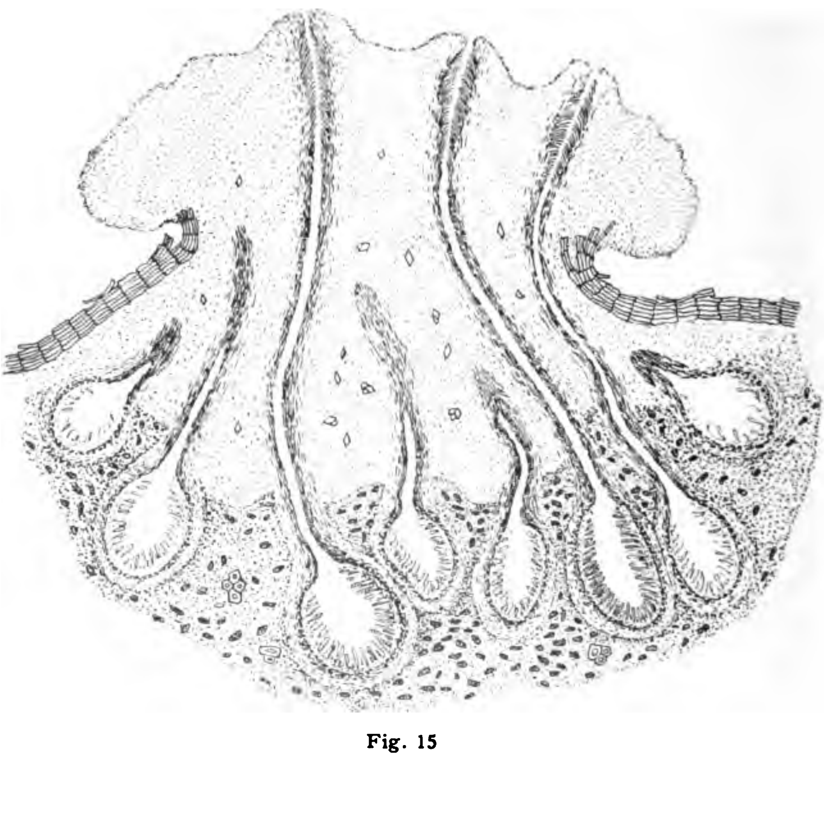


Fig. 15

Fig. 16

Fig. 17

Plate XII

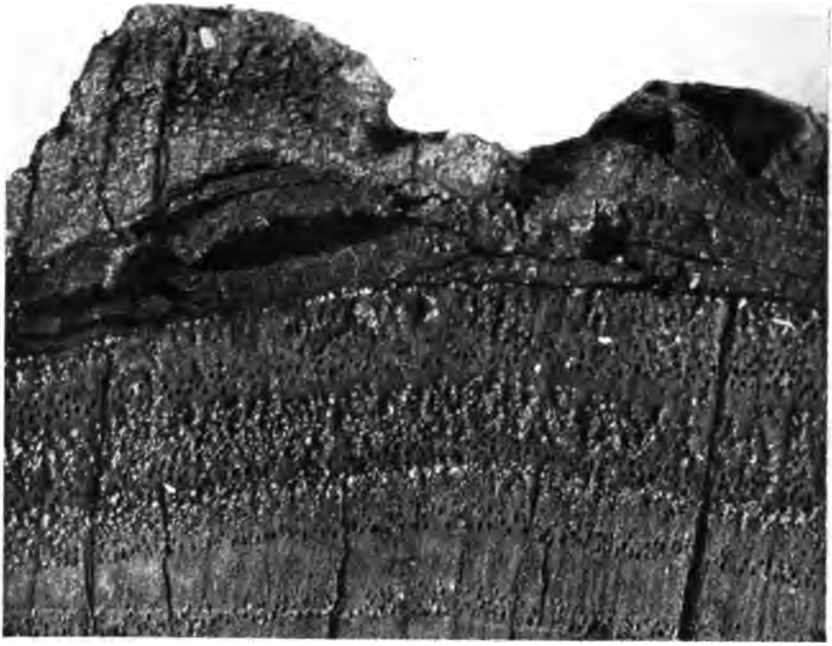


Fig. 18

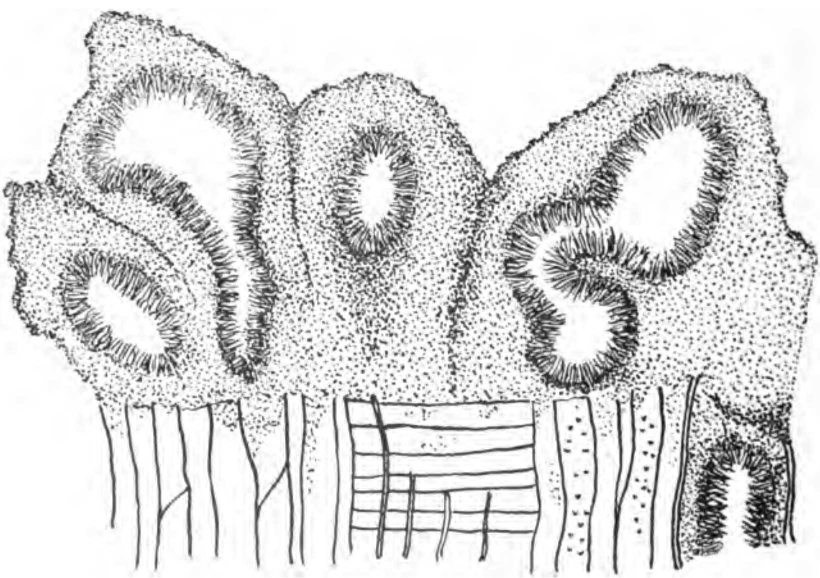


Fig. 19

Plate XIII

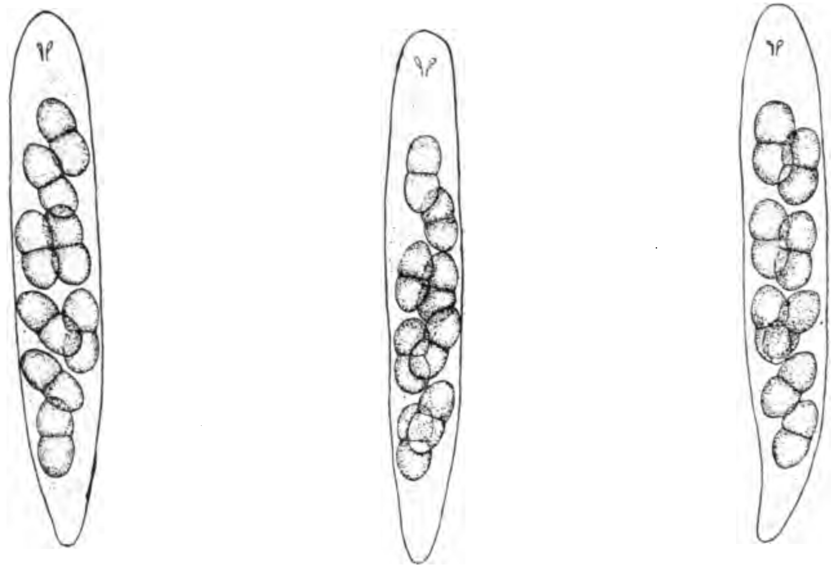


Fig. 20

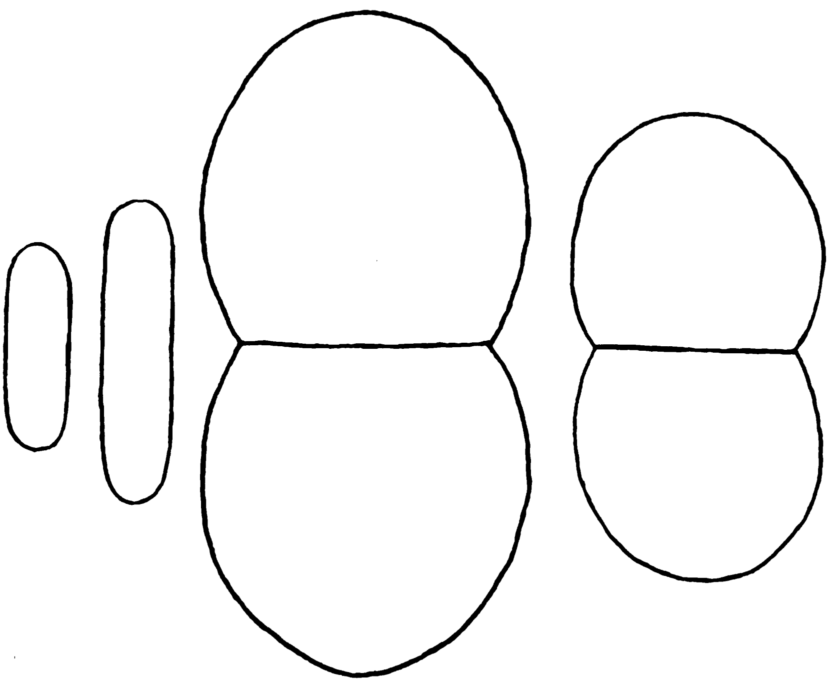


Fig. 21

Plate XIV

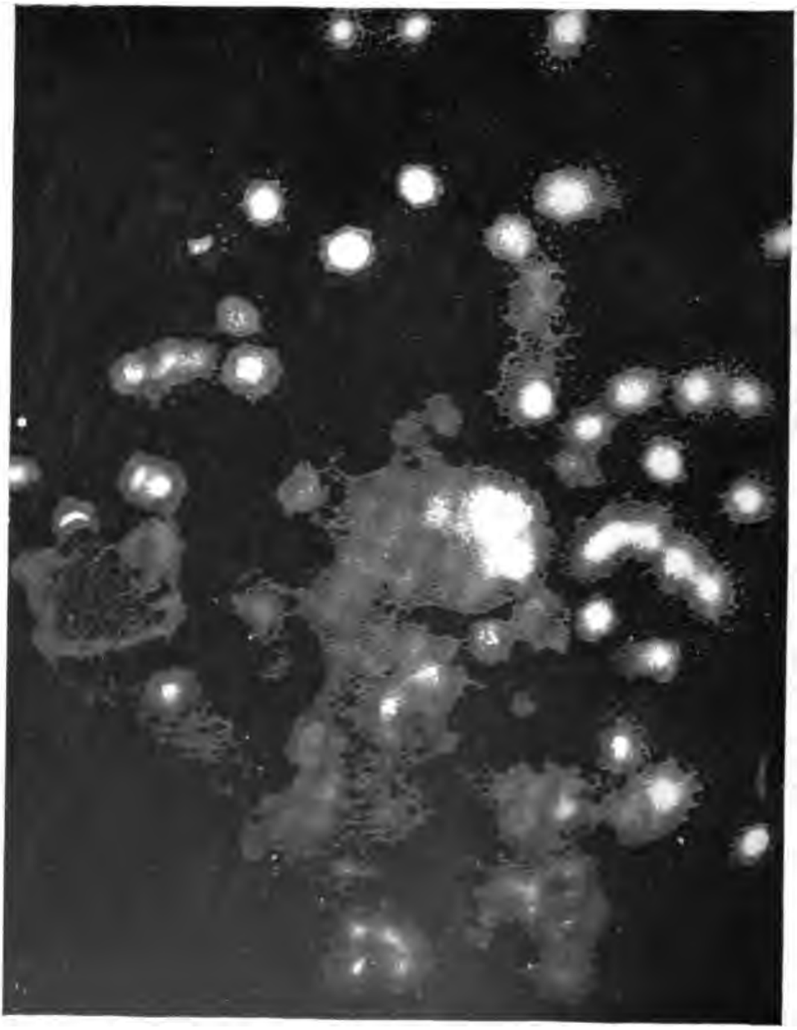


Fig. 22

Fig. 23

Fig. 24

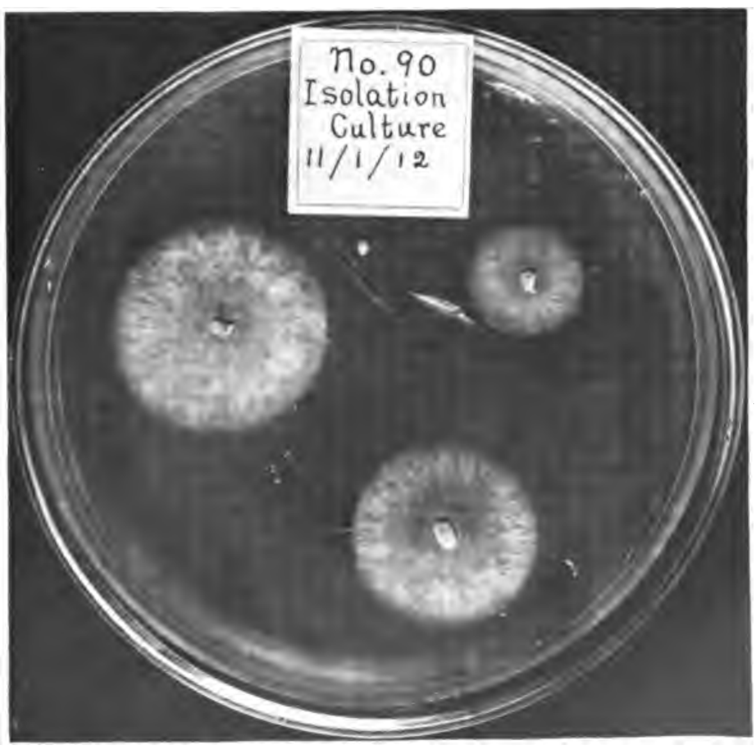


Fig. 25

Plate XVI

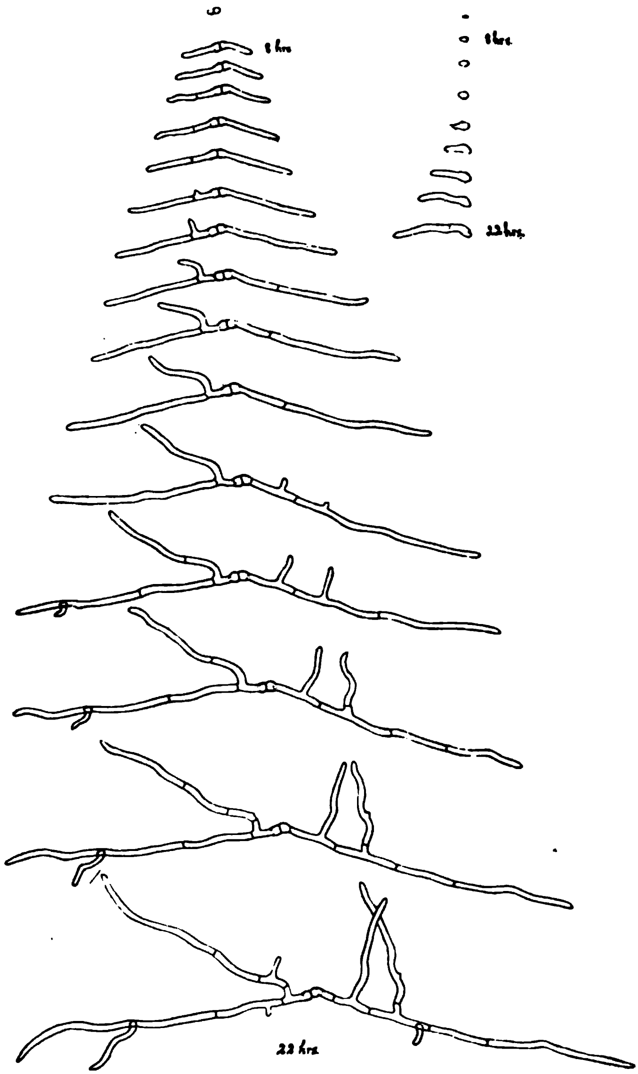


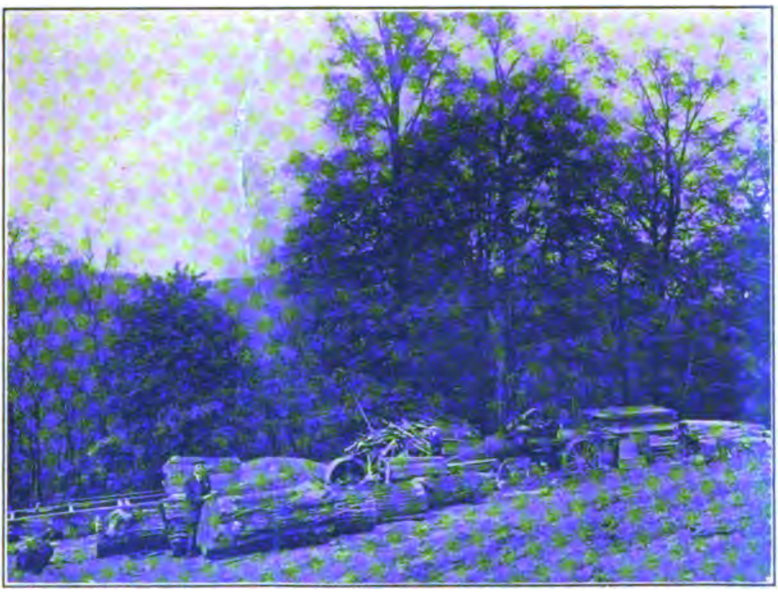
Fig. 26a Fig. 26b

The Commission for the Investigation and Control of the
Chestnut Tree Blight Disease in Pennsylvania
1112 MORRIS BUILDING
PHILADELPHIA

BULLETIN NO. 6 AUGUST 15, 1913

The Chestnut Tree

Methods and Specifications for the Utilization of Blighted Chestnut



UTILIZING BLIGHTED CHESTNUT TREES

1913

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

1112 MORRIS BUILDING
PHILADELPHIA

THE CHESTNUT TREE

METHODS AND SPECIFICATIONS

FOR THE

UTILIZATION OF BLIGHTED CHESTNUT

BULLETIN No. 6
AUGUST 15, 1913

Pennsylvania Chestnut Tree Blight Commission.

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THE CHESTNUT TREE.

The genus *Castanea*, or chestnut, contains four distinct species, two of which are found in the United States, and two in Europe and Japan. Of the two species found in the United States, one is a shrub or small tree, the chinquapin, and the other is our native American sweet chestnut (*Castanea dentata*). Some botanists recognize a third species in the United States, this being *Castanea almifolia*, which is found only in the Southern states and which is only a small shrub.

Reproduction.

Chestnut reproduces from seed and by stump sprouts. Sprouts grow more rapidly than seedlings and produce what is known as second-growth chestnut. Chestnut is the American species best adapted for regeneration by sprouts, known as coppice. Stumps of any diameter may put forth sprouts. Coppice chestnut from twenty to forty years old will yield telephone poles, posts, railroad ties, extract wood, etc.

Some Uses of Chestnut.

The following are some of the important uses of chestnut:

Telephone and telegraph poles; railroad, trolley and mine ties; extract wood, fuel wood, charcoal wood, kindling; paper pulp, in mixture with other woods; construction timbers; sills, especially when placed in the ground; fence posts, stakes, rails and paling; staves and heading for barrels and kegs; mine material, props, lagging timbers, brattice boards; boxes and crates; shingles; lath; furniture, as chairs, built-in sideboards, tables, beds, church pews, organs, pianos, billiard tables and fixtures; cabinet making; interior finish—doors, door and window frames, wainscoting, beams, picture molding, panels, base boards, ceiling, etc.; flooring; vine and hop poles; carriages and parts of automobile bodies; tubes for water pipes; caskets and rough boxes; agricultural implements; veneer cores; veneer; gymnasium goods; toys; musical instruments; car sills and frames; show cases, bank and barbershop fixtures and sewing machines; ribs of ships; brush backs; trunks; tie plugs, etc.

The fruit is an article of food, both in its raw state and when manufactured into meal and flour. Its leaves are used in the manufacture of medicine.

CHESTNUT POLES.

KINDS.

Telegraph, telephone, trolley.

TELEPHONE POLES.

Telephone poles are usually classified according to the size of the poles, and to the number of wires which they are intended to carry. There are two general classes of poles: firsts and seconds. Some electric companies, however, make as many as four classes. Poles are usually required to be perfectly sound, squared at both ends, reasonably straight, well proportioned from butt to top, peeled, and to have the knots trimmed to the surface of the pole.

Pole dimensions consist of length, top circumference and circumference taken six feet from the butt. Poles are variously classified, according to the requirements of the consumer.

First-Class Poles			Second-Class Poles		
Length of Pole	Top Circumference	Circumference 6 Feet from Butt	Length of Pole	Top Circumference	Circumference 6 Feet from Butt
25 feet	24 to 25 inches	33 to 36 inches	20 feet	22 inches	30 inches
30 "	24 to 25 "	36 to 40 "	25 "	22 "	31 to 33 "
35 "	24 to 25 "	40 to 43 "	30 "	22 "	32 to 36 "
40 "	24 to 25 "	43 to 45 "	35 "	22 "	34 to 40 "
45 "	24 to 25 "	47 to 48 "	40 "	22 "	38 to 43 "
50 "	24 to 25 "	50 to 51 "	45 "	22 "	43 to 47 "
55 "	22 to 25 "	53 to 54 "	50 "	22 "	47 to 50 "
60 "	22 to 25 "	56 to 57 "	55 "	22 "	53 "
65 "	22 to 25 "	59 to 60 "	60 "	22 "	56 "
70 "	22 "	63 "	65 "	22 "	59 "
75 "	22 "	66 "	70 "	22 "	62 "

Some electric companies make two more classes, with specifications as follows:

Third-Class Poles			Fourth-Class Poles		
Length of Pole	Top Circumference	Circumference 6 Feet from Butt	Length of Pole	Top Circumference	Circumference 6 Feet from Butt
25 feet	20 inches	30 inches	25 feet	20 inches	27 inches
30 "	20 "	33 "	30 "	20 "	31 "
35 "	20 "	36 "	35 "	20 "	35 "
40 "	20 "	40 "	40 "	20 "	39 "
45 "	20 "	43 "	45 "	20 "	43 "
50 "	20 "	46 "	50 "	20 "	46 "
55 "	20 "	49 "			

The following table gives the length of poles that may be obtained from average trees of different diameters. This is based on a table in Bulletin 53, U. S. Forest Service, "Chestnut in Southern Maryland." The tenths of inches in the original table have usually been placed in the nearest inch or half-inch class, and were in a few cases disregarded so that the figures given would compare with the average pole specifications:

Size of Pole from Tree.

Diameter Breast-high (D. B. H.)	Length of Pole	Diameter at Top	Diameter 6 Feet from Butt
11 inches	25 feet	8 inches	10½ inches
12 "	30 "	8 "	11½ "
13 "	35 "	8 "	12½ "
14 "	35 "	8½ "	13½ "
15 "	40 "	8½ "	14½ "
16 "	40 "	8½ "	15½ "
17 "	45 "	8½ "	16½ "
18 "	45 "	8½ "	17½ "
19 "	50 "	8½ "	18 "
20 "	50 "	8½ "	19½ "

CHESTNUT TIES.

Chestnut is cut into railroad, trolley and mine ties. These may be round, sawed or hewn. Round ties are used by mining companies.

Railroad ties usually are 8½ feet in length, trolley ties 7 to 8 feet, and mine ties from 5 to 6 feet. Each company has its own specifications, prices, and methods of piling, which vary to some extent.

DURABILITY.

Chestnut ties are not usually treated with a preservative, but when treated with 10 pounds of creosote per cubic foot the life of the tie is doubled.*

QUALITY OF TIMBER.

Ties must be cut from sound timber, which is free from imperfections which might affect their strength. It does not pay to cut ties from timber under 11 inches in diameter because of the large amount of waste in trees of small diameters.

RAILROAD TIES.

The usual specifications for railroad ties are:

No. 1.

Pole		Squared	
Sawed	Hewed	Sawed	Hewed
7 x 7" x 8½′	7 x 7" x 8½′	7 x 8" x 8½′	7 x 8" x 8½′

No. 2.

Pole		Squared	
Sawed	Hewed	Sawed	Hewed
6 x 7" x 8½′	6 x 7" x 8½′	7 x 7" x 8½′	7 x 7" x 8½′

No. 3.

Pole		Squared	
Sawed	Hewed	Sawed	Hewed
5 x 6" x 8½′	5 x 6" x 8½′	6 x 6" x 8½′	6 x 6" x 8½′

* Bulletin 118, Forest Service.

THE VOLUME TABLE, GIVING AVERAGE NUMBER OF POLE TIES (8.5 feet long by 7 by 9 inches) IN TREES OF DIFFERENT HEIGHTS AND DIAMETERS.

D. B. H. Inches	Height in Feet					
	50	60	70	80	90	100
	Number of Ties per Tree					
10	....	0.7	0.9	1.1	1.2	1.2
11	0.8	1.1	1.3	1.5	1.7	1.8
12	1.3	1.7	2.0	2.3	2.5	2.7
13	1.8	2.3	2.7	3.1	3.5	3.7
14	2.3	2.9	3.4	3.9	4.3	4.5
15	2.7	3.4	4.1	4.7	5.1	5.4
16	2.7	3.5	4.3	5.0	5.6	6.0
17	2.8	3.7	4.6	5.4	6.0	6.4
18	2.8	3.8	4.8	5.7	6.3	6.7
19	2.9	3.9	4.9	5.8	6.5	6.9
20	2.9	4.1	5.1	5.9	6.6	7.1

From Bulletin 10-B, Tennessee Geological Survey.

TROLLEY TIES.

The usual sizes of trolley ties are 6 x 8″ x 8′, 6 x 7″ x 8′, and 6 x 6″ x 8′

The following table gives the number of ties which can be cut from trees of various diameters and heights and the excess of top wood in cubic feet:

The Volume Table, giving Average Number of Ties (8 feet long by 6 by 8 inches) from Trees of Different Heights and Diameters.

Diameter Breast-high	Height in Feet									
	50		60		70		80		90	
	Volume									
	Ties	Top-wood*	Ties	Top-wood	Ties	Top-wood	Ties	Top-wood	Ties	Top-wood
Inches	No.	Cu.Ft.	No.	Cu.Ft.	No.	Cu.Ft.	No.	Cu.Ft.	No.	Cu.Ft.
10	1	9.0	1	10.3	1	11.1	1	10.5	3	9.5
11	1	8.2	1	9.6	2	10.7	2	10.4	4	9.8
12	2	7.5	2	9.0	3	10.4	3	10.3	4	10.1
13	3	6.9	3	8.3	3	9.7	4	10.0	5	10.2
14	3	6.2	3	7.8	5	9.4	5	10.0	8	10.3
15	5	6.1	5	7.6	5	9.3	6	10.0	9	10.7
16	6	6.0	6	7.2	7	9.1	7	10.2	9	11.2
17	....	....	6	6.7	8	9.0	8	10.7	10	12.7
18	....	....	7	5.9	8	9.2	9	11.5	11	13.5
19	....	....	7	5.6	8	9.2	10	12.1	12	15.3
20	....	....	8	5.1	10	9.9	11	13.5	13	17.3
21	....	....	9	5.1	10	10.3	11	14.7	14	19.4
22	....	....	11	4.5	10	10.9	14	16.8	17	21.8
23	....	....	12	4.4	12	11.8	14	18.8	17	25.2
24	....	....	12	4.7	13	13.2	15	21.6	19	29.1
25	....	....	15	4.9	15	14.8	18	24.4	21	34.0

* Topwood down to a diameter of 2 inches.
From U. S. Forest Service, Bulletin 96.

MINE TIES.

Chestnut mine ties may be either flat or round, although chestnut is not favored for the latter. Round ties are notched, the notches being 4 inches wide. These bring about 9 cents delivered.

Both the dimensions and prices for flat ties vary considerably. One thousand ties weigh about 20 tons, and 100 will make a good load for two horses. From 1,000 to 2,000, depending upon size, may be placed in a box car.

The usual sizes are:

6 x 6″ x 6′
5 x 5″ x 6′
6 x 6″ x 5½′
5 x 6″ x 5½′
5 x 5″ x 5½′
4 x 6″ x 5½′
4 x 5″ x 5½′
4 x 4″ x 5½′
3 x 5″ x 5½′
3 x 4″ x 5½′
5 x 5″ x 5′
4 x 5″ x 5′
3 x 4″ x 5′

CHESTNUT FOR CORDWOOD.

Chestnut cordwood is used chiefly in the manufacture of tannin extract and charcoal; also to some extent for fuel.

Tannin Extract.

There are at present between fifteen and twenty establishments in the United States manufacturing tannin extract from chestnut wood. A number of these are located in Pennsylvania.

Chestnut wood contains a higher percentage of tannin than does the bark, differing in this respect from oak and hemlock, the bark of which contains more tannin than the wood. For this reason chestnut wood is used extensively in the manufacture of tannin extract. Some of the extract plants in Pennsylvania use chestnut wood almost exclusively.

Old chestnut wood is richer in tannin than wood from young chestnut trees. Analyses show that there is a higher percentage of tannin in the butt of a tree than in its top; also a higher percentage in dead than in living wood. Chestnut extract wood in the Southern states is largely old or of first growth, and is more profitable in the manufacture of tannin extract than is our Northern or second-growth chestnut, such as is found largely in this State. For this reason the largest and the most profitable extract plants are located in the Southern states.

Chestnut blight does not seem to decrease the per cent. of tannin in the wood. Extract plants accept blighted chestnut as readily as unblighted, or sound wood. The light-colored extract derived from our Northern chestnut is preferred by some tanners to the dark-colored extract made from Southern chestnut.

SPECIFICATIONS OF EXTRACT WOOD.

Extract wood is purchased either by the standard cord (4 x 4 x 8′ or 128 cubic feet) or the long cord (5 x 4 x 8′ or 160 cubic feet). A cord of 128 cubic feet contains approximately 90 cubic feet of solid wood and 38 cubic feet of air space. A cord of 160 cubic feet contains approximately 128 cubic feet of solid wood. Split wood from large trees is preferred, but extract plants will accept chestnut sticks that are not less than 4 inches in diameter at the small end. A cord of 128 cubic feet usually sells for from $2.50 to $3.00 on board cars at shipping point, and from $3.00 to $3.50 a cord of 160 cubic feet. Wood with the bark on is as readily accepted as wood that has been peeled.

CHESTNUT WOOD FOR CHARCOAL.

Chestnut cordwood is used to some extent in the manufacture of charcoal. It may be used pure, or in mixture with other woods. There are two general methods of manufacturing charcoal—the kiln process and the retort process.

Charcoal is used in a number of industries, among which are glass plants and iron furnaces. Considerable quantities are used by railroads for cooking in dining cars, and it is also used to some extent in restaurants.

CHESTNUT WOOD FOR FUEL.

This wood is not very desirable for use in open fireplaces, because of its tendency to throw out sparks. Its heating value is less than oak or hickory, and where these woods are available, chestnut is used very little. It produces an excellent kindling wood, and is used to some extent for this purpose, in mixture with other woods. In certain parts of the State large quantities of chestnut are used in burning limestone. Because of its rather mild heat, it is used for tempering glass, and is particularly desirable for annealing brass, being for this purpose better than any of our other woods. Some iron furnaces use small quantities each year for kindling fires.

SPECIAL TARIFF ON BLIGHTED CHESTNUT CORDWOOD.

The Pennsylvania Railroad has issued a special tariff on blighted chestnut cordwood which will aid timber owners in marketing this cordwood at a profit. The minimum rate in this tariff is 35 cents, and the maximum $1.00 per ton. This rate can be applied only upon shipments of cordwood entirely within the state.

PENNSYLVANIA RAILROAD COMPANY

NORTHERN CENTRAL RAILWAY COMPANY
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY

LOCAL FREIGHT TARIFF

—ON—

BLIGHTED CHESTNUT CORD WOOD

CARLOADS

—TO AND FROM—

ALL STATIONS ON PENNSYLVANIA RAILROAD

EXCEPT BRADFORD, EAST BRADFORD AND MARTIN'S CREEK, PA.

IN STATE OF PENNSYLVANIA

Governed, except as otherwise provided herein, by the Official Classification, I. C. C.—O. C. No. 38 (F. S. Holbrook, Agent), supplements thereto and reissues thereof; and by Exceptions to said Classification, G. O.—I. C. C. No. 3774, supplements thereto and reissues thereof.

TABLE OF RATES.

The following rates will be applied to and from stations on the Pennsylvania Railroad, as provided on this page, for movement wholly within the State of Pennsylvania, and lists of stations and mileages will be ascertained by reference to G. O.—I. C. C. No. 3800 (G. O. No. 402), supplements thereto and reissues thereof.

MILES	RATES
1 to 70 inclusive	35 cents per 2000 pounds.
71 to 80 "	40 " " " "
81 to 90 "	45 " " " "
91 to 100 "	50 " " " "
101 to 110 "	55 " " " "
111 to 120 "	60 " " " "
121 to 130 "	65 " " " "
131 to 140 "	70 " " " "
141 to 150 "	75 " " " "
151 to 160 "	80 " " " "
161 to 170 "	85 " " " "
171 to 180 "	90 " " " "
181 to 190 "	95 " " " "
191 to 272 "	100 " " " "

This tariff has not been filed with the Interstate Commerce Commission, as it is intended to be applied only on traffic entirely within the State of Pennsylvania, and the rates contained herein must not be used to or from any junction points with connecting lines.

ISSUED JUNE 19, 1912, BY **GEO. D. OGDEN,** EFFECTIVE JUNE 19, 1912

General Freight Agent,
Philadelphia, Pa.

[OVER]

RULES GOVERNING THE TARIFF.

CERTIFICATE OF INSPECTION.

With the forwarding of the first shipment the shipper will file with the agent a certificate, such as provided for below, which certificate may be used for subsequent shipments by the same shipper up to and including the number of cords of wood covered by such certificate, record of which will be indicated on the certificate as each shipment offers, showing waybill reference, car number or numbers, number of cords and destination of each shipment.

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 I have examined................cords of chestnut wood on the property owned by............................at.......................................
and have found the same to be infected with Chestnut Blight, caused by the fungus Diaporthe parasitica, and entitled to be shipped as blighted chestnut wood.

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

...........................Inspector,

For the Chestnut Tree Blight Commission.

Shipped........................cords of the above-mentioned wood in car......................

Shipped......................cords of the above-mentioned wood in car......................

(Signed)

....Station Agent.

CHESTNUT FOR FENCING.

Chestnut is the post-and-rail timber of Pennsylvania. Chestnut posts are either round, hewn on one side, rough-split, split and hewn, or they may be sawed. Rails may be used round, but are usually split. Posts intended for wire or board fences are used solid, while posts for rail fences are usually mortised, each post containing from two to five holes, to receive the ends of rails.

COST OF MANUFACTURE.

The cost of making fence posts depends on the size of chestnut timber, and the labor. Rails are 11 feet long, usually split and pointed at both ends, when used in mortised posts.

FACTS ABOUT POSTS; THE RESULT OF INVESTIGATION.

Chestnut posts in actual use, when compared with good quality of white-oak posts, used under the same conditions, show a higher per cent. of durability than the best white oak.

A large post usually lasts longer than a small one of the same wood.

Decay proceeds with equal rapidity whether the post is set with the large end down, in the position the tree grew, or reversed, with the small end down. Therefore, the larger or sounder end should receive preference.

In stiff clay soil the posts rot principally just beneath the top of the ground, and in the porous sandy or gravelly soil they usually rot from the top of the soil all the way down; the effect is the same in both cases.

In soil that is full of water all the time, posts will last longer. It is the alternating between wet and dry that causes decay.

It seems that seasoning has little effect on the durability.

TABLE SHOWING NUMBER OF HEWED AND ROUND POSTS OBTAINABLE FROM FOREST-GROWN CHESTNUT TIMBER.

DIAMETER BREAST-HIGH	NUMBER OF 7-FOOT CUTS	NUMBER OF POSTS		TOTAL NUMBER OF POSTS
		SPLIT	ROUND	
7	1	....	1	1
8	1	....	1	1
9	2	....	2	2
10	3	2	2	4
11	5	4	3	7
12	5	8	2	10
13	6	11	2	13
14	7	15	2	17
15	8	20	2	22
16	9	24	2	26
17	10	28	2	30
18	10	33	1	34
19	11	37	1	38
20	11	42	1	43
21	11	46	1	47

NOTE.—Data compiled from actual measurements of 150 trees.

CHESTNUT FOR SLACK COOPERAGE.

STAVES.

Chestnut is manufactured into slack cooperage stock for the manufacture of barrels and kegs, to hold such commodities as nails, lime, cement, fruit, etc. For staves it is particularly desirable. It is sometimes cut into hoops. Timber which is four inches in diameter and up may be used, and that from six to ten inches is preferable. Large, loose knots only are objectionable.

Stave timber is either cut in the woods into small logs or bolts, which have approximately the same length as the staves to be cut from them, or it may be brought in as long logs and sawed into these lengths at the mill. Nail-keg staves are 18 inches long and 3 to 5 inches wide, while barrel staves are 28 inches long and about the same width. Bolts for keg staves are 19 inches and up in length, and those for barrels about 30 inches. Keg staves are packed in bundles of 100 for shipment, and barrel staves in bundles of 50.

The cost of a stave mill of 12,000 daily capacity of ten hours is from $1,500 to $1,750. To operate such a mill requires seven or eight men, only three of which need to be skilled. A power plant which will develop 25 horsepower is required.

A cord of 160 cubic feet will produce 2,000 keg staves.

Timber which will produce 1,000 board feet will make 5,000 keg staves, and approximately 2,500 barrel staves. One cord of bolts, with the bark, will make 1,000, or, without the bark, 1,200 barrel staves.

Heading.

An ordinary slack cooperage barrel has a head diameter of 17 inches. Chestnut which is of sufficient size is very suitable for this purpose.

Hoops.

Some chestnut was used for hoops in 1907, but none was reported as being used for this purpose in 1909. This may be attributed to the fact that wire hoops have to a large extent replaced wooden hoops in slack cooperage.

CHESTNUT FOR SHINGLES.

Chestnut shingles may be split or sawed. Owing to the scarcity of good quality straight-grained chestnut, and to the development of shingle-sawing machinery, split shingles have fallen into disuse. Sawn chestnut shingles are usually 4 inches wide, $\frac{1}{16}$ inch thick at small end, $\frac{1}{2}$ inch thick at the butt end, 16, 18 or 24 inches in length They are usually sold in bundles containing 250 shingles. Four bundles, or one thousand shingles, will lay about one "square." A square is 10 feet on each side, or 100 square feet. Shingles are laid about one-third to the weather.

Durability.

No. 1 chestnut shingles on a roof of $\frac{1}{3}$ pitch or more should last about twenty years. Chestnut shingles are inclined to leak after a short time, around the nails, due to the corroding action of the tannin in the wood upon the iron in the nail. No. 1 chestnut shingles are next in durability to No. 1 white pine or to cedar shingles.

Quality of Timber.

Chestnut for shingles is sawn into bolts or blocks the exact length of the shingles to be made. For this reason shingles may be cut from chestnut which is too crooked or too short for lumber or poles, so long as the wood is reasonably clear of defects.

TO FIND THE VOLUME OF STANDING TREES.

A "rule of thumb" for estimating tall, sound trees by the Doyle rule is as follows: Volume in board feet equals $\frac{3}{2}$ of the square of the diameter, breast high; for example, a tree 20 inches in diameter, breast high, contains 600 feet board measure.

A more accurate rule is as follows: From the diameter of the log in inches (at the top inside bark), substract 4 for the slabs; then multiply the remainder by half itself and the product by the length of the log, in feet, and divide the result by 8.

Volume in Board Feet of Chestnut by the Doyle-Scribner Rule, Southern Appalachian Region.

D. B. H. Inches	Height of Tree in Feet					
	50	60	70	80	90	100
	Volume in Board Feet					
12	30	35	40	50	55	65
13	35	45	55	60	75	85
14	45	55	65	75	90	100
15	55	65	75	90	105	120
16	65	80	90	105	125	145
17	80	95	110	125	145	170
18	95	110	125	145	165	195
19	110	125	145	165	190	225
20	125	145	165	185	215	255
21	145	165	190	210	240	290
22	165	185	210	235	270	325
23	185	205	235	260	305	360
24	205	230	260	290	340	400
25	225	255	285	320	380	440
26	250	280	315	335	420	485
27	275	305	345	395	460	530
28	300	335	380	435	505	580
29	320	360	410	480	555	630
30	345	390	445	520	600	685
31	370	420	480	565	650	745
32	390	450	520	605	700	810
33			555	640	755	875
34				680	805	940
35				715	860	1010
36				750	910	1080

U. S. Forest Service, Bulletin 36.

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

1112 MORRIS BUILDING
PHILADELPHIA

BULLETIN No. 7 DECEMBER, 1913

The Morphology and Life History

OF THE

Chestnut Blight Fungus

By PAUL J. ANDERSON, Field Pathologist

HARRISBURG, PA.:
WM. STANLEY RAY, STATE PRINTER
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Pennsylvania Chestnut Tree Blight Commission

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The Morphology and Life History of the Chestnut Blight Fungus

By PAUL J. ANDERSON, Field Pathologist

Penn'a. Chestnut Tree Blight Commission

INTRODUCTION.

Considering that it has been only seven years since the first article on chestnut blight was published, the amount of literature on the subject is becoming extensive. Eighty-five of the principal contributions are given in the bibliography at the close of this bulletin, but none of these give us more than the briefest facts concerning the development and morphology of the producing organism, *Endothia parasitica* (Murr) And. To be sure, various authors have given such superficial facts as the size, shape, and color of the spores, asci and perithecia, the general times of years at which they occur, the macroscopic appearance of the stromata, spore horns and "fans;" the behavior of the organism in culture has been pretty well covered by Murrill (2, 3, 4), Pantanelli (34,89) and Clinton (83); inoculation experiments are recorded by Murrill (2, 3), Clinton (83), Rankin (101) and the writer (81). Interesting facts and observations have been added by many others but we know of no one who has made a detailed study of the life history and morphology. The necessity of this study is readily apparent; until such study is made we are dealing with an unknown enemy, our control measures are guess work and their success a matter of chance. The writer has not exhausted the subject by any means in the work which is recorded in the following pages. He presents the facts discovered with the hope that they may be of assistance to others who are working on this phase. The matter is presented under the heads of Spores, Mycelium, Pycnidia, Stromata and Perithecia, not because these all represent distinct stages and because they do not overlap, but because he finds it more convenient to group the facts about these heads.

The writer is under great obligations to Professors Whetzel and Reddick of Cornell University, Messrs. Detwiler, Carleton and Heald, officers of the Pennsylvania Chestnut Blight Commission, Messrs. Babcock, Kirk, Gates and Keefer, who have assisted him especially in the laboratory, and to a host of others who have sent specimens and given valuable aid and suggestions.

SPORES.

Like most other Ascomycetes, this fungus produces two kinds of spores: (1) pycnospores, otherwise known as conidia, conidiospores, asexual spores or summer spores and (2) ascospores, which are also called the winter spores or perfect or sexual spores. These will be treated below in the order named.

PYCNOSPORES.

On active young cankers during the spring, summer and autumn, slender, curling, yellow tendrils are especially abundant shortly after rain periods. If one of these "spore-horns" is put in water, it swells up and then apparently dissolves, but if a drop of this water is placed under the microscope, it will be found to contain millions of minute, hyaline bodies—the pycnospores.

Morphology. Murrill (4) who first described the species, gives their size as 1 x 2-3 microns, Clinton (92:367) as .75 x 2.5-4 microns, Pantanelli (89) as 1.7 x 3.8 microns. The writer made two hundred measurements of pycnospores from spore horns and got an average of 1.28 x 3.56 microns. An equal number of measurements was made of pycnospores produced in pure culture on oat agar and also of pycnospores from superficial pycnidia on wood, but the difference in size was found to be negligible. Their shape is shown in figure 52, being oblong of cylindrical with rounded ends, or slightly oval. As a rule they are straight, although occasionally slightly curved. Dr. Mickleborough's curved figures (19) are evidently exaggerated; they remind us more of the spores of a species of Naemospora which grows on the chestnut and the spore horns of which cannot always be distinguished macroscopically from those of *Endothia parasitica.* Although the tendrils of the latter species are bright yellow, the spores themselves, as seen under the microscope, are quite hyaline. This color is due to a pigment which is evenly diffused in the spore, or more likely the spore wall, and can be noticed only when there is a mass of them together. The pigment is the same as is found in the hyphae and will be discussed under the head of mycelium.

The wall of the resting spore is extremely thin and is not readily differentiated by staining. No markings, germ pores or layers can be detected. The spore is densely filled with protoplasm which is homogeneous; only occasionally are oil globules or vacuoles seen in the resting spore. By staining it can be determined that each spore contains a single small nucleus, which is elongated in the direction of the long axis of the spore. It usually lies close to the wall, about equi-distant from the ends, but may be almost in the end. It is shown at the center of figure 14. With carbol fuchsin, and various other stains, a single body in each end of the spore stains very deeply. The significance of these polar bodies is uncertain. They cannot be located after germination and it is conceivable that they are used up in the enormous growth of the spore during that process. The outside of the spore is covered with a mucilaginous, sticky coat which is hard when dry and holds the spores together in the characteristic brittle "horns," but, on wetting with water, it first swells and then apparently dissolves and the spores float away free from each other. The mucilage of the spore horns is however, insoluble in alcohol.

Germination. Unlike the ascospores, the pycnospores do not germinate in cultures in water. Tap water, rain water, spring water and distilled water have been tried without success except that a slight and uncertain germination was secured in rain water. A small percentage of the spores germinated in water made slightly acid with sulphuric acid. A large number of media have been tried but mostly with disappointing results. Entirely successful germination was secured, however, in a decoction made by boiling chestnut bark in water, filtering and then sterilizing the filtrate in the autoclave. With this solution, a percentage of over eighty has been uniformly secured, and it has therefore been used almost exclusively in tests for longevity, vitality, etc. This suggests that there is some soluble substance in the bark of the chestnut tree that is necessary for their germination. In order to see if this substance is peculiar to the chestnut, sterilized twigs of the chestnut, red oak, white oak, black oak, sour gum, sumach, hickory, walnut, red maple and yellow poplar were sterilized in test tubes, and then washed with a suspension of pycnospores. From the fact that they germinated and produced the characteristic mycelium on all of these species, it is certain that the substance needed for germination is not peculiar to the chestnut tree, and that a spore would germinate just as readily if it fell into a wound of a sour gum or any of the other trees as it would on a chestnut. It is also significant that they will germinate perfectly in potato agar and most any of the ordinary nutrient agars. To determine whether they would germinate in the humus about the base of the trees if washed down into it by the rain, twelve petri dishes of sterilized humus were inoculated by spraying pycnospores over them. Not only did they germinate, but the mycelium grew and produced typical pycnidia on this medium. Tannin also is apparently not essential to germination because they germinate readily in media which are free from this substance.

Two methods of artificial germination have been used. In the first, a slide is supported on two glass rods in a petri dish as a moist chamber, and a drop of the bark decoction containing a suspension of the spores placed on the center of the slide. In the second method a film of pycnospores in water is spread on a sterile cover glass and permitted to air dry. It is then covered with a drop of potato agar or some other nutrient agar and inverted over a Van Tieghem cell. This second method was used when it was desired to study the process of germination because it offered the advantages of keeping the spores stationary, and at the same time they could be put under the immersion lens.

The time required for germination varies widely with the temperature. Fulton (48:52) says: "Conidia germinate best at a temperature of 60 degrees F. and distinctly less rapidly at temperatures 10 degrees below or above that point." The writer, on the other hand, secured the most rapid germination at 89 degrees F., the shortest time secured for the appearance of germ tubes being twelve hours. At temperatures ranging from 60 to 75 degrees F., germination occurs in from 18 to 36 hours. At lower temperatures it often requires four or five days. No effort was made to find the exact maximum and minimum temperatures. Some experiments by D. C. Babcock in our laboratories indicate also that light hinders germination. From the data given, it appears that the very warm periods of the summer are most favorable for infection by pycnospores. That winter conditions are not favorable is indicated by the following experiment: At the beginning of every month during the last year, twenty-five or more inoculations in healthy chestnut trees have been made with conidia. At the present time, (June 15, 1913), none of those made after September or before April show any signs of producing cankers. Cankers are appearing about the inoculations made in April. Apparently then, infection will not necessarily result even if conidia do gain access to wounds during the winter.

The process of germination is preceded by an enormous swelling of the spores. This swelling begins in fifteen to twenty hours after they are placed in neat bouillon agar, and is then very rapid until the germ tube is pushed out. As previously stated, a mature spore measures about 1.28 x 3.56 microns. At the end of 18 hours, 50 spores which were just on the point of pushing out germ tubes, gave an average of 6.86 x 10.53 microns. The largest one observed was 9.05 x 14.48 microns. The volume of the spore just before germination is thus more than eighty-five times that of the resting spore. This increase in size is shown in figure 38, at the center of which are a number of resting spores. The various shapes assumed by the germinating spores will also be observed here. They may become cylindrical, oblong, elliptical, isodiametric, ovate, pyriform, reniform or dumb-bell shaped. in which latter case they resemble ascospores. The contents become coarsely granular, and often large vacuoles are seen, due to the rapid swelling. The first indication of a germ tube is a small protrusion or pimple at one end which rapidly increases in length. So far as observed, the tubes are always at the ends of the spores. A few hours after the beginning of the first tube, another one starts at the other end of the spore. Only very rarely do both start at once. The rate of growth, size of the tubes and order of the laying down of the septa are brought out by the series of camera lucida drawings of single spores at short intervals reproduced in figures 39 and 40. This is an average growth in potato agar in Van Tieghem cells at 21-26 degrees C. The pycnospores generally produce two germ tubes. Very rarely a third one comes out laterally. From three to six hours after germination starts, the first septum appears in the tube and other septa are laid down often enough after that to make the cells of the mycelium 4-10 times as long as broad. As the germ tube lengthens, the cells composing it increase in diameter but the septa, being solid plates, do not increase in size correspondingly; hence the constrictions at the septa which become more marked as the mycelium becomes older (Fig. 8). Sometimes a septum divides the spore during this process. After a time it is difficult to locate the old spore since the first cells of the germ tube become exactly like it, and it is now merely one of the cells of the hypha. The branching of the germ tube is shown in the figure just referred to.

The swelling of the spores is due not merely to a mechanical imbibition of water; it is really a process of growth. To be sure, dead spores will swell, but only to about half the size acquired by living spores. Pycnospores, stained just before the germ tube is pushed out, show that the increase in size is accompanied by active nuclear division. Even at this time, two to six nuclei, rather larger than the original nucleus, may be made out. Also the polar bodies have disappeared and the protoplasm is not dense. The nuclei push out into the germ tube almost as soon as it starts. The wall in the meantime has increased in thickness until it almost equals the diameter of the resting spore and is quite distinct in stained sections. A germinating spore is shown in optical section in figure 13.

Vitality. All experiments up to the present indicate a remarkable vitality of the summer spores. Reasoning from analogy to what is known or believed of the imperfect spores of most fungi, one would not expect them to survive winter conditions. But the case is quite the contrary. During every month of the past winter pycnospores were taken from the woods, (a) from spore horns, (b) from pycnidia imbedded in the stromata and (c) from superficial pycnidia on bare wood and tested for germination in bark decoction. The percentage of spores which germinated ranged between 54 and 71 per cent., being only slightly lower than that of fresh conidia in culture, and showing only slight variation for the months. Apparently, then, weather conditions such as we have had in Pennsylvania during the past winter, have very little if any effect on their vitality. Heald and Gardner (93) also found that freezing does not affect the vitality of the pycnospores. Tests made at various times during the summer of 1912 show also that the hot and dry weather of summer does not affect their vitality. Three series of tests were conducted to determine their longevity. In the first series, spore horns were detached from the bark and stored in open vials in the laboratory. At the end of each month, sterile twigs have been inoculated with the spore horns. Every test has been successful, including the last, which was at the end of one year. In the second series the spore horns were left attached to the bark, which was kept dry in the laboratory, and germination tests made in decoction as given above. The last test—at the end of 11 months and 15 days—gave a germination of 65 per cent. In the third series, pycnidia in the bark were stored. This series has been running only eight months; the last test gave a germination of 40 per cent. All these series are being continued and there is little doubt that they will retain their vitality much longer than a year since very little decrease in the percentage has been noticed. On the other hand, if the conidia are separated by dissolving the spore horn in water and then dried, they do not retain their vitality very long. The writer has not seen them germinate when kept in this condition longer than one month, but more experiments are necessary.

Inoculation experiments with conidia are described in detail by the writer and Babcock in Bulletin 3 of the Pennsylvania Chestnut Tree Blight Commission. In general it has been proved that almost any kind of a wound in the bark may be infected with pycnospores, whether they are introduced dry or suspended in water.

ASCOSPORES.

On older cankers, as shown in figure 46, the mature stromata are beset with projecting papillae. The black speck at the apex of each papilla is the opening of a little flask in which the winter spores are produced.

Morphology. The shape of the spores is shown in figure 37, being oblong to oval with rounded or more or less blunt pointed ends, 2-celled and constricted at the septum when mature. Clinton (92:368) in Connecticut, evidently does not consider the constriction as constant. His photomicrographs however—as they have been reproduced in his plate XXVIII—show beautifully constricted spores. They are quite hyaline both as seen under the microscope and when seen in mass. Murrill (4) gives their size as 9-10 x 4-5 microns, Pantanelli (89-73) the same as Murrill, Clinton (92:368), says they vary from 6-10 x 2.75-5 microns and average (92:427) 7.45 3.2 microns, based on the measurement of one hundred spores. His measurements are the smallest of any we have seen. The average of one hundred and forty measurements made by H. W. Anderson and reported in Bulletin 4 of the Pennsylvania Chestnut Blight Commission, was 8.53 x 4.49 microns. These were from points in Pennsylvania. In the same bulletin seventy-five measurements of ascospores made by Rankin in New York are reported and give an average of 8.8 x 4.4 microns. One hundred measurements of spores from points in Pennsylvania and Maryland more recently made by the writer gave 8.68 x 4.51 microns as the average.

The walls are thicker than those of the pycnospores and are also more resistant to chemicals. With strong sulphuric acid they may be made to swell until their thickness often equals the diameter of the contents but they do not dissolve. This treatment shows no stratification of the walls and no germ pores or markings of any kind. The septum is also swollen greatly by this reagent; in fact, in none of its reactions does it seem to differ from the wall, and it is evidently of the same composition. It is a true septum and not merely a dividing line between the protoplasts. This fact was particularly noticed because Saccardo in his description of the genus Endothia intimates that it is a false septum, and also because it differs in this respect from the long-spored southern Endothia, as reported by H. W. Anderson before the American Phytopathological Society in January, 1913.

The spore is densely filled with homogeneous protoplasm. Only occasionally have anything like oil globules or vacuoles been seen. The writer has not found the large globules (or vacuoles), represented in Murrill's figures (4), to be common. Chemical tests have shown no glycogen or other storage products except proteids. As shown in figure 37, each cell of the spore contains two or four nuclei; occasionally there is one or three, and in some cases the number is not the same in both ends of the spore; more than four in one cell have not been found. The nuclei are best brought out by staining with iron-alum haematoxylin. The ascospores, like the pycnospores are sticky and adhere with great tenacity to any object with which they come in contact. The nature of the sticky covering has not been exactly determined, but it is conceivable that it is due to the matrix of epiplasm in which the spores lie while in the ascus.

Germination. They readily germinate in tap water, spring water, rain water or any of the ordinary media used for this purpose. A higher percentage was secured in chestnut bark decoction, however, than in pure water but as a rule more than ninety percent germinate even in water. They germinate as soon as mature without a period of rest. Spores were produced in September from inoculations made the previous June, and as soon as mature, were tested and gave a good percentage of germination. The same methods for artificial germination were used as were described in treating of the pycnospores.

The time required is much shorter than for pycnospores. At room temperatures they push out a tube in from six to twelve hours. The shortest time secured was one hour and twenty-five minutes after ejection from the perithecium. As for the effect of temperature on germination, Fulton (48:52) says: "Ascospores germinate best at a temperature of about 70 degrees F., but a good percentage of germination occurs at 85 degrees and 45 degrees F. Even at 38 degrees F. the germination of ascospores was 25 per cent in 24 hours and reached 70 per cent in three days."

Like the pycnospores they swell before germination, but not to such an extent. The resting ascospore measures approximately 4.5 x 8.5 microns. Fifty spores measured after ten hours in nutrient agar averaged 7.27 x 13.84 microns—representing an increase of about four times the volume of the resting spore. The largest one was 17.2 x 9.05 microns. During the swelling the shape remains practically the same except that the sinus becomes deeper. The first germ tube usually appears at the end, but this is not always the case—sometimes it is lateral. The second tube to appear is in the other cell; this is generally followed by a second one from each of the cells, making a total of four germ tubes, which is the rule for the ascospores of this species. Their order of appearance, size, manner of septation and branching is best explained by reference to the successive camera lucida drawings of single spores in figures 41 and 42. The germ tubes from the ascospores grow much more vigorously than those from the pycnospores. By sowing ascospores on chestnut bark agar, in summer weather, mature pycnidia have been produced in five days. The early and rapid development of the mycelium from the ascospores is probably due to the larger amount of food material available in the spores.

During germination the contents of the spore becomes granular and vacuoles often appear. The nuclear behavior is the same as that of the conidia described above.

Vitality. So far as has been determined, weather conditions have no effect whatever, on the vitality of the ascospores. During every month for the last year they have been collected from the woods and tested, but the differences in the percentage of germination for the months have been entirely negligible. Their longevity is indicated by the following two series of experiments: In the first series, ascospores ejected from the perithecia were caught on glass slides and then stored and tested every two weeks for germination by covering them with a drop of water. They continued to germinate for five months and six days. After that they would not germinate. In the second series, bark containing mature perithecia was stored in the laboratory and tested every month. The last test—at the end of approximately twelve months—gave a germination of above 90 per cent. There is no doubt that this experiment will give a much longer record, since they germinate almost as well now as they did a year ago. These experiments also show that the spores will live much longer when they remain in the perithecium than if they are ejected and free from each other. These tests of course, indicate only the time they would retain their vitality if they were kept dry. If, on the other hand, they were in a moist place, they would germinate at once and unless they gained entrance to their proper host or possibly, some suitable substratum for a saprophytic existence, they would die without causing any damage.

The results of a large number of inoculation experiments are given by the writer and Babcock in Bulletin 3 of the Pennsylvania Chestnut Tree Blight Commission. In general, the same thing may be said of them as was said of the pycnospores; any kind of a wound in the bark deeper than the cork layer may be readily infected either by dry ascospores or with ascospores in suspension in water. In fact, there seems to be very little difference in the ability of the ascospores and pycnospores to produce the disease on the trees.

MYCELIUM.

This is the absorbing system of the fungus. It consists of millions of fine branching threads—the hyphae—which grow into the living tissues of the bark and sap wood, killing and digesting them in its progress round the tree. It is thus the immediate agent in producing the canker and ultimately killing the tree.

In culture. The beginning of the mycelium is the germ tube; the mature mycelium with its millions of hyphae is produced simply by the continued elongation and branching of the germ tube. In all essential points it is alike, whether produced from an ascospore or a pycnospore. A few hours after the germ tube starts it begins to divide into cells by laying down septa. (See figures 38-42.) Shortly afterwards, branches are pushed out from these cells and these in turn become septate and give off branches until a thick tangle of filaments is produced. These processes, so readily followed in the simple germ tube, are in all essentials the same in the later growth of the mycelium. Branching is nearly always preceded by septation; it is always monopodial and it is very rarely that more than one branch is produced from a single cell. The sinus at the septum, seen in the younger mycelium, is less distinct in older hyphae. The manner of branching is shown in figure 8. The individual hyphal cell is best studied in agar culture although it shows some slight differences from the cell in the bark, as will be explained later. The diameter of the hypha in agar culture varies from 2 to 12 microns, and the length of the cells from 20 to 50 microns. The apical cells have very dense protoplasm, but, further back in the hyphae, large vacuoles appear, as shown in figure 8. The protoplasm is not homogeneous but shows larg granules and certain refractive bodies. The wall is very thin and easily collapses when dried. Each cell contains several small nuclei as shown in the figure.

The yellow pigment. The mycelium grows luxuriantly on a large number of artificial media. Cultural studies have been reported in detail by Murrill (2) and Clinton (83). Results secured by the writer largely duplicate theirs, and will not be recorded here. For ordinary purposes the writer has used potato agar. On this medium, at the end of from four to six days the mycelium begins to turn yellow, due to the production of a pigment in the cells. The same pigment gives the characteristic color to the spore horns and the stromata on the bark. It is apparently evenly diffused in the cells or cell walls. The writer has noticed that old agar cultures of the fungus often become purple or wine colored. Other experimenters have told him they have had the same experience and were at a loss to explain it. The connection between the purple color and the yellow pigment, as worked out by H. W. Anderson, is this: The pigment is yellow and insoluble when in an acid or neutral medium, but in an alkali medium is readily soluble and takes on a purple color. This can readily be demonstrated by pouring a solution of sodium hydroxide or any other alkali over the yellow mycelium. The fungus, in its growth on the agar, gradually causes it to become alkaline in character, and the pigment goes into solution and colors the medium purple. Pantanelli (34) says that the pigment is a lipochrome. Quite recently it was isolated and its chemical reactions determined in some detail by Cecil Thomas of Wabash College.* In this excellent piece of research, he shows that it does not resemble a lipochrome in any way except in color and solubility but that it is one of the colored compounds known chemically as the aurines. It is best isolated by extracting with alcohol and then precipitating with hydrochloric acid.

The fans. In order for the germ tube to gain access to the host tissue the spore must germinate in a wound. As reported in Bulletin 3 of the Pennsylvania Chestnut Tree Blight Commission, all attempts to produce infection without a wound have failed. The germ tube is not able to bore through the cork layer nor to enter through lenticels. Even if one secured an occasional infection without making a wound, it would be difficult to prove that the bark was free from small abrasions which had escaped the notice of the experimenter. But if germination takes place in fresh wounds, the germ tube will thrive on the injured and dead cells until it has produced a mass of mycelium. Then, gradually accumulating strength as it increases in size, the mycelium *en masse* pushes out through the living tissues of the bark.

*Master's Thesis. Publication of the Botanical Department of Wabash College.

Single threads do not seem to possess the power to penetrate alone among the living cells. Starting from a narrow point, the hyphae grow out in ray-like bundles, completely destroying the parenchyma and collenchyma and cambium cells as they go. All the rays starting from a single point are contiguous and they form a fan-like mat of mycelium as shown in figure 50. These fans are flat because they are not able to destroy the segmental bast zones but must squeeze between them. The edge of the fan is quite regular and is surrounded by a darker gelatinous band of the disintegrating host cells. Whether the cells are killed by a toxin secreted by the parasite or whether they are killed by the mechanical action of the mass of hyphae was not determined. The fans vary in length from one-eighth to three-quarters of an inch. The young ones, on the advancing edge, are pure white but as they become older they become light yellow or buff in color. This color, however, is not due to a development of pigment, since the pigment is never found in the fans; it is probably due to a decomposition product of the disintegrating host cells, which stains the mycelium. Each ray consists of a loose bundle of hyphae running almost parallel and branching only sparsely. They are much more uniform in diameter than the hyphae in agar culture. They are about 7 microns in diameter and are divided into cells about 30 microns long. They are not anastomosed in any way; a section of a ray showing their relation is represented in figure 9. The individual cells of the hyphae are densely filled with rather coarsely granular protoplasm. As the fans become older, however, the cells become vacuolate. Like most of the other cells of this fungus, they are multinucleate. The fans are produced only in the growing season. Although the canker spreads slowly in the winter, no white fresh fans are found in that season.

Rate of growth. The rate of growth of the mycelium under natural conditions on the tree can be measured by the increase in the size of the cankers. During the last twelve months, a large number of cankers have been outlined at the end of each month as shown in figure 49, and the averages computed for the months. Table I gives the increase in diameter during the last year. The increase in length—up and down the tree—is greater but not so important since it is not the growth in this direction that kills the tree. The table shows the effect of winter temperatures on the growth. The last winter in Pennsylvania, however, was exceptionally mild, especially the months of December and January.

Even the most rapid growth in the summer time—as indicated by the table—is less than one millimeter per day. But on artificial media, such as chestnut bark agar, the writer has often seen a growth of three millimeters per day. Also, in the dying bark after the tree is cut, the mycelium will spread at a much more rapid rate than when it is invading the bark of a healthy tree. In the latter case, it does not advance by producing fans but by individual strands.

TABLE 1.

Showing the monthly rate of growth of cankers. Transverse diameters of the cankers.

Month.	Number of cankers.	Average growth per month in centimeters.
June, 1912,	31	1.88
July, 1912,	200	2.78
August, 1912,	186	2.83
September, 1912,	140	1.85
October, 1912,	53	1.92
November, 1912,	27	0.00
December, 1912,	27	*1.35
January, 1913,	89	.51
February, 1913,	89	0.0
March, 1913,	84	.7
April, 1913,	21	1.1
May, 1913,	41	2.4

*Doubtful record. No growth at all on a large number of other trees examined.

Vitality. The mycelium, like the spores has a remarkable vitality. That it is not injured in the least by low temperatures in winter is proved by the fact that successful isolations were made from under the bark during every month of the last winter, and also by the vigor with which the canker resumes growth in the spring. To see if freezing would affect it when exposed while growing under artificial conditions, colonies were started on agar plates which when they were about one inch in diameter, were put out of doors and kept frozen up during the whole month of February which was the coldest month of the winter. When brought back into the laboratory, they resumed growth as vigorously as fresh colonies. Desiccation also has no detrimental effect, as shown by the following experiments: In the first one, bark was removed from a canker and stored under perfectly dry conditions in the laboratory. Isolations have been made each month and at present—at the end of ten months—the isolations are just as successful as when the experiment was started. The second was like the first except that diseased wood was stored instead of diseased bark. This has been in progress only six months, but the isolations are still successful. That a pile of bark or chips may be a source of infection for a long time on account of the mycelium is indicated by the following experiment: One year ago, some diseased logs were peeled and the bark thrown into piles. Isolations have been made from these heaps at the end of every month—being careful to avoid contaminations from spores of the fungus—and up to the present have been entirely successful. The writer has been unable to find any especially resistant cells in the hyphae which tide it over.

The mycelium also invades the sap-wood to a depth of about four or five rings. The hyphae are not different here except that they are smaller than in the bark and do not enter the wood as fans. They grow through and destroy the cells of the medullary rays and wood parenchyma to some extent, and are found in the vessels in abundance, but the walls of the latter are not affected by them.

PYCNIDIA.

The summer spores in all cases are produced in pycnidia. The stages in the development of this organ are most readily observed on artificial media, such as potato agar or chestnut bark agar. The process is the same whether it takes place on agar or under the cork layer of the tree or superficially on the exposed wood. But on agar it is more simple and more easily followed. It will therefore be taken up in detail as it occurs on artifical media, and then more briefly on the bark and on the wood, noting particularly the points in which they differ.

Development on artificial media. The first stages can be watched directly under the microscope in Van Tieghem cells. Cultures of pycnospores are made just as stated previously in describing the methods of artificial germination of these spores. At the end of twenty-four hours they are germinating, and in about four or five days, at summer temperatures, the beginnings of the pycnidia can be seen. They appear first where the weft of mycelium is the thickest but they are more easily followed if one finds them on more isolated branches. At certain points short cells are developed in the hyphae by laying down of new walls, thus dividing the old cells. The cells also increase in diameter and in the amount of cell contents. Each of these short cells now sends out stubby, septate branches, the cells of which in turn send out other branches. Such a stage is shown in figures 1 and 2. By the continued branching—or budding—of these cells, a tuft of hyphae is formed which reminds one of a witches' broom. This tuft seems also to exert an influence on the neighboring hyphae and the more distant branches of the same hypha, because they now grow toward it and mingle with its branches so that in another day or two, the mass of hyphae becomes so dense that a surface view no longer shows what is occurring. The little blocks of agar are then fixed in fixing solution, sectioned and stained to be studied in cross section. Figure 3 shows a cross section of a pycnidium grown in this way. It is merely a solid ball of hyphae densely intertwined but not grown together in any way by their lateral walls. The hyphae appear to be all alike in every particular, that is, there is no differentiation of wall cells and core cells.

The succeeding stages are best studied by the following method: A single culture is made at the center of an agar plate and permitted to grow until it has almost reached the edge of the plate. Beginning at the center, concentric rings of pycnidia are formed as shown in figure 51. Starting from the outermost, the pycnidia of each ring are one day younger than those of the next succeeding ring. This gives a perfect series of successive stages, from those which are so small that they can barely be seen with the naked eye to fully mature ones pushing out spore horns at the center of the plate. A perfectly flat cross section of one on the outer ring is given in figure 4 and shows that it corresponds to the stage observed in Van Tieghem cells and represented in figure 3. It is merely a solid tangle of undifferentiated hyphae. There is, as yet, no evidence of a cavity at the center. In the next older stage, figure 5, the hyphae begin to pull apart slightly and become loose at the center but are not otherwise differentiated. Those branches which extend into this loose area begin to lay down cross walls at regular intervals and as the cells, thus formed, become mature they are cut off successively from the ends of the hyphae and lie free in the cavity (Figure 57). These short cells are the first pycnospores. As all the branches projecting into the central area are cut up to make spores, the cavity is naturally enlarged. But other branches now push in from the surrounding hyphae and more spores are cut off from their apices until the cavity becomes densely filled with them. The size of the cavity increases then, first, by the constant cutting off of the branches and, second, on account of the increased pressure from within caused by the packing of the spores. Also the crowding for space by the new conidiophores would tend to distend the walls. This pressure from within causes the hyphae which are on the periphery to be crowded together and to form a sort of a wall. This wall layer is not so distinct in the pycnidia on agar because there is nothing on the outside to resist the pressure but in the pycnidia on the bark it is quite distinct. Also, the membranes of the wall cells become somewhat thicker at this time. A section from the wall in this stage, showing the relation of the conidiophores, is shown in figure 6. There is no ostiole whatever at this time but a little later the hyphae become loose at a point on the upper wall of the pycnidium and the spores are forced out through this by the pressure from within. The ostiole is thus formed by the same process as the cavity itself. It is very indefinite at first but as it becomes older and wider, it becomes surrounded by a more definite wall just like that of the cavity.

When fully mature, the cavity may be as much as a fourth of a millimeter in diameter. It is usually almost circular in cross section, but sometimes shows the convoluted form which will be described later as occurring in mature stromata on the bark. The conidiophores form a dense, brush-like fringe and extend directly out into the cavity from every point of the wall. They are of uneven lengths, the majority being 20-40 microns long and about 1.5 microns in diameter. Four of them are shown highly magnified in figure 7. In an unstained section, the septa of the conidiophores cannot be made out but, when properly stained with iron-alum haematoxylin and erythrosin, the septa show up very plainly as unstained lines across the sporophore. It will be seen that almost the whole length of the conidiophores is divided into regular cells, each of which contains a single nucleus. As the cells become mature, they break off successively as conidia. Just how many break off from a single conidiophores was not determined. The majority of them are simple, but branched conidiophores, as shown in figure 7, are not uncommon. But they are never so frequent or so much branched in this type of pycnidium as in the types to be discussed later. In the older pycnidia they are longer than in the young ones. Among the conidiophores are certain longer branches which project further into the cavity. These are evidently the structures which Pantanelli (89) calls paraphyses. Yet he seems to have some hesitation in designating them by that name, because in a footnote at the bottom of the page he adds; "Non tutte si possono considerare come parafisi o pseudoparafisi, perche talvolta formano conidii alla loro estremita." The writer also found pycnospores on the tips of them and they are also divided into the same regular uninucleate cells as the conidiophores. They branch like the conidiophores and, as for their length, all lengths can be found from 75 microns down to 10 microns. One would be excusable for wondering on what basis they would be distinguished from the conidiophores.

Factors influencing production. As indicated above, the time required for the production of pycnidia on artificial media is very short. When ascospores, naturally ejected from the perithecia, are caught on plates of sterile chestnut bark agar, they germinate in a few hours and at the end of from five to seven days—where they fall thickly on the agar—a pycnidium containing mature spores will be formed at every point where a spore or group of spores fell. These pycnidia differ in no way from those described above. When cultures are made from pycnospores by making streaks on potato agar, pycnidia containing mature spores are usually developed within eight days at ordinary summer temperatures. At lower temperatures, the time required is much longer. As previously mentioned, plates of the fungus exposed to out-of-doors temperatures during the last winter showed considerable growth of the mycelium but in no case were pycnidia produced on these plates. Also on the trees, where the spread of the cankers was measured each month by a painted outline, it was observed that no pycnidia or even "blisters" were developed on the diseased areas that were added during the winter. These experiments indicate that the fungus will grow at a lower temperature than that at which it will produce pycnidia.

Another factor which influences the production of pycnidia is light. When plate cultures are grown in total darkness on chestnut bark agar, no pycnidia are developed, while on plates made at the same time and grown in the light, the usual rings of pycnidia appear (Figure 57). Experiments were also tried in which the plate was left in darkness until about half-covered with mycelium and then brought into the light. Circles of pycnidia were developed, beginning with the ring which marked the outermost limit of the colony when removed from the dark chamber. The concentric rings which always appear on agar cultures are due to the alternation of night and day.

When young trees in the woods are inoculated, the pycnidia do not become evident as soon as on artificial media. But, even here, the spore-horns have been observed in three weeks on inoculations made with pycnospores. "Blisters," indicating the development of the pycnidia under the cork layer, have been observed in eighteen days.

Development of pycnidia on the young canker. The first outward indication of the pycnidia is the appearance of numerous little raised "blisters" just back of the advancing edge of the canker (Figure 45). They are perfectly smooth little mounds and, under the hand lens, appear slick and somewhat translucent. Contrary to published statements of investigators of this disease (e. g. 4: 187), they bear no relation whatever to the lenticels. They seem rather to avoid the lenticels. On account of their smooth, unbroken surface they cannot be confused with the latter at this stage, but at later stages, when they are broken open at the apices, they often give the erroneous appearance of having been formed in the lenticels. They are much more numerous than the lenticels, often being so thick as to be in contact with each other. If the cork layer is carefully removed, the beginning of a single pycnidium will be found under each of these raised places. At this stage they are hyaline, more or less globose or biscuit-shaped cushions with a moist gelatinous appearance, about half imbedded in the disintegrating collenchyma tissue, the other half projecting upward and raising the cork layer to form the pimple. In size, they vary from those on the outermost edge which are almost microscopic to those a millimeter in diameter just before the breaking of the phelloderm. There is no stroma at this time, but each one is very early surrounded with a fringe of loose mycelium which is the forerunner of the stroma. It is at first white but begins to turn yellow even before the cork layer is broken. When a cross section is made of this moist-looking cushion, it is found to be a closely wound ball of hyphae corresponding to figure 4, as decribed under the development of the pycnidium in culture. There are no pycnospores and as yet no indication of a cavity. From the periphery toward the center of the canker the cushions are successively larger and more of the developing stroma about them until the cushions are entirely covered by the mycelial weft, which is now bright yellow. The cavity, sporophores and pycnospores are developed from this cushion in exactly the same way as described above on agar plates and will not be again described. Where the pycnidia originate very closely together, the stromata often come into contact and coalesce so that we now have a compound stroma—to all appearances, a single stroma containing several pycnidia. This condition has been found by the writer in mature stromata several times but seems to be rather the exception—a single much convoluted or labyrinthiform pycnidium in each stroma being the rule. Apparently, even when by coalescence several pycnidia are thrown into one stroma, the receding walls of the chambers soon come into contact and portions of them are broken down so that there is now one large, irregular cavity. So far as observed, the stroma never precedes the pycnidium. A pycnidium first starts and later the stroma forms about it. There is no rind layer on the stroma previous to the breaking of the cork layer. This latter process is brought about through pressure exerted by the growing pycnidium beneath. By this time the spores have developed and soon push out in curling tendrils through the rent in the cork layer.

Spore Horns. They are light yellow in color at first and have a waxy appearance. As they become older they take on a reddish cast. They vary in size from the diameter of a hair to a half-millimeter and in length from a millimeter to more than 2.5 cm. The writer and J. R. Guyer measured an exceptionally long one that was two and one-half inches in length. On young cankers on smooth-barked trees, they are usually small in diameter, single and twisted into several coils, but on the bark of old trees, where they come from the lines of stromata in the crevices, they are large, stout and irregular and often a whole line of them are united comb-like. Figure 48 shows this condition in which they are coming out from rough, burnt-over bark. In cross section, the horns are usually flat or irregular in shape, and only rarely circular. This accounts largely for the way they curl. The irregular twisting is shown in figure 47. When dry, they are hard and brittle, and it takes some little effort to break them loose. It is doubtful if a wind is ever strong enough to break them off and carry them away when dry. But when they become wet, they swell and the spores—of which they are entirely composed—separate and wash down the tree, but as soon as the rain is over, new spore-horns appear with surprising rapidity. Just how long a pycnidium will continue to produce spores has not been determined. During the last season, on young cankers produced by inoculation in the spring, the horns were abundant after each rain until the latter part of the summer, when the pushing out of the stromata indicated the beginning of the perithecial stage. After that, very few spore-horns were found on these cankers. Heald and Gardner (93) have shown that the pycnospores are produced in the winter. Except in cases where they were protected and kept dry, so that tendrils produced in the summer were not washed away, the writer has not seen spore-horns in the winter, but this is probably due to the fact that they are produced at such a slow rate that they are washed away before their size makes them noticeable. They first began to appear this season, (1913), about the middle of April.

Pycnidia in the older stromata. About the middle of the summer, on cankers produced by inoculations in the spring, there is an active increase in the amount of stromatic tissue, and the pycnidia in the top of this new stroma are pushed out through the cork layer. Meanwhile they continue to increase in size. During this increase, the cavity does not remain round but becomes intricately labyrinthiform, as shown in figures 11 and 55. This shape is easily explained when one considers the method by which the pycnidium increases in size. As previously indicated, the walls are constantly receding in all directions. The new stromatic tissue is mingled with portions of the disintegrating host tissue, and when the receding wall comes in contact with this tissue, it continues to recede on both sides of it, but the part around the obstruction remains as a process jutting out into the cavity. This is repeated many times until often the entire stroma will be found honeycombed with numerous but communicating irregular chambers. A simple case is shown in figure 55. This explanation accounts for the shape of the pycnidium only in part because this type is sometimes found on agar cultures where there are evidently no such obstructions. When cross sections of the stromata are cut, a single section usually shows a number of cavities which do not appear to be connected, but if the entire stroma is cut into serial sections, it will usually be found to contain but a single many-chambered pycnidium. Occasionally however, the writer has found stromata which contained three or four distinct pycnidia.

The pycnidial form of this fungus has often been referred to the genus *Cytospora,* based on the idea that the stroma typically contains a number of pycnidia. Evidently this is a mistake. If there is need of a distinct generic name for this stage, it should be referred to *Endothiella,* a genus erected by Saccardo, (Ann. Myc. 4:73), based on the imperfect form of *Endothia gyrosa.* Saccardo did not apply this name merely to the superficial type on wood, but under this word he included all forms of the pycnidial stage. The labyrinthiform pycnidium in the mature stroma becomes larger than the forms developed on agar and on wood. Cavities more than a millimeter in diameter have been found by the writer. Besides differing somewhat in shape and size, this type also differs from the type on agar in that the wall layer is more distinct, and the conidiophores are more branched and longer.

Superficial pycnidia. Another form of the pycnidium is found on the cut ends of stumps and logs and both on the wood and the inside of the bark where the latter has broken loose and an air space is left between it and the wood. These are superficial, single pycnidia. A group of them is shown in figure 12. A favorite place for them is on the inside of the bark where it has drawn away from the stump around the top, after the tree is cut. Also after a log or stump on which there was a canker is peeled, the pycnidia will develop on the surface very quickly if it does not dry out too soon. Their production is largely dependent on the water supply. This is illustrated by the fact that in dry weather they will develop on the lower side of a log lying on the ground, but not on the upper side. Their shape also varies with the amount of moisture. In the more moist, shaded situations, they are long pear-shaped or conical, as shown in figure 12, or the base may be flattened out slightly on the substratum. But on tops of stumps—where they occur abundantly on the outermost four or five annual rings, and where the supply of moisture is not constant—they are flattened out on the substratum and do not stand out free as shown in the figure. Also they have more of a tendency to run together here. In color they are deeper red than the stromata, but have light yellow conspicuous ostioles which project upward in a sort of neck or beak. They are surrounded by no stroma whatever, and stand out free so that they can easily be picked off with a dissecting needle. They measure about a quarter of a millimeter in diameter and the same in height. The outer wall is perfectly smooth as seen under the hand lens. Often several of them grow together, but their ostioles remain distinct and we have the appearance of a single pycnidium with several ostioles.

The writer has not seen all the developmental stages of this type, but there is no reason to believe that they differ essentially from those on agar or under the cork layer. A cross-section of one when mature, (fig. 54), shows no differences in the configuration of the cavity, the character of the conidiophores, etc. The walls are thicker and much more dense, however, and the ostiole is more perfectly formed than in the others previously observed.

Usually, this type of pycnidium is not followed by the perithecia, but in two cases, where they were between the bark and the wood, the writer has found perithecia developing among them.

STROMATA.

The stromata are more often seen and better known than any other stage of this fungus. They are the reddish brown cushions mentioned in the introduction, which are scattered thickly over the canker and make it so conspicuous and easy of diagnosis. A canker thickly beset with them is shown in figure 44. The beginning of the stroma has been mentioned in treating of the pycnidium. As stated there, it always starts as a loose growth of hyphae around the pycnidium. It does not precede, but follows the first stages in the development of that organ. This stage of the stroma may often be observed on agar cultures where the pycnidia are rather far apart. A fluffy growth of light yellow mycelium surrounds the pycnidium, and covers it over until often nothing can be seen but a mass of spores oozing from the top of a loose ball of hyphae. If these are imbedded and sectioned, they will be found to contain a loose tangle of undifferentiated hyphae surrounding a central pycnidium. No rind layer is produced under these conditions. This corresponds to the stage on the bark which precedes the rupturing of the cork layer. But as soon as the cork layer is broken, the stroma undergoes a change. There is a rapid increase in size, and at the same time, a differentiation of the cells at the tips of those branches which reach the exposed surface. These cells now become shorter and thicker, acquire heavier walls, and are densely crowded together, so that in cross section they appear as a pseudoparenchymatous tissue (Fig. 10). The rind thus formed covers all of the exposed surface of the stroma, and also grows up around the necks of the perithecia (Fig. 11). The cells are pretty well filled with protoplasm and stain deeply. They also contain more pigment than the other cells. The interior or medulla of the stroma remains the same. As shown in the base of figure 10, it is merely a loose tangle of hyphae which are much branched and more often septate, but in all other respects, like the usual vegetative hyphae. The cell contents, nuclei, vacuoles, walls, etc., are just the same. They also contain a large amount of pigment. Stone cells, bast fibres and remnants of the walls of the collenchyma cells are scattered through the basal parts. A diagrammatic drawing of a stroma showing the location of the pycnidium, perithecia and rind layer is given in figure 11. When they first come through the cork layer, they are lemon yellow in color but with age the color deepens to orange, reddish brown and finally cinnamon brown, But when cut into, they are found to be lighter colored on the inside than on the surface. Fully mature, they average about 2.4 x 1.2 millimeters in size, being usually elongated horizontally as shown in figure 44. They average about 1.3 millimeters in depth. The size however, depends largely on the location and the season. If they grow in a moist situation they are much larger than where they are exposed to desiccation. On old rough bark, they do not occur as shown in figure 44, but come out only in the crevices of the bark, often united in a solid line for several inches so that they apparently form one long stroma. Otherwise they do not differ from those described above.

PERITHECIA.

Previous to the beginning of the perithecial stage, the cork layer has been broken only by the emerging spore-horns. The small amount of stroma that is developed lies entirely beneath this cork layer, that is, none of it is erumpent as yet. The change to the perithecial stroma has been observed within eight weeks after inoculation. On trees inoculated in June the stromata have been observed in August. The stroma increases very rapidly in size and pushes off more of the cork layer. Not only does it fill up the enlarged rent in the phelloderm, but it also grows out over the torn edges to some extent so that they are included in the stroma as shown in figure 11. If one peels off the cork layer now, either the entire stroma, or at least the top comes off with it. The stroma now has an erumpent superficial appearance as shown in figures 43 and 44.

Primordia. When we speak of the perithecial stroma, however, we do not mean that it contains perithecia as yet. Spot infections have been under observation where the perithecial stromata were in abundance on all the cankers in the early spring, but there was no outward appearance of perithecia during the entire summer. On the other hand pycnospores may be pushed out from these stromata in numerous spore-horns during the entire season. Cross sections of these stromata show that the pycnidia are now located in the periphery, the mass of stroma having been formed beneath them and pushing them out through the cork layer. Their location is shown in figure 11.

The most noticeable feature in a cross section at this stage is the numerous primordia—the earliest stages in the development of the perithecia. These arise usually in the tissues of the bark below the base of the original pycnidium and by their growth and the growth of the new stromatic tissue about them, they push these disorganized elements upward and apart so that scattered fragments of them are found included throughout the base of the stroma. The primordia do not always originate however in the lower layers. At times they may be found well up in the stroma without a trace of the disorganized bark about them. A stained cross section shows one or two very prominent large, deeply stained cells at the center of each primordium, and running around these in close concentric circles are enlarged strands of mycelium. These latter also stain quite heavily so that the stain may be taken out of all the rest of the stroma and still leave the primordia quite prominent.

The number of primordia in a single stroma may be very large—over one hundred having been counted in one. They fill up most of the available space in the base of the stroma and are often so close that they give the appearance of double or triple primordia. All of them however, do not develop into mature perithecia on account of the lack of space and possibly of food supply. When the perithecia are mature there are usually fifteen to thirty in a stroma. This means that one out of every four or five primordia reaches maturity. Their degeneration takes place at all stages almost up to the mature perithecium, but by far the greater number never get past the ascogonial stage. Sections of the stroma at any subsequent stage will show these starved primordia in the base. Both the ascogonial cells and the enveloping hyphae lose their contents almost entirely, and appear as empty cells which no longer take the stain like those of the healthy primordia and are usually pressed out of shape by the growth of the latter.

The large central cells are part of the organ which was first known as the Woronin Hypha but now more commonly called the carpogonium. The cells of the carpogonium lying within the enveloping hyphae as described above are the ascogonial cells, or simply the ascogonium. In a thin section usually only one or two of them is seen, (Figs. 19 and 20), but if serial sections are examined, it will be found that they number from two to five in each primordium and are wound into a circle or, more often, a spiral of one or two coils. Occasionally, the entire structure may be seen in one section as shown in figure 21. The cells are elongate, oval and slightly curved to fit into the segment of the spiral of which they are a part. Fully mature, each measures about 10 x 25 microns. They are deeply constricted at the septa and apparently are only loosely connected; in fact in prepared sections they are very frequently not in contact at all—especially the older ones.

They are very densely filled with protoplasm, and for this reason, easily brought out by differential staining, retaining the protoplasmic stains with great tenacity. They are best stained with Heidenhain's iron-alum haematoxylin and erythrosin. The nucleoli are especially tenacious of the haematoxylin, and in a properly differentiated cell, the writer has counted as high as eighteen nuclei. They may be quite readily brought out by Flemming's triple stain. These two stains have been used interchangeably, their relative efficiency depending on the points to be brought out and the stage under consideration. Outside the nucleolus, however, the resting nucleus does not retain the stain when treated with the haematoxylin and a definite nuclear membrane is made out only in the more favorable cases. The usual appearance of the nucleus is shown in figure 20, merely an intensely stained nucleolus surrounded by a circular clear area. The nuclei are much more numerous in the ascogonial cells than in the cells of the enveloping hyphae, usually only about two to five appearing in each of the latter. They are also larger and more prominent.

The ascogonial spiral does not terminate inside the primordium but is continued up through the stroma as a large-celled, prominent, deeply staining thread. The thread can be traced entirely to the surface of the stroma. The cells are of a less diameter than in the cells of the ascogonium and not curved and do not show such deep constrictions at the septa. The cell contents, including the prominent nuclei, are the same as in the ascogonium. Fourteen nuclei have been counted in a single cell. This thread has been called the trichogyne and the writer will continue to use that term, not implying by so doing that it has the functions of a true trichogyne. They are often found branching, and in the upper part of the stroma they may be distinguished in great numbers on account of their avidity for stains. It is not so easy to trace them through the pseudoparenchymatous rind because the cells of the latter are quite compact and stain deeply. The apical cells usually project slightly beyond the surface.

So far as could be determined, the trichogyne is a useless organ in the development of the perithecium. It is probably a remnant of an ancestry in which a copulation with a free spermatium was essential to the further development of the carpogonium. Lindau* has suggested as the function of a similar organ in the lichens the breaking of a way through the thallus for the emerging apothecium. A similar function here, that is, making a path for the advancing neck of the perithecium, is very doubtful. The trichogyne threads become less distinct as they become older and finally cannot be seen any more.

The stage containing the mature ascogonia is evidently a resting stage for it has been found more numerously than any of the other developmental stages of the perithecium. As a rule, the primordia of one stroma are all in the same stage. The writer hoped to find stromata in which the primordia were all in a younger stage, in which he could determine the exact origin of the ascogonium. Up to the present however, he has not secured such a stroma, and has

*Lindau, G. "Uber Anlage und Entwicklung einiger Flechten Apothecien." Flora, 1888.

had to depend on a relatively small number of apparently incipient primordia which were found in older stromata. The earliest stages found are represented in figures 15, 16 and 17. They show merely a coiled hyphal branch, somewhat larger than the stromatal hyphae which surround it and taking the stain very deeply. In figure 15 there is no indication of a differentiation of the surrounding hyphae to form the envelope. Figures 16 and 17 show the beginning of such a differentiation. Whether this young ascogonial branch is a new formation, or whether it is merely a transformed pre-existing branch of the mycelium, could not be determined with certainty, but the writer is inclined to the latter view by what evidence he has seen. The envelope is differentiated from the surrounding hyphae, and is in no direct connection with the ascogonial branch. As the ascogonial cells increase in size, the number and size of the enveloping cells also increases as indicated by the succession shown by figures 16, 17, 18, etc.

Degeneration of the ascogonium and growth of the enveloping hyphae. Figure 21 shows the highest point of development in what we have called the ascogonial stage. The entire primordium is now about 50-75 microns in diameter. The material from which this figure was drawn was taken in the late fall. In the first week of the following March, material was collected from the same tree, and all the primordia now appeared in cross-section like figure 22. This is the beginning of a new stage of development. The seat of activity seems to have been removed from the ascogonium to the enveloping hyphae. From this time on, the ascogonium degenerates. The dense protoplasmic content gradually disappears, and now the contents are represented either by ragged bridles across the lumen and irregular masses around the walls, as shown in figure 22, or else the entire contents draws up into a misshapen mass which stains very deeply with safranin.

The behavior of the enveloping cells is quite the contrary. Their contents now becomes more dense and retains the protoplasmic stains more deeply than the ascogonial cells. Their nuclei also become more prominent and apparently more numerous. Up to this time the individual hyphae can be traced, and there are open spaces between them; but now they have increased both in size and in number, and filled up the intervening spaces. They appear as a pseudoparenchymatous tissue instead of a coil of hyphae. The increased growth presses in the sides of the ascogonial cells which now have nothing within to keep up their turgor.

The most important question at this time is in regard to the branching of the ascogonium. Reasoning from analogy with many other Ascomycetes, we would expect the ascognia to give rise to ascogenous hyphae before their degeneration. Many hours were spent searching for these hyphae. Only in a few cases was a condition found which would lead one to believe that there were such branches. Three of these cases are shown in figures 24, 25 and 27. All of these, however, occurred when the ascogonium was about ready to break down. A distinct opening between the ascogonia and these cells could be made out. The cells of these "apparent branches" differ little from the surrounding cells except that the first cell is usually almost devoid of contents, like the ascogonium. Since there is no way of distinguishing them from the surrounding cells, their identity cannot be determined in subsequent stages. In the vast majority of cases, no such branches were found, but this may have been due to a lack of sufficient material in the right stage for observation of this point.

Beginning of the differentiation. The primordium now increases very rapidly in size. The cells at the center grow more rapidly than those at the periphery and at the same time the contents become more vacuolar. The reciprocal pressure gives them more and more the appearance of a pseudoparenchymatous tissue. The peripheral cells on the other hand become elongated and flattened by the pressure from the center, and at the same time are less vacuolar than the central cells. This stage is shown in figure 23. As yet there is no sharp differentiation of the wall cells. The crushed remains of the ascogonium are occasionally seen at this stage but have not been found later.

This period also marks the beginning of the neck, which is initiated by a vigorous outgrowth of small cells at a point of the periphery toward the exposed surface of the stroma, forming a blunt cone (Fig. 23). The cells are very compact and have a dense protoplasmic content with several small nuclei in each cell. It is not possible at this time to trace individual hyphae in the young neck. No canal is evident.

The next step marks a complete differentiation of the core cells and the cells which are to form the wall of the perithecium. The cells at the center become larger and still more vacuolated. The membranes remain very thin. They form a perfectly spherical core and are set off by an even line from the wall cells which have now become more distinctly elongated and flattened. The membranes of the latter cells become thicker and the contents still remain dense so that it is now easy in stained sections to tell the exact dividing line between wall and core. The distinctness of this line gives the impression of two different tissues. A camera lucida drawing of a few cells on either side of this line is given in figure 28. It will be noticed here that one of the cells seems to be differentiating into a core cell at one end and a wall cell at the other. Such a condition indicates that these two tissues are not of different origin. The core now measures about 135 microns in diameter and the wall is composed of eight to twelve layers of cells and is about 35 microns in thickness.

Pathological conditions. Peculiar pathological conditions of the young perithecium are numerous at this as well as previous stages. The delicate-walled core cells break down very easily and primordia containing a central cavity, even before the beginning of the neck, are common and misleading to any one searching for the normal beginning of the cavity. Frequently very fine hyphae are found entering between the corecells and apparently living parasitically upon them, causing them to break down and thus furnish a rich pabulum for the invading hyphae. Soon a dense, deeply stained tangle of these hyphae fills the lower part of the cavity. These are not the ascogenous hyphae, as the writer suspected when he first saw them, and such perithecia develop no further but may often be found crushed out of shape between the naturally maturing perithecia.

The cavity and paraphyses. The normal formation of the cavity appears about the time the length of the neck equals the diameter of the perithecium. A portion of the cells in the lower part of the core—not on the periphery of the core but inward by about two to four layers of cells—begins to break down, and in this cavity are now found only scattered, irregular masses of protoplasm, degenerated nuclei and occasionally a part of a wall. Sometimes an entire cell may remain intact even after all the cells about it have broken down. But there is never a large cavity at any one time. As soon as a few cells are broken down, the cells which border on the cavity below begin a new period of activity. Even at this time they can be distinguished by more prominent and numerous nuclei; the walls are more distinct and the contents increases slightly in density. These are the initial cells of the paraphyses which are now pushed out into the cavity and follow its receding upper limit. Their origin is shown in figure 29. They very soon become septate and at subsequent stages their origin would be hard to determine. They are composed of short, plump cells, very rich in protoplasm, staining very deeply, and containing several nuclei. The paraphyses branch frequently and are very crooked, and, hence difficult to trace individually in thin sections. Not only do they extend upward into the cavity, but some of them run around the periphery and send out frequent vertical branches into the cavity. They line only the bottom and never come from the roof, at which place the core-cells remain intact for a long time. A perithecium in a rather young paraphyses stage is shown in figure 30. It is now about 200 microns in diameter. There are no ascogenous hyphae or young asci at this time. The outer wall has become more pronounced and is distinctly divided from the bases of the paraphyses by several layers of large, clear core cells.

As the paraphyses become older, their component cells become more elongated and slender. When the young asci appear they begin to lose their dense contents and are soon not easy to distinguish. But even after the first asci are mature, they may be seen as slender filaments devoid of contents except for the nuclei, which persist for a long time. Their function is probably to nourish the growing asci.

The asci. The writer was unable to determine the origin of the ascogenous hyphae. The young asci arise as branches of a system of hyphae which appear among the bases of the paraphyses, but which cannot be distinguished from the paraphysogenous hyphae by staining reactions or otherwise. They are undoubtedly a different system and in no case has an ascus and a paraphysis been seen coming from the same hypha. At the time the asci first appear the perithecium is about 250 microns in diameter, and the neck is nearing the surface of the stroma but has not yet begun to turn black. So far as could be determined from the material examined, the asci arise as ordinary lateral or terminal branches. The young ascus is broadly clavate. In the uninucleate stage, the protoplasm is gathered about the large nucleus, which is usually at the center, the ends being less dense and therefore taking less stain. By three successive divisions, eight nuclei are produced and the protoplasm about them becomes clear and is soon closed off from the epiplasm by a membrane. But, at the same time, the nucleus is dividing again and by the time the wall can be distinguished, there is also a distinct septum in the spore. This condition, in which there is a single nucleus in each end of the spores, does not persist very long but soon there is another division, making two nuclei in each end and frequently, by successive divisions, the mature spore has three or four nuclei in each end, as previously stated. The details of the nuclear divisions and the cutting out of the spores in the ascus, being purely cytological and outside the scope of this work, were not followed more closely.

Mature asci with the spores in place are shown in figures 34, 35 and 36. The arrangement of the spores in the ascus is irregularly uniseriate or subbiseriate. There is, however, no uniformity in their arrangement and two asci can hardly be found in which the spores are placed alike. The epiplasm is still very distinct, especially where it tapers to a point at the top of the ascus. There is a thickened ring—reminding one of a doughnut—about the upper extremity of the lumen of the ascus which is very prominent and shows peculiar staining reactions. It has been suggested that it is at this point that the top of the ascus breaks off to free the spores. This explanation is at least, plausible, but the writer has never been able to find the asci in the process of liberating the spores, and is therefore, unable to confirm the theory. When the ascus is lying flat on the side—as is practically always the case in water mounts, the ring appears in cross section as two highly refractive disks such as is shown in figures 35 and 36. As figure 34 shows, the spore-bearing part of the ascus is only about three-fourths of its total length. But in dried specimens the point draws down until the ring is very close to the spores as shown in figure 36. The natural shape is not recovered at once on placing the ascus in water. This fact should be taken into account in making measurements. It is best to use only fresh specimens. Murrill (4), gives the dimensions of the ascus as 45—50x9 microns. The average of one hundred and fifty measurements made by the writer was 51.2 x 8.9 microns.

Development of the neck. Even before the complete differentiation of the core- and wall-cells, it is noticeable that the cells on the upper side are pushing outward in a sort of a knob, and by the time the core has become distinct, this structure has become a definite cone as represented in figure 23. At this time the cells are small and very compact, and distinct hyphae cannot be made out. The cone is a perfectly solid mass, that is, there is no indication of a canal in the center. But as the hyphae elongate toward the surface of the stroma, they become less entangled, running almost parallel, converging toward the apex of the advancing cone and leaving an open canal through the center. This advancing apex is shown in figure 31. The hyphae, are slender, very densely filled with protoplasm and, therefore, stain quite deeply. The arrangement is loose and individual hyphae can be traced for long distances. The septa are far apart. The converging apices are usually somewhat swollen. As the apex pushes toward the surface, the stromatic hyphae are not destroyed but are merely wedged apart to make room for the neck. At a distance of about 50-75 microns from the apex, it will be noticed that the hyphae are increasing in diameter and new branches are being inserted. This process continues until the wall of the neck is composed of densely packed hyphae and is quite firm. The walls of these cells also become thick, and about the time the apex has reached the surface, they become black. The apices of the branches which extend into the central canal, however, do not take on these latter characters but remain thin-walled and loose. These are the periphyses. They extend outward and upward and their apices almost come into contact. They are shown in figure 32. They are confined to the neck and never occur within the perithecium proper. But as yet the canal in the upper part of the neck is separated from the cavity of the perithecium by the upper wall of the latter and the cells of the solid cone which formed the beginning of the neck. About the time that the paraphyses are maturing in the cavity, the cells in a direct line from the cavity to the upper canal begin to draw apart and to react differently to stains. These cells have not become thick-walled like the other cells of the perithecial wall. There is probably also a disintegration of some of the cells which formed the perithecial wall, but not of the cells of the original cone. These latter merely draw apart, and the cells left projecting into the canal thus formed take on the character of periphyses. Also where the canal breaks through the wall, some of the cells are left projecting like periphyses. These periphyses in the lower part of the canal differ from those in the upper part in their irregularity, and in not projecting upward at an acute angle. An early stage in the formation of the lower canal is shown in figure 32.

It is impossible to tell whether the neck follows the course taken by the trichogyne up through the stroma since the trichogyne has entirely disappeared by this time. The stroma is usually much broader at the bottom than at the place where it breaks through the cork layer. For this reason the necks seem to converge at the top. The way in which the necks bend to get through the cork layer is shown in figure 53. Where a broad stroma has formed, however, and a large area of the cork has broken away, the necks extend almost straight upward. There is not naturally a distinct valsoid disk in which all the necks converge. The arrangement is diatrypoid rather than valsoid. This fact is of importance in placing the species in its proper genus. The neck does not usually end flush with the stromatic surface, but extends beyond as a little papilla (Fig. 11). The distance to which the papilla extends depends largely on the location of the stroma and the conditons under which it grows. In a dry situation with plenty of sunlight, it may hardly project at all, while in shaded places and especially where it is moist, it may project more than a millimeter. Much longer ones may be produced by developing them in moist chambers. These papillae are not composed entirely of the hyphae which grow out from the wall of the perithecium but as they push out beyond the surface, the rind tissue grows up about them. A cross section of a papilla is shown in figure 33. If the advancing apex of the neck encounters a pycnidium in the stroma, it grows directly through it or occasionally may curve slightly around it

The mature perithecium. When mature, the perithecium measures about 350-400 microns in diameter and is mostly spherical in shape but the shape is often modified by pressure of other perithecia. As seen under the hand lens, the wall is gray or lead colored but not jet black and shining like the wall of the neck. In cross section, the wall now appears thinner than when the perithecium was young, and the cells are more flattened. The cell-walls are heavy. The structure of the perithecial wall is shown in figure 30. The layers of large core cells which previously divided the contents of the cavity from the wall, have now entirely collapsed and, as a result, the ascus mass is only loosely attached to the wall, and usually pulls away in sectioning. The entire cavity is now tightly packed with asci. The older ones, having been pushed up are at the center and in the upper part, and the younger ones lining the walls. The writer has calculated the number of asci in a full perithecium at 3600, or 28,800 spores.

Ejection of the spores. Rankin (59) has discovered that the ascospores are forcibly ejected from the necks of the perithecia into the air, and showed that this occurs only during periods of rain. Heald and Gardner (76, 93) demonstrated the effect of temperature, showing that expulsion does not take place below 52° F., and that after being subjected to lower temperature, it requires three or four days of favorable weather to cause further ejection. The writer and Babcock (95) studied the phenomena of ejection with especial reference to its bearing on dissemination. The most essential factor in producing ejection was found to be an abundance of moisture. Under the hand lens it will be noted that there is a film of water over the tip of each active ostiole, and that at each discharge this film is broken and usually eight spores are shot outward, that is, the contents of one ascus. What causes these asci to leave the body of the perithecium and come up to the mouth of the neck was not determined at that time.

If a fresh stroma containing mature perithecia is cut across with a razor, the cut surface will remain level except where the perithecia were cut through. Here the viscous contents will bulge out in a prominent bead, showing that there is a tension inside the perithecium. This is the force which drives the asci up through the canal. There are at least three factors which aid in producing this pressure: (1) The asci do not all mature simultaneously. Young ones are continually pushed up between the bases of the older ones. As they become mature they are pushed up into the center and upper part of the cavity which is soon densely packed, and new ones are still pushing for space. The remaining layers of core cells are first pressed out flat against the walls. (2) But when they would tend to pass out the canal of the neck, the periphyses act as so many little springs and press them back. (3) The most immediate cause of the outward pressure, however, is the swelling of the asci themselves when they become moist. Figure 34 represents an ascus which has been kept in water for several hours. When it is dry, the ascus wall is drawn so tightly up around the spores that it can hardly be distinguished at all except at the top. Figures 35 and 36 show stages of this process. The entire structure occupies less than half the space occupied by the distended ascus. Thus the sudden addition of water, tending to double the volume of the perithecial contents, would easily drive the asci up the neck to the surface. Prepared sections of perithecia which were fixed during the process of ejection, showed that up to the tip of the neck the spores are still in the ascus. Since the asci are never ejected into the air, it follows that they must burst and liberate the spores when they arrive at the surface film at the tip of the neck.

SUMMARY OF RESULTS.

1. Each pycnospore contains a single nucleus which divides several times before germination, and a polar body at each end. The ascospore contains from one to four nuclei in each cell.

2. Ascospores germinate readily in water; pycnospores require a nutrient medium. Pycnospores germinate on twigs of a large number of common forest trees. They also germinate in humus about the base of the tree.

3. At summer temperatures, pycnospores germinate in 12-36 hours; ascospores in 2-12 hours. Lower temperatures retard germination.

4. Both kinds of spores swell greatly before germination.

5. Pycnospores usually germinate by two tubes and ascospores by four.

6. Ascospores in the perithecia and pycnospores in the "horns" retain their power to germinate at least a year. The longevity is diminished when the spores are separated from each other and when exposed to the air.

7. Winter weather conditions do not affect the vitality of either kind of spores.

8. The cells of the mycelium are multinucleate under all conditions. They are densely filled with protoplasm when young but become vacuolated as they become older.

9. The mycelium and pycnospores are colored by a yellow pigment belonging to the aurine group of compounds.

10. The mycelium does not invade the living tissue as individual hyphae, but in flat fan-shaped mats.

11. The mycelium continues to grow in the bark even during the winter months but much more rapidly in the summer. Its vitality is not affected by winter temperatures.

12. The fungus may be carried over in the bark for a year or more by the mycelium even when the bark is kept dry.

13. The pycnidium is produced symphiogenetically. In the simplest type it is merely a loose tangle of hyphae, the central branches of which become the sporophores. It has a indefinite ostiole.

14. The sporophores are branched and the pycnospores are produced successively from their tips.

15. Pycnidia are not produced in the absence of light.

16. The pycnidium is started before the stroma is formed. It occurs directly under the cork layer and bears no relation to the lenticels. The stroma is formed about the pycnidium and typically there is but a single pycnidium in each stroma.

17. Stone cells, bast fibers and walls of the collenchyma cells are contained in the basal parts of the stroma.

18. The perithecia are produced at the base of the stromata in which the pycnidia are contained.

19. The beginning of the perithecium consists of a coil of large cells—the ascogonium—surrounded by "enveloping hyphae." The ascogonium is continued up to the surface of the stroma in a prominent trichogyne.

20. The trichogyne is not functional as such.

21. The perithecium is differentiated from the "enveloping hyphae."

22. The cavity is formed by the breaking down of the core cells.

23. Paraphyses grow out from the wall into the cavity and almost fill it. They have almost disappeared when the asci are mature.

24. The asci arise as branches of hyphae among the bases of the paraphyses.

25. The neck of the perithecium is produced by an outgrowth of the hyphae on the periphery of the forming perithecium.

26. The spores, still in the asci, are forced out of the body of the perithecium and up to the tip of the canal by (a) the continued growth of young asci from the walls, (b) the swelling of the asci when they become moist.

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NOTE.—Many titles were added to original proof sheets.

EXPLANATION OF PLATES*

PLATE I.

Figs. 1, 2.	Initial stages in the development of the pycnidium, x 230.
Fig. 3.	Cross section of a pycnidium on agar before the beginning of the cavity. x 400.
Fig. 4.	Same as figure 3 but a little older. x 430.
Fig. 5.	Beginning of the cavity in the pycnidium. x 430.
Fig. 6.	Section of pycnidial wall showing conidiophores. x 430.
Fig. 7.	Conidiophores. x 800.
Fig. 8.	Mycelium from agar. x 800.
Fig. 9.	Section of a ray from the fans in the bark. x 430.
Fig. 10.	Section of a stroma showing the rind layer. x 600.
Fig. 11.	Diagrammatic drawing of a stroma showing the relation to the cork layer and of the organs to each other. x 25.
Fig. 12.	Superficial pycnidia. x 14.
Fig. 13.	Section of a germinating pycnospore. x 700.
Fig. 14.	The resting pycnospore. x 3500.

PLATE II.

Fig. 15, 16, 17,	Initial stages of the carpogonium. x 650.
Fig. 18. to 21,	Later stages of the ascogonium. x 650.
Fig. 22.	Degeneration of the ascogonium and growth of the enveloping hyphae. x 650.
Fig. 23.	The young perithecium and the beginning of the stage of differentiation. x 650.
Fig. 24, 25, 27,	Apparent branching of the ascogonium. x 650.
Fig. 26.	Degeneration of the tricgogyne cells. x 650.

PLATE III.

Fig. 28.	Wall and core cells. x 650.
Fig. 29.	Beginning of the paraphyses. x 650.
Fig. 30.	Perithecium in the young paraphyses stage. x 230.
Fig. 31.	Advancing tip of the neck. x 500.
Fig. 32.	Lower part of the canal in the neck. x 460
Fig. 33.	Cross section of papilla showing periphyses in the neck. x 260.
Fig. 34, 35, 36,	Asci showing stages of drying up. x 650.

*All drawings made with the aid of camera lucida except 11 and 12.

Fig. 37. Mature ascospores. x 900.

PLATE IV.

Fig. 38. Outline drawings of germinating pycnospores.

PLATES V AND VI.

Fig. 39. Germination of pycnospores.
Fig. 40. Germination of pycnospores.

PLATES VII AND VIII.

Fig. 41. Germination of ascospores.
Fig. 42. Germination of ascospores.

PLATE IX.

Fig. 43. Canker showing atrophy.
Fig. 44. Canker showing stromata.

PLATE X.

Fig. 45. The blister stage.
Fig. 46. Stromata showing papillae, indicating the perithecial stage.

PLATE XI.

Fig. 47. Spore horns on smooth bark.
Fig. 48. Spore horns in crevices of rough bark.

PLATE XII.

Fig. 49. Canker outlined with paint to indicate monthly growth.

PLATE XIII.

Fig. 50. Mycelial fans under the bark.

PLATE XIV.

Fig. 51. Rings of pycnidia on chestnut agar cultures.

PLATE XV.

Fig. 52. Photomicrograph of pycnospores.
Fig. 53. Vertical section of a perithecium.

PLATE XVI.

Fig. 54. Photomicrograph of pycnidium on wood.
Fig. 55. Stroma containing labyrinthiform pycnidium.

PLATE XVII.

Fig. 56. Vertical section of stroma showing empty perithecia and the black necks.
Fig. 57. Vertical section of young pycnidium on agar showing early stage in the formation of the cavity.

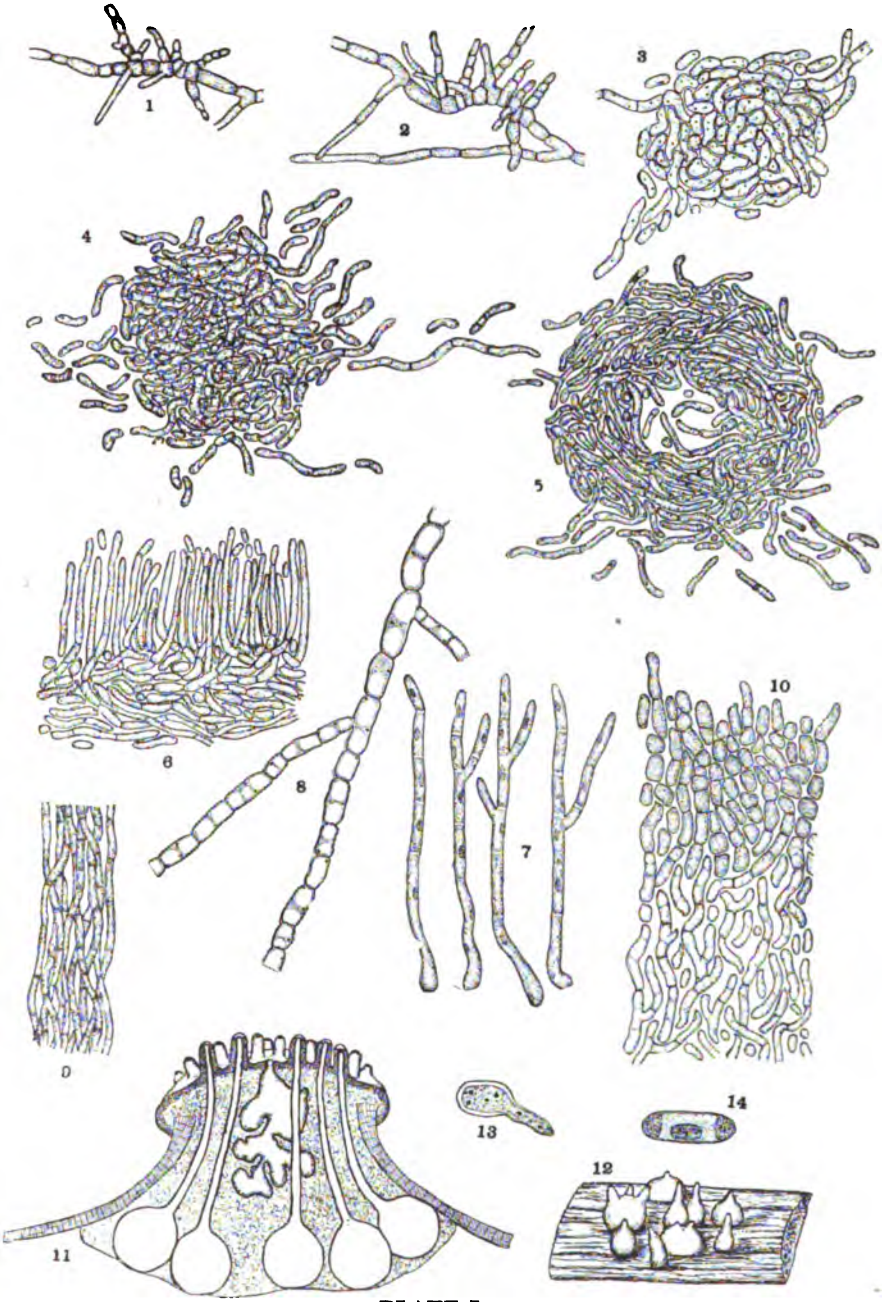

PLATE I.

Development of Pycnidium.

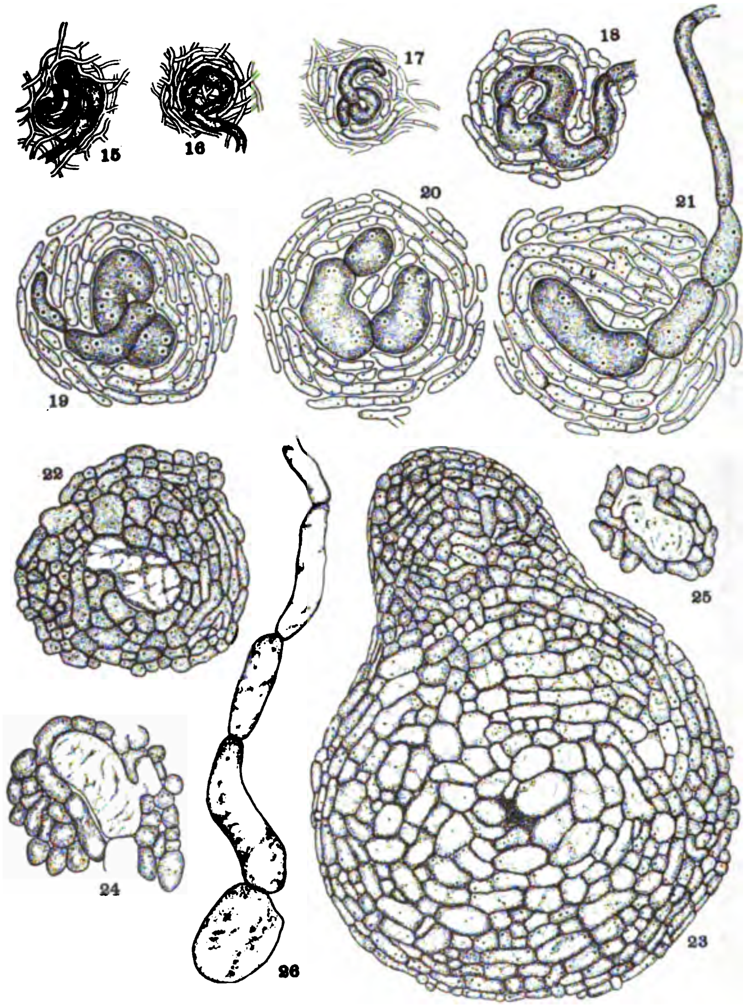

PLATE II.

Development of Perithecium.

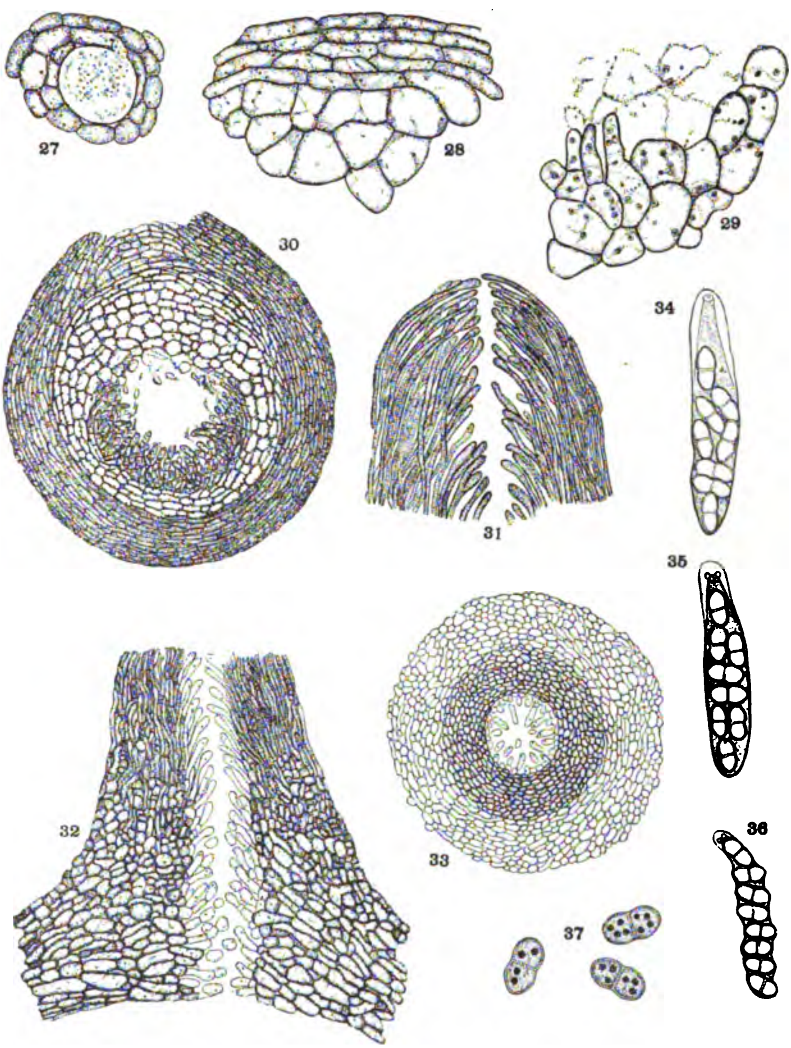

PLATE III.

Development of Perithecium.

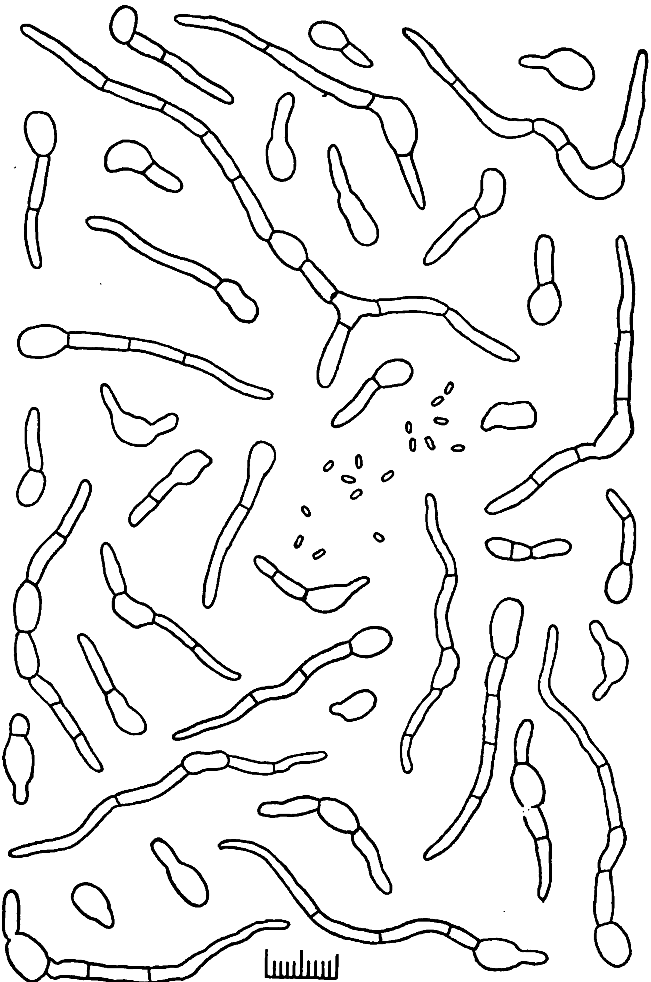

PLATE IV.

Germinating pycnospores

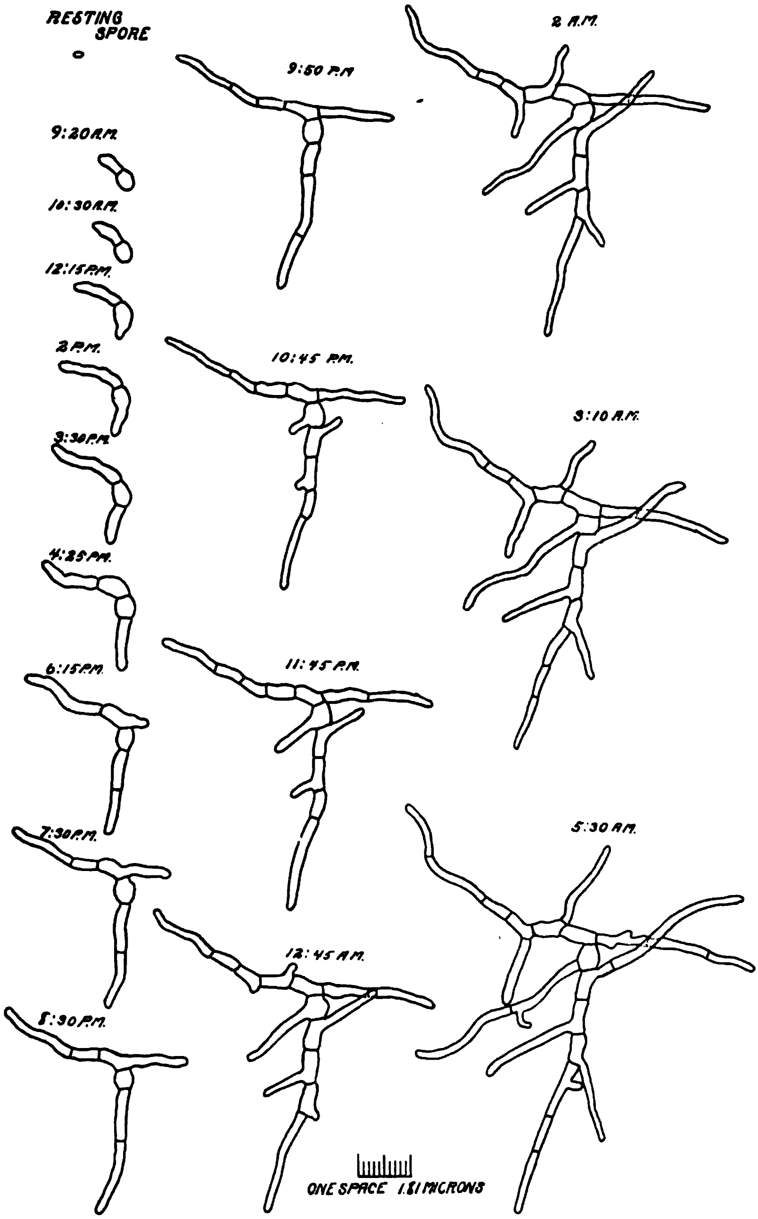

PLATE V.

Germination of pycnospores.

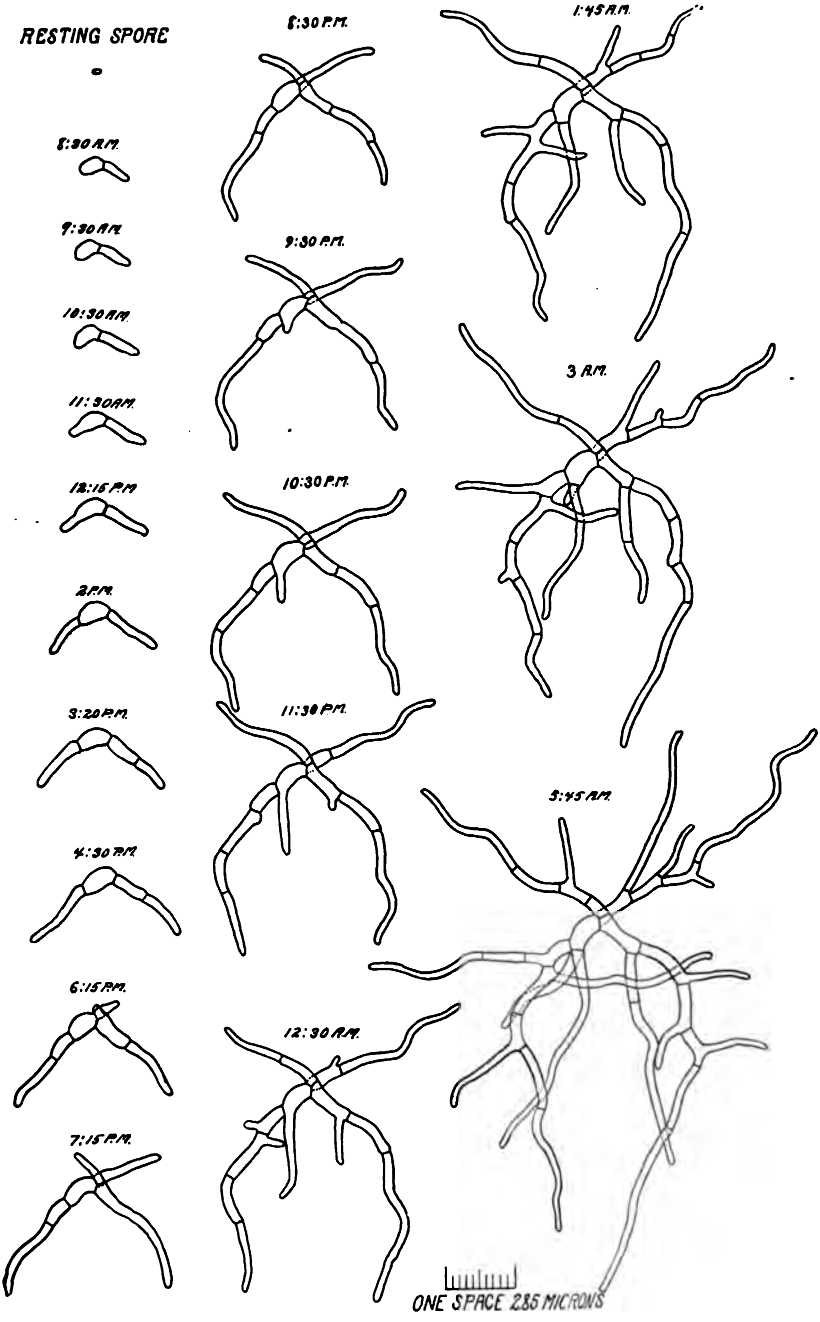

PLATE VI.

Germination of pycnospores.

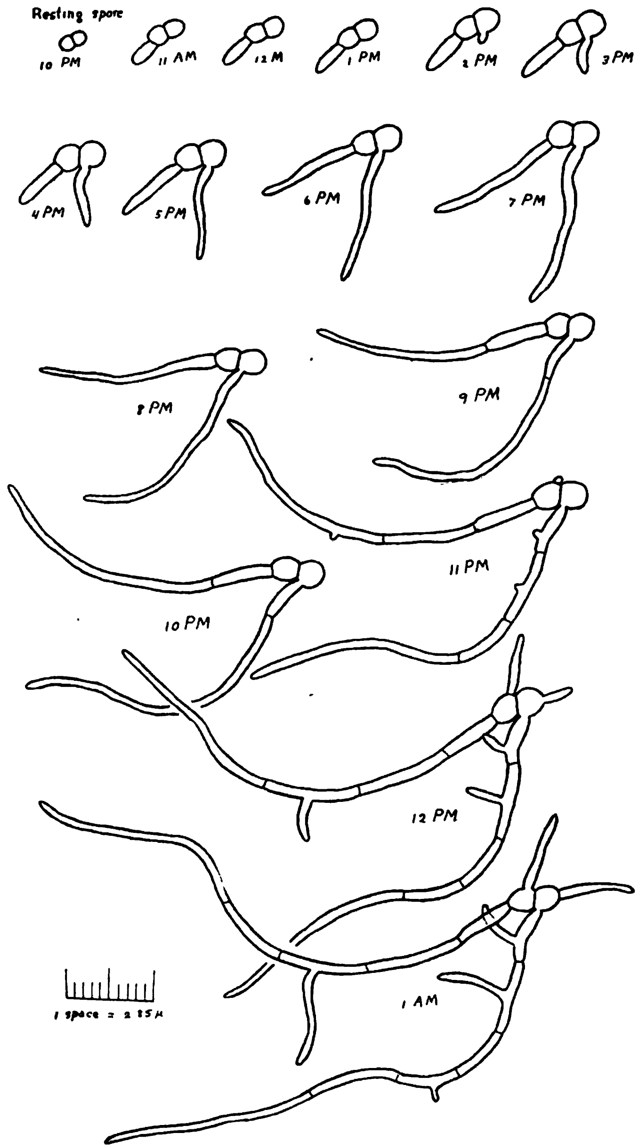

PLATE VII.

Germination of ascospores.

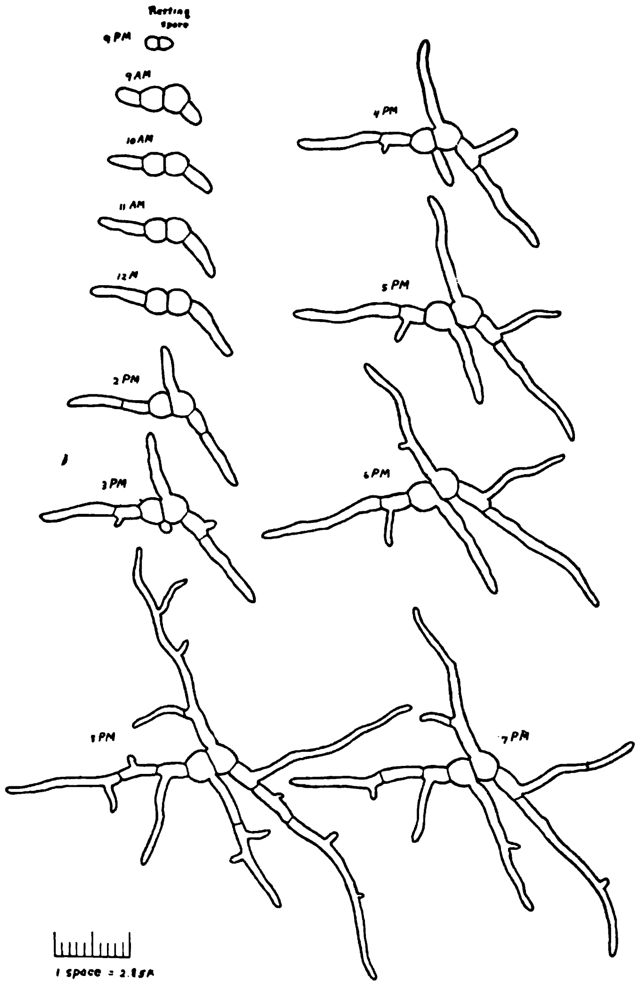

PLATE VIII.

Germination of ascospores.

PLATE IX.

Fig. 43.—Canker showing atrophy.

PLATE IX.

Fig. 44.—Canker showing stromata.

PLATE X.

Fig. 45.—Blister stage of canker.

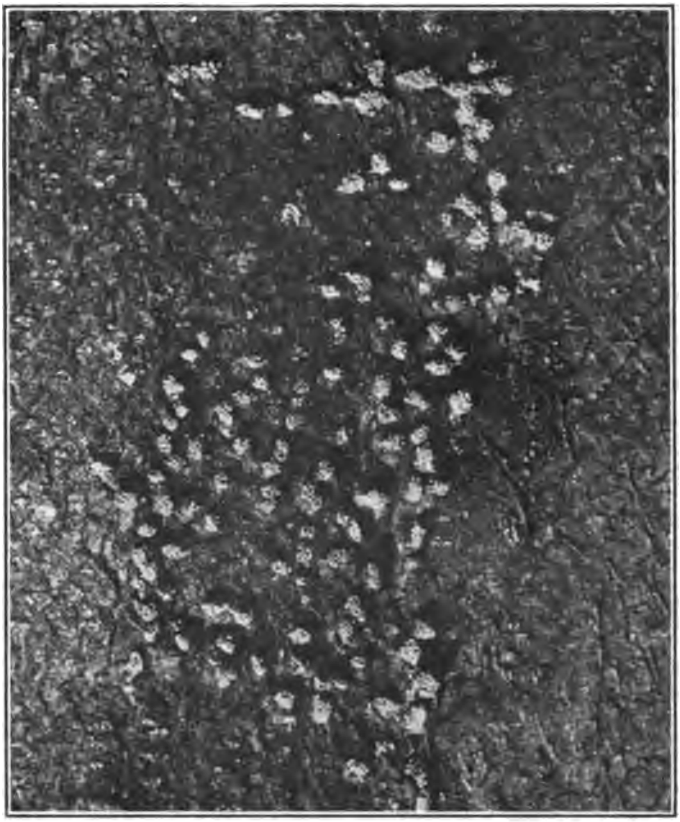

PLATE X.

Fig. 46.—Stromata showing papillae, indicating parithecial stage.

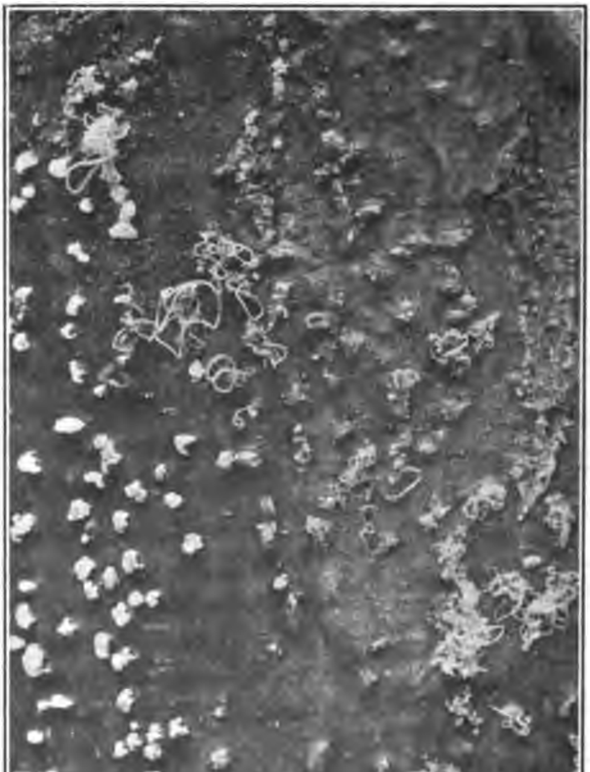

PLATE XI.

Fig. 47.—Spore-horns on smooth bark.

PLATE XI.
Fig. 48.—Sporehorns in crevices of rough bark.

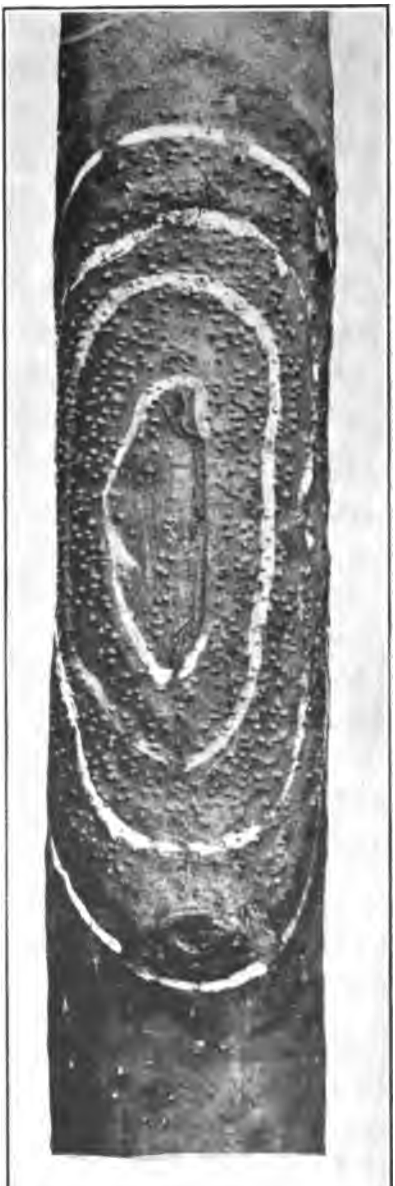

PLATE XII.

Fig. 49.—Outlined canker, indicating monthly growth.

PLATE XIII.

Fig. 50.—Mycelial fans under the chestnut bark.

PLATE XIV.

Fig. 51.—Petri dish culture of pycnidia.

PLATE XV.

Fig. 52.—Photomicrograph of pycnospores.

PLATE XV.

Fig. 53.—Vertical section of a perithecium.

PLATE XVI.

Fig. 54.—Photomicrograph of pycnidium on wood.

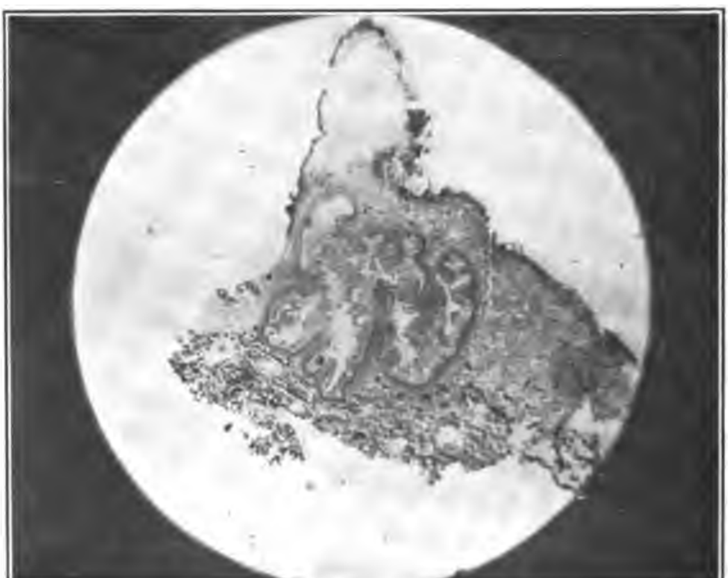

PLATE XVI.

Fig. 55.—Stroma containing labyrinthiform pycnidium.

PLATE XVII.
Fig. 56.—Vertical section of stroma showing empty perithecia and black necks.

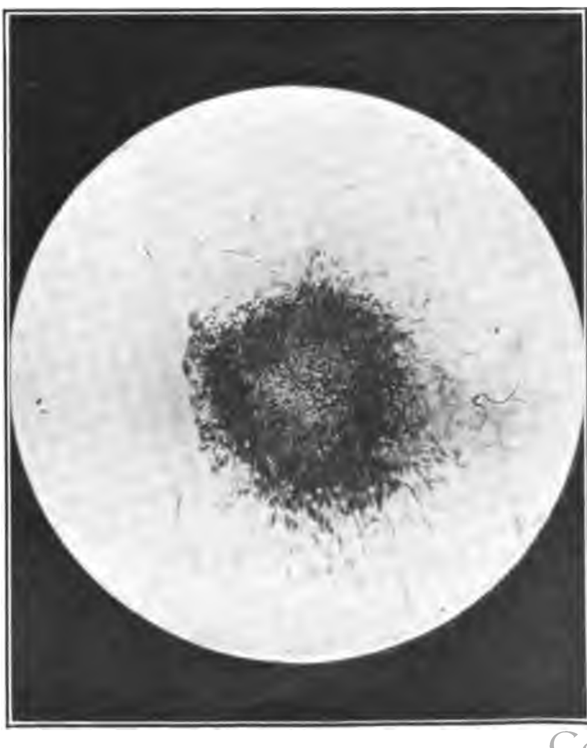

PLATE XVII.
Fig. 57.—Pycnidium on agar showing early stage in the formation of the cavity.

Commonwealth of Pennsylvania

FINAL REPORT

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

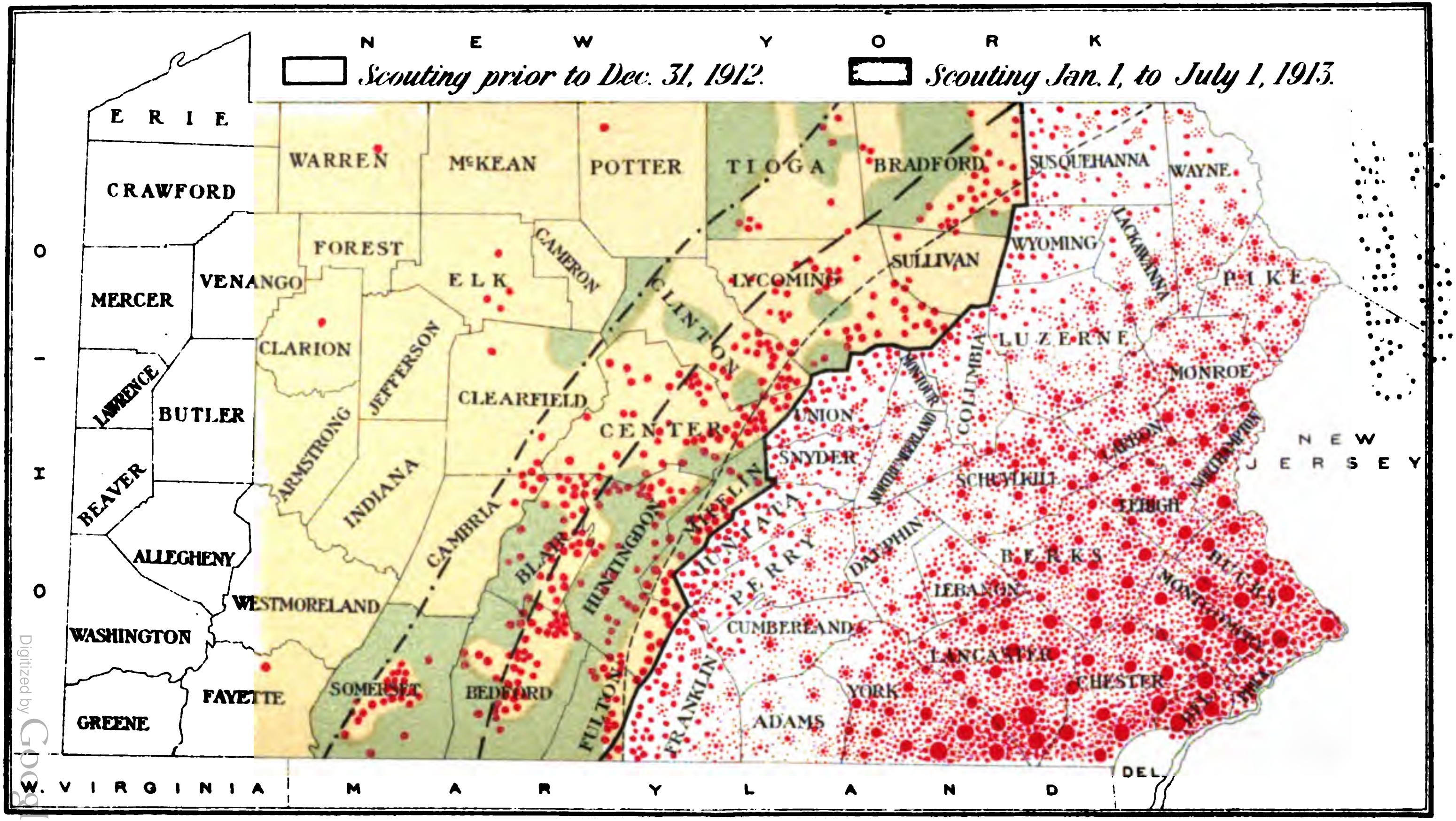

FIG. 1.

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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VIRTUE LIBERTY AND INDEPENDENCE

Pennsylvania Chestnut Tree Blight Commission

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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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Oliver D. Schock, Assistant General Superintendent
Thomas E. Francis, Field Manager, Western District
Joseph R. Wilson, Field Manager, Eastern District
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Irvin C. Williams, (Pennsylvania State Forestry Department), Collaborator

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A. G. Ruggles, Entomologist
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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

Scouting for the chestnut tree blight.

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 attempt 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 neighborhood, 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 destroying 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.

§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.

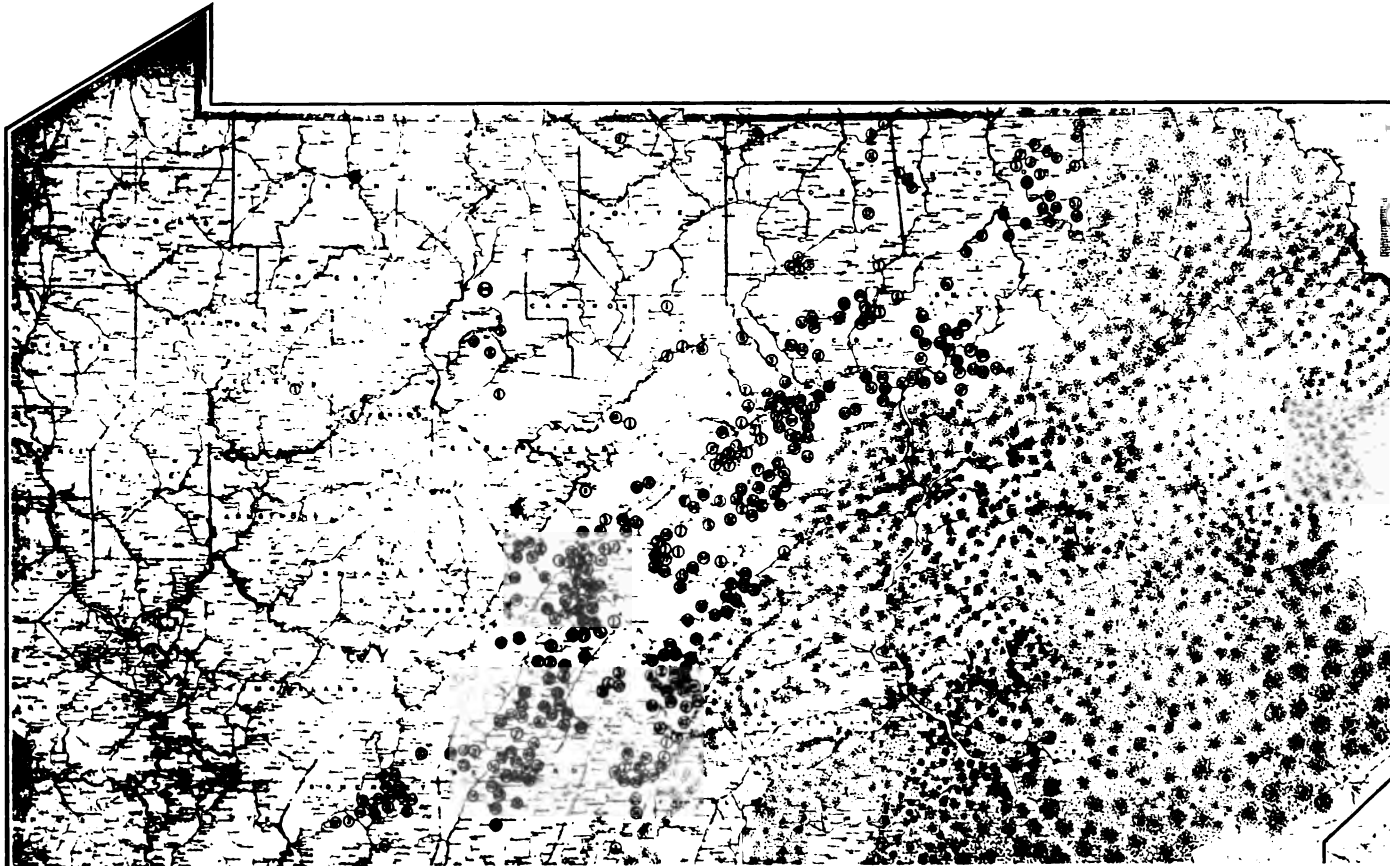
The experience of the past two years has demonstrated that more can be accomplished in locating and destroying the blight after the leaves have fallen than while the trees are in full foliage. Girdled twigs and branches bearing withered leaves are prominent at great distances in winter, and the increased 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,	226	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.

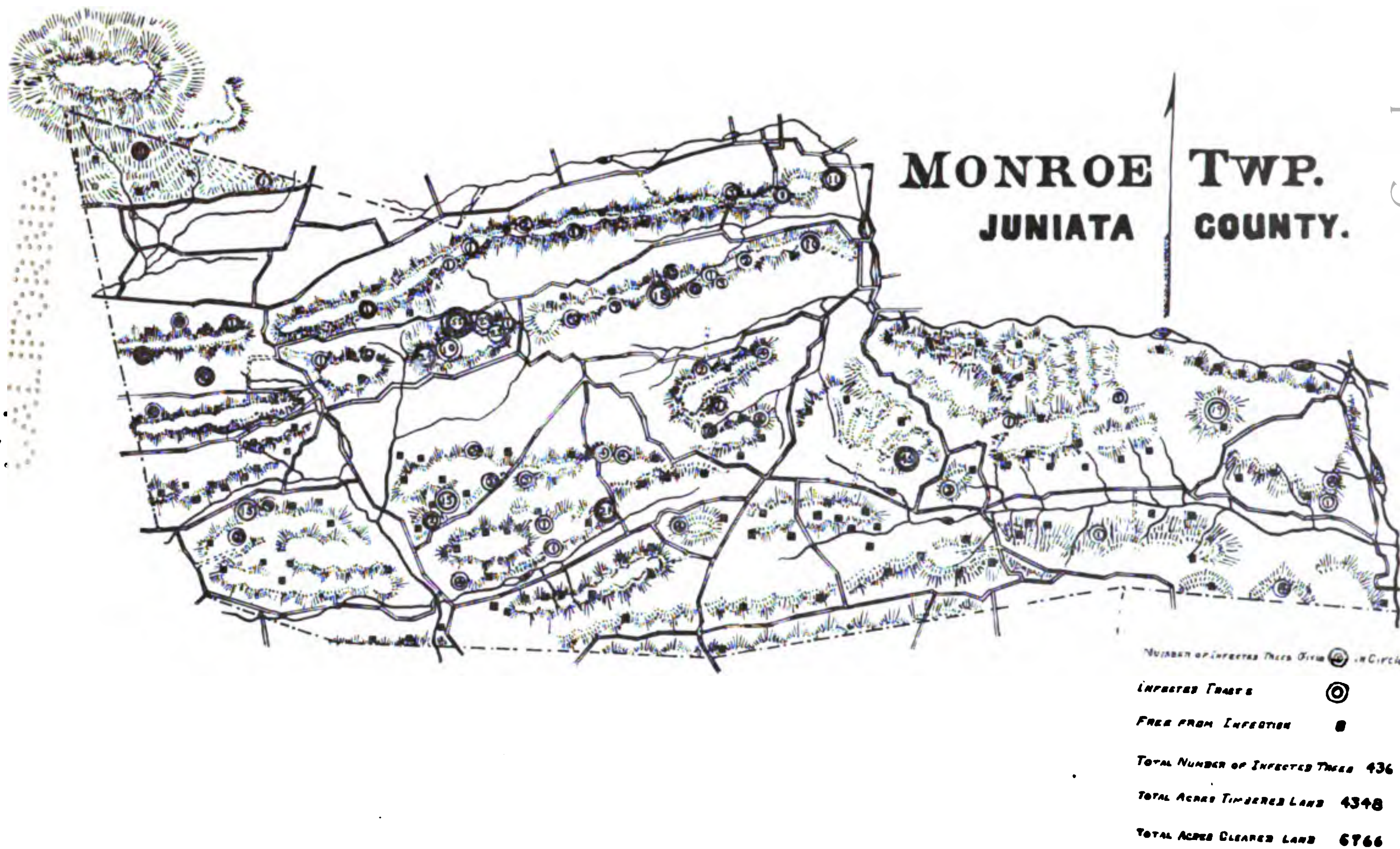
7. Great care should be exercised in burning material so as not to injure other trees, or allow fires to remain unwatched in the woods. Forest fires may result, causing much damage. Burning should not be done when the woods are very dry, or a high wind is blowing.

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 present 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 cooperation 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.

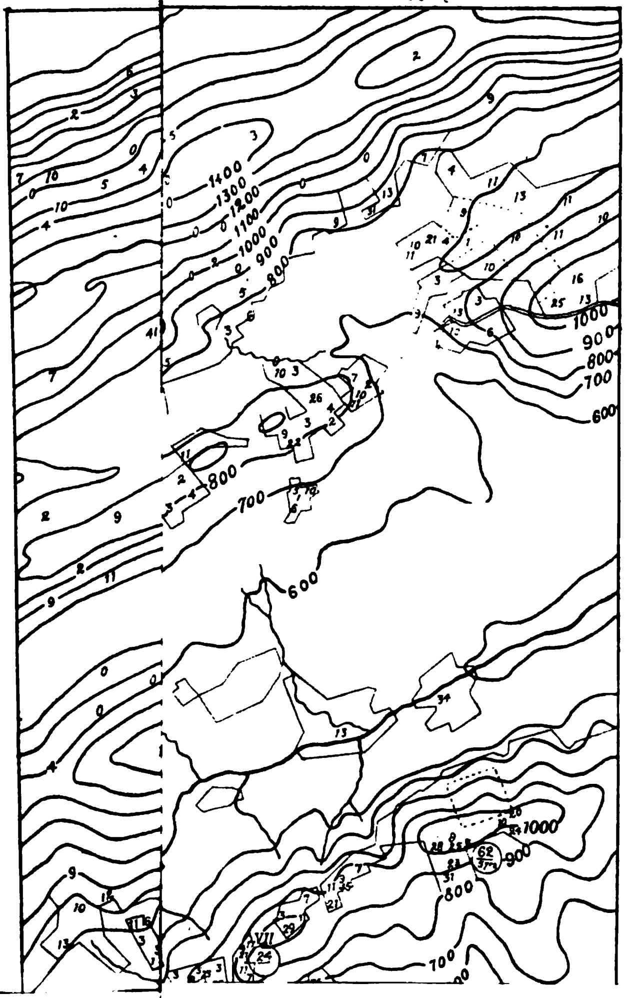
In view of the continued rapid spread of the chestnut blight, and the great damage sustained through this relentless parasite, it is important at the present time to have more complete information on the possibility of controlling its spread. It is now an established fact that the disease exists in China, 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.

f. infections of blight were accurately located on



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

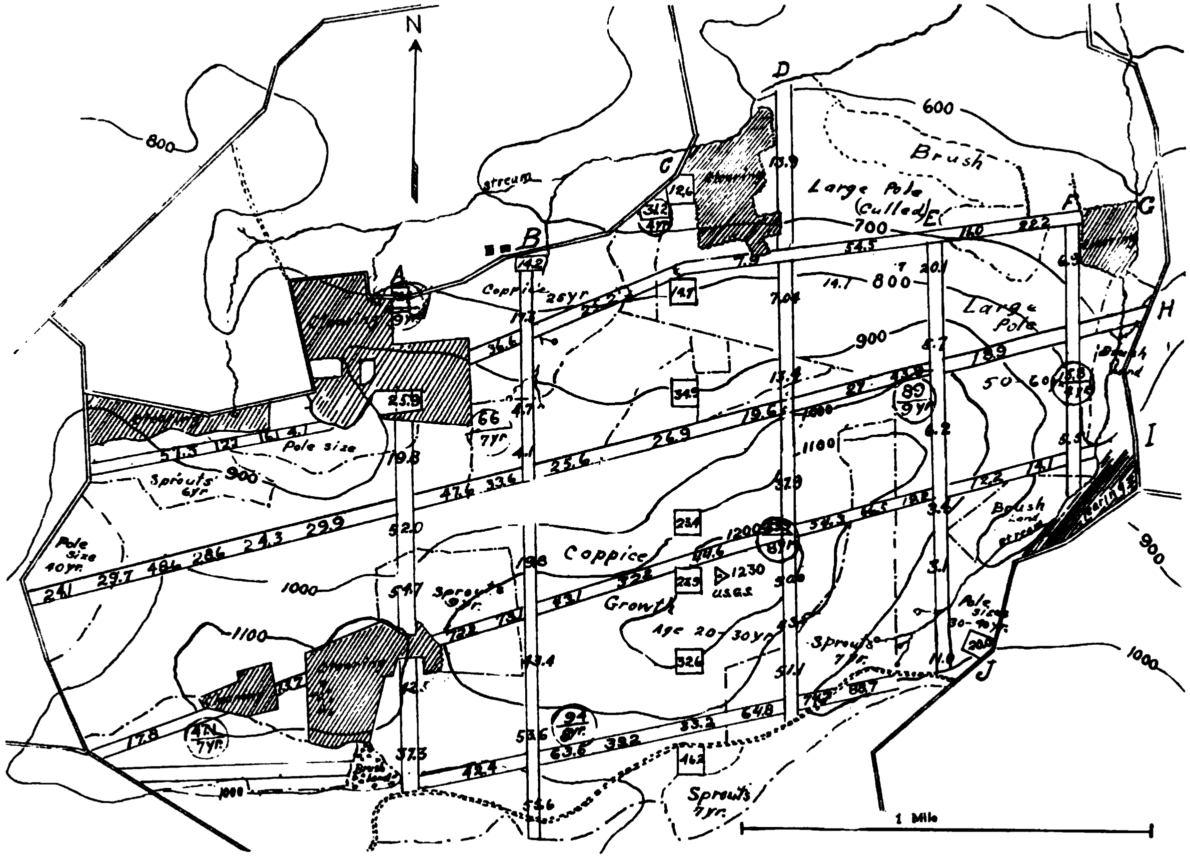
The highest point of this mountain rises about 600 feet above the base, the summit being 1,230 feet above sea level. The long axis of the ridge runs about 15 degrees north of east, the east end of the ridge terminating abruptly. The area studied comprises about 2,000 acres, about 600 of which are cleared, 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 blight center, upper figure is per cent. of infection on an area within 50 feet radius or more of the center.
6-yr 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

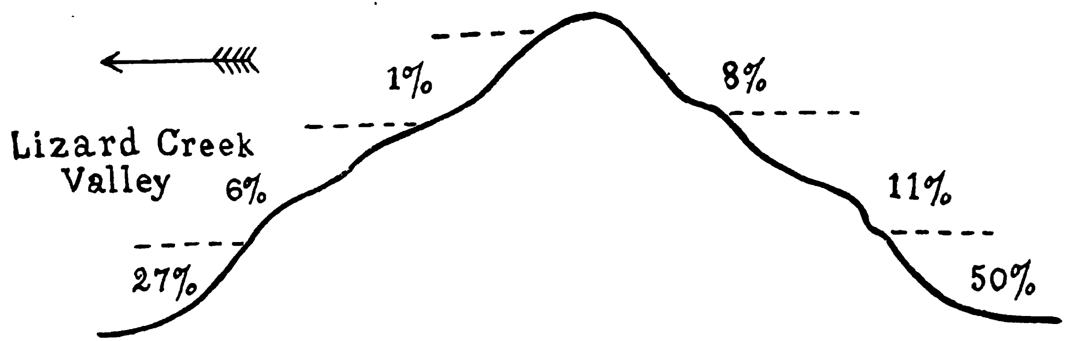


Figure 2.
Cross section of the Blue Ridge Mountain, showing altitudinal distribution of the chestnut blight on north and south slopes

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.

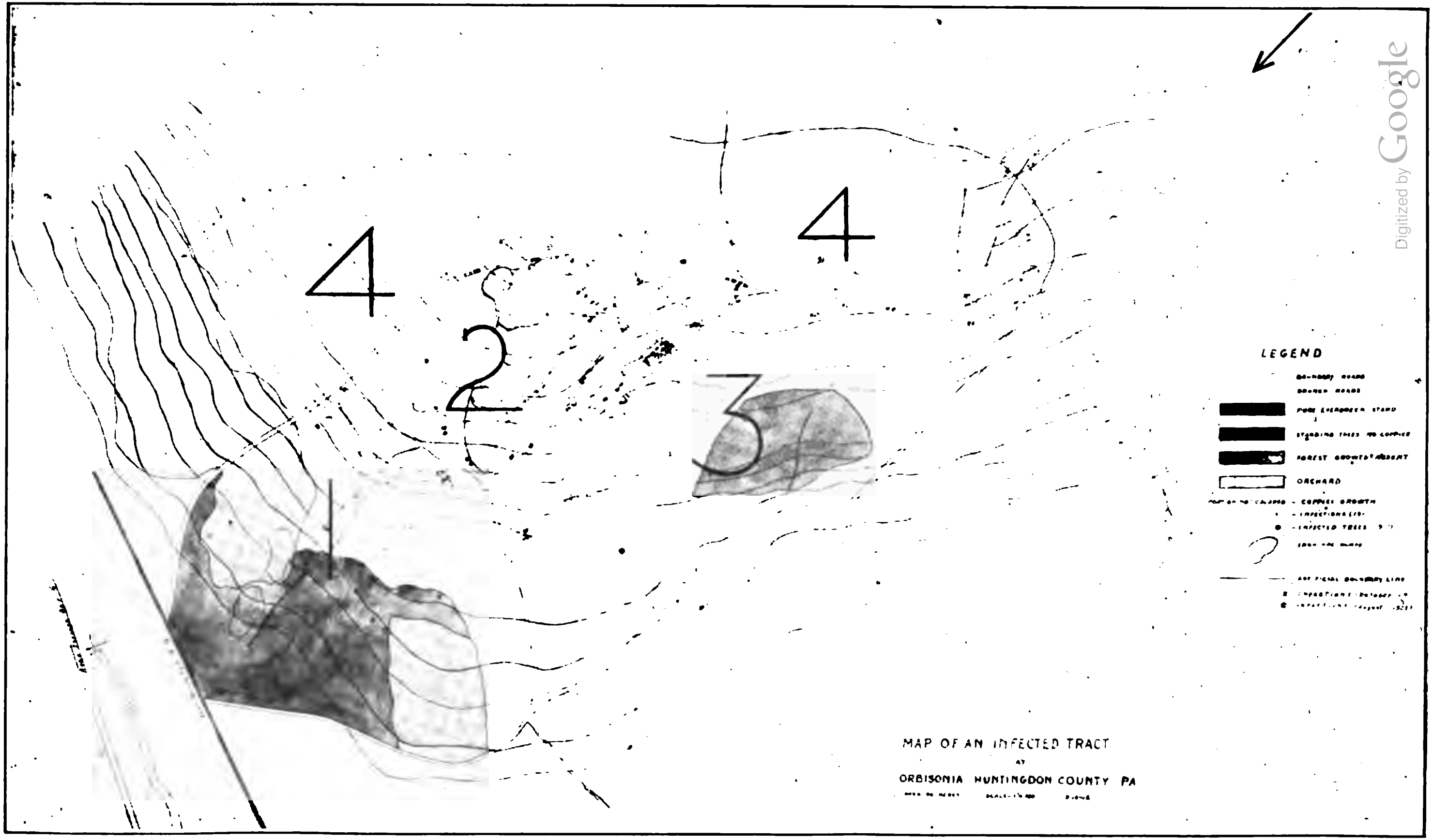
In applying sanitation measures for the control of the blight, it is not practicable to use tree surgery methods and spraying, (except possibly in orchards), but only to cut out bodily every infected tree and to sterilize the stumps. When the blight is generally distributed through a region, as is the 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,	23
	Damp,	37
	Dry to damp,	[illegible]
	Medium dry,	13
	Medium damp,	20
	Windy, dry,	3
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, canno' 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 disadvantag of fewer hours of daylight and occasional loss of a day or two n acount of snow storms that tend to hide the cankers on the tru k and branches. If the snow becomes very deep it is not easv examine the bases of the trees sufficiently, and the snow also gr 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.

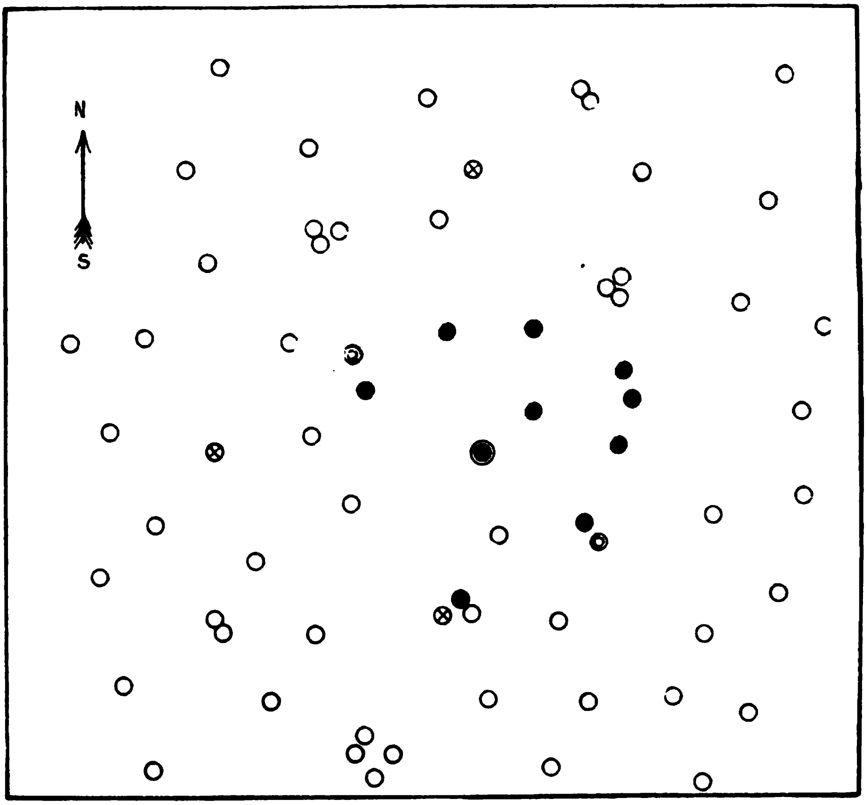
METHOD OF ERADICATING A SPOT INFECTION.

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.

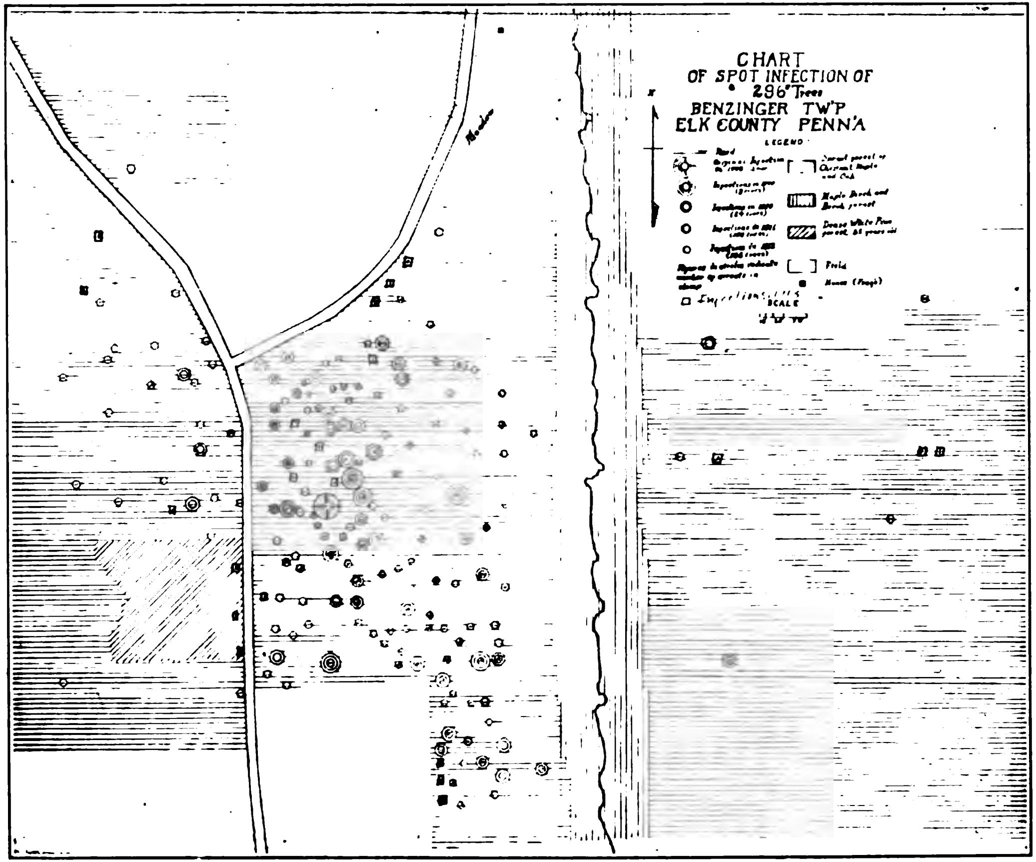
One of the most important time saving items is to peel the lower portion of the tree before felling, and it is still more important to cut the stumps as low as possible. Bark remaining between buttresses and deep crevices of stumps can be removed very readily by chipping down from a position directly 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 reinfection. 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,	8	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 Sprouts. Infected in insect galls.	Infected Sprouts. 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.

Stump Number.	Number of sprouts.	Infected on crotches.	Infected in insect galls.	Basal infection.
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. 813.

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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