Commonwealth of Pennsylvania

DEPARTMENT OF FORESTRY

A REPORT

ON

THE CHESTNUT TREE BLIGHT

THE FUNGUS, DIAPORTHE PARASITICA, MURRILL

By JOHN MICKLEBOROUGH, Ph. D.

MAY, 1909

HARRISBURG:

C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA

1909

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

DEPARTMENT OF FORESTRY

A REPORT

ON

THE CHESTNUT TREE BLIGHT

THE FUNGUS, DIAPORTHE PARASITICA, MURRILL

By JOHN MICKLEBOROUGH, PH. D.

MAY, 1909

HARRISBURG:

C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA

1909

SB
608
C45
1152
1909

LETTER OF TRANSMITTAL.

Hon. Robert S. Conklin,
Commissioner of Forestry:

Sir: I have the honor to present my report on the deadly fungus, *Diaporthe parasitica*, that has caused the destruction of many chestnut trees within the borders of the State of Pennsylvania. The investigations have been carried on to ascertain the presence of this disease in the valleys of the Delaware and Susquehanna rivers. Accompanying the report of its geographical distribution is an account of its life history, its prolific propagation, the damage already done, and suggestions for remedial treatment.

Thanking you and your associates for many courtesies, I have the honor to be,

Most respectfully yours,

JOHN MICKLEBOROUGH, Ph. D.

THE CHESTNUT TREE BLIGHT.

BY JOHN MICKLEBOROUGH, PH. D.

The devastation produced by the chestnut tree fungus, *Diaporthe parasitica*, is arousing the attention of State authorities and deeply concerns the owners of woodland, also the owners of chestnut groves and chestnut orchards. Nothing more serious has ever appeared in the forests of this country than the destructive work of this parasite. Its presence is known by the writer from personal examinations to extend from near the northern boundary of Maryland, through south eastern Pennsylvania, across New Jersey and New York. The line of inspection covers a distance of nearly two hundred and fifty miles. On Long Island the disease has spread for fifty or sixty miles with great rapidity, and is most prevalent and its ravages the most deadly.

In December, 1908, I was invited by Dr. Jane Baker, the physician in charge of Chester County Insane Hospital, to speak before an Educational Conference at Embreeville, Pa. On this visit several infested chestnut trees were found. The disease was not prevalent.

The inspection of forests to ascertain the presence of the blight, under the direction of the Department of Forestry, began March 29th, 1909. The counties first to receive attention were, Dauphin, Lebanon, Berks (west), Cumberland, and Franklin. This is a rich agricultural section of the State lying between South Mountain and North Mountain or the Blue Ridge. The Lebanon and Cumberland valleys are a limestone formation and very few chestnut trees are to be found until the mountain slopes are reached where the chestnut growth is abundant. A careful inspection of the forests was made on each side of the Susquehanna where the river cuts through the Blue Ridge to the north of Harrisburg, and at Middletown where it wends its way beyond the broken ridges of South Mountain. An examination of chestnut forests was made at Wernersville in Berks County, and as far west as Mont Alto in Franklin. Examinations were made along South Mountain at Hunters Run, Mt. Holly Springs, and farther south at Idaville. *The Chestnut tree blight was not found to the north and west of South Mountain.* It becomes an interesting question whether the valley from twelve to twenty miles or more in width between North and South Mountains may not act as an effective barrier to the progress of the disease into the interior of the State. At Mont Alto, the State Forestry Academy was visited. This institution is doing most excellent work. The instructors are able and practical men, and the students are enthusiastic lovers of nature.

The value of having trained men in the service of the Department can not be too highly estimated. The next region of the State to be inspected was to the south and east of South Mountain. From the city of Lancaster three trips were made by trolley, first to Ephrata, second to Quarryville, and the third to Gap. At each of these places the blight was found. Specimens of bark were taken from trees six and eight inches in diameter. Infected sprouts or coppice about stumps were obtained. Under the microscope spores of the deadly fungus in uncountable millions were shown. The disease was most prevalent at Gap. Ephrata in Lancaster is south of South Mountain and is only twelve miles from Wernersville in Berks county where the forests of South Mountain furnished no evidence of the disease.

At Gap, Mr. Levi Wise has a chestnut grove of one hundred trees, consisting of Paragon and Spanish grafts. A distinction is made between a chestnut grove and a chestnut orchard. When the stock is a native chestnut and the scion for grafting is a foreign variety or species, such as Paragon, Spanish, Japanese, Numbo, Ridgely, Alpha, etc., it is termed a grove. When young seedlings are set out in rows, whether grafted or not, it is called an orchard. The blight had invaded Mr. Wise's grove. Infected spots were found on the native stock and also on grafts. The following note was made at the time of the inspection: "The Paragon and Spanish grafts are unusually healthy considering the number of infected native trees in the immediate vicinity." On these trips in Lancaster county it was my good fortune and very great pleasure to have the company of Deputy Commissioner of Forestry, Mr. Irvin C. Williams. It was decided at once to make an Experiment Station at Gap and to plant twenty-five Japanese chestnut trees and to start with one hundred grafts of the same species. Surrounded by natural woodland in which the disease is quite prevalent, here was an opportunity to test the immunity or resisting power of three foreign chestnut growths side by side.

Through the generosity of Mr. Isaac Hicks, a nurseryman at Westbury, Long Island, twenty-five Japanese chestnut trees were donated for the experiment and all the Japanese scions that could be used. Three of these Japanese trees will probably bear this year, and all should begin to bear next year. Mr. Wise had made one hundred new grafts this season, using Paragon scions on native stocks. Within half a mile of Mr. Wise's grove there is another small grove of Paragons on the property of Mr. Thomas J. Bitzer. Seven of the Japanese trees were given to Mr. Bitzer. During the past winter, the writer has had in his laboratory specimens of bark and limbs and sprouts of native chestnut, Paragon and Japanese, all infected. And yet from the examination of hundreds of trees of each kind,

and nine chestnut groves in widely separated localities it is firmly believed these chestnut groves and orchards may be protected from the ravages of this fungus growth.

Since the blight was found at three places on the east side of Lancaster county, an inspection was made at two points on the western border. At Martic Forge, or Marticville, the blight was found on native chestnut trees in the immediate vicinity of, and in the grove of the Paragon Nut Co. The grove contains nearly four hundred acres. About two hundred infected trees had been removed from the grove. The wood was on a pile at the woodshed. Many of the sticks on the wood pile were infested with living spores. The blight is a bark disease and when a tree is felled the bark should be burned at once. When the bark has been removed, the wood may be used for various purposes. The bark on the stump should be burned for two or three inches below the surface of the ground. Spores will be developed and propagated many months after the tree has been cut down. Specimens of infected bark have been kept in sealed test tubes for more than nine months and on examination the spores were alive and as active as on the day when selected for the experiment. Martic Forge is thirteen miles directly south of the city of Lancaster and about four from the Susquehanna river. The next inspection was made at Marietta, located on the Susquehanna and about sixteen miles directly west of Lancaster. At this place Mr. John G. Engle has a grove of one hundred and twenty-five trees, chiefly Paragon. His grove is in excellent condition. There was no evidence of the blight and no indications that it has ever existed on his property. The grafting which had been done by him several years ago is as perfect in the union between scions and stocks as can well be obtained. Infected trees on other property were found at Marietta. Specimens of bark and branches showing the disease were taken from native growth and also from Paragon grafts from two small groves in the vicinity which had been seriously infected. In Lancaster County the disease was found at three places on the eastern border and at two places on the west. In Adams county, at Gettysburg, there is no chestnut growth to speak of, but in the northern part of the county at Idaville the forests are chiefly chestnut and oak. This village is on the south side of South Mountain. Much care was exercised in the inspection at this place and hundreds of trees on several lots were examined. No evidence could be obtained of the presence of the disease at Idaville.

The next county to receive attention was Montgomery. Specimens showing the infection were obtained from the trees on the campus of Haverford College. Three estates near Haverford were examined. The chestnut was the prevailing tree in this portion of the State. In

one case all the chestnut trees had been carefully treated by cutting off all dead limbs and each wound covered with tar or paint. All the trees, several hundred in number, on the estate of Mr. Harold Pierce were in a fine healthy condition. On two other estates, dead trees had been felled during the winter, but in one instance the pile of cordwood contained abundant evidence that the fungus parasite had done its deadly work, and in the other all the wood and brush had been burned, but an examination of the bark on the stump revealed the fact of the existence here of enough living spores to infect all the trees of the neighborhood, should they find a lodgment on their favorite hosts, the chestnut trees.

The next trip was to follow up the valley of the Susquehanna to the north of Harrisburg. At Sunbury in Northumberland county, the North Branch and the West Branch unite to form the Susquehanna river. At this point the forests for a distance of ten miles, along the river and its two main branches, were examined. The chestnut growth was not so abundant as along the slopes of South Mountain. No evidence could be obtained of the presence of the blight. A side trip was taken up the Shamokin valley. This gave an opportunity to examine the Paragon grove of Mr. C. K. Sober, situated about twelve miles in a direct line from Sunbury. This famous grove contains about four hundred acres and all the trees bearing fruit. Here is a demonstration that waste mountain land, on which the native chestnut grows, may be redeemed and become a profitable investment. One year Mr. Sober had two thousand bushels of Paragon chestnuts to sell. And since the selling price has ranged from \$5 to \$12 per bushel, one can estimate the income from this source. In his nursery, he had approximately three hundred thousand seedlings and about one hundred thousand of these were to be grafted in the spring of 1909. In large banks or mounds of sand there were one hundred bushels of nuts which would be planted early in May. The object on all trips was primarily to inspect the natural woodland. The native growth of chestnut on Herndon Knob was examined and also the opposite ridge two miles away across the valley. There was no sign of the blight in Shamokin valley nor in any other portion of Northumberland county that was visited.

At Sunbury an inspection was made to the east and south of the Susquehanna, and at Bloomsburg it was to the north or on the opposite side of the river. No sign of the blight could be found in Columbia county. With Mr. S. C. Creasy a drive was taken to Millville, twelve miles from Bloomsburg on the Susquehanna. The chestnut trees are very abundant in certain parts of Columbia county. Mr. Creasy is well informed on all subjects pertaining to forestry in

its practical bearing and his company was a great delight. The next stop was made at Wilkes-Barre. In company with Mr. J. E. Patterson a trip was taken to Glen Summit Springs, about nine miles south of Wilkes-Barre. In these trips frequent stops were made and a dozen or more investigations were undertaken. Luzerne county did not furnish a single specimen that gave any indication of the presence of the blight.

At Scranton on the Lackawanna river, a tributary of the Susquehanna, there is little or no chestnut growth. Valuable information was obtained from Mr. T. J. Snowden, a lumber dealer, as to the character of what little forest growth remains in that part of the State. In his lumber yard there were four hundred chestnut posts from six to eight feet in length. These had been cut at Hawley near the border of Pike county. Having been recently cut, the bark which was on the posts would have given evidence of the disease had it existed. There was no sign of the blight on any of these posts.

The next stop was made at Carbondale in the northeasterly part of Lackawanna county. Here as at Scranton, the lack of forests in general, and especially of chestnut trees, precluded an extended investigation. Going eastward over the divide between the Lackawanna river and the Lackawaxen creek or in a broader sense over the highland which separates the watershed of the Susquehanna from that of the Delaware river, the work was taken up at Honesdale. No chestnut growth could be found within ten miles of Honesdale, was the information received from Mr. Kreitner of that town. Since the writer had found the blight at Milford on the Delaware, in Pike county it became an important question to ascertain if it had spread westward and been carried into the upper portions of the Susquehanna valley. The disease exists at Milford and farther north to within three miles of Matamoras, Pa., opposite Port Jervis, N. Y. With Mr. E. T. Riviere of Milford, infected trees were found to the west and again to the south of Milford. Specimens of the blight were taken about one mile from the Camp of the Yale Summer School of Forestry on the estate of Mr. Gifford Pinchot, Chief of the U. S. Forest Service.

To sum up for the Susquehanna valley. The chestnut tree blight was *not found* north of South Mountain. It was found in several localities south of South Mountain along the Susquehanna and on the watershed lying to the east of the river.

In the Delaware valley infected chestnut trees were found at Embreeville in Chester County, on the Brandywine, a tributary of the Delaware river; at Haverford in Montgomery county; at Trenton, N. J., and across the river at Morrisville in Bucks county; near Easton in Northampton county; and at Milford and Matamoras in Pike county. Nowhere in Pennsylvania has the blight become so virulent

1.

2.

*The flasks or perithecia,
with long tubes. Magnified.*

*Thread mass of
summer spores.
Magnified.*

3.

4.

*The 8 spored sacks.
Magnified.*

*Spores from thread
mass. Highly magnified.*

and malignant as in New York, especially on Long Island. In the winter of 1908, over eleven hundred chestnut trees were felled in Prospect Park in Brooklyn, N. Y. Many of them were dead and the others so infected that removal was the best course to pursue. Forest Park, is another large park in Brooklyn. It contains 536 acres of which about 350 acres are natural woodland. The Park Commissioner reports fifteen thousand or more chestnut trees in Forest Park. At this date, May, 1909, these trees are standing, but greater havoc from blight or insect pest on forest trees has probably never been excelled in deadly malignity. The disease is so prevalent, that it is proposed to cut every chestnut tree in the Park. On many estates on Long Island similar conditions exist.

THE LIFE HISTORY OF THE BLIGHT.

Neither insect pests nor blights can be dealt with successfully until the life history is known. It is almost useless to strike at one of these supposed antagonists in the dark. Is it much better to know your antagonist, where it lives, and how and when it is propagated. As to the chestnut blight, its general appearance should be known at different stages of growth and for each season of the year. Does it have the same appearance in the resting stage of winter as in the rapidly growing condition of summer?

The first scientific description of the chestnut blight was given in 1906 by Dr. Wm. A. Murrill of the Bronx Botanical Garden, New York City. After a year or more of study and experiment the fungus was proved to be a new species. It belongs to the class known as the sac-fungi and to the genus *Diaporthe* of which more than one hundred species are known to science. The scientific name of this blight is *Diaporthe parasitica*.

Many of the fungi derive their nourishment from decayed vegetation. Such are the common brackets or shelves on stumps and logs and are properly called saprophytes. Other saprophytes live on decayed animal matter. When one looks at a puff-ball, mushroom, or bracket on a log, it is the fruiting body of the fungus that is under observation. Besides this there are hundreds of fine threads a yard or more in length penetrating the mould or decayed log. These threads or mycelia take up the nourishment and produce the fruiting body. Some fungi, however, derive their nourishment from *living* plants or animals, and are consequently called parasites. Ringworm that attacks man is a fungus parasite, *Trichophyton tonsurans*. The deadly chestnut blight is also a fungus parasite. The ringworm burrows beneath the skin and the chestnut blight lives in the bark and derives nourishment from the new cells of the cambium. The other hundred or more species of *Diaporthe* live, as a general rule,

on decayed wood and do not attack the living. They are saprophytes and not parasites. This distinction should be kept in mind.

The saprophytes are found on *dead* limbs and trunks of the locust, mountain maple, hickory, ironwood, ash, chestnut, basswood, elm, walnut, oak, red maple, beech, willow, sassafras, golden rod, aster, and many other plants. After a forest fire many forms of saprophytes may be found on the *dead* limbs and trunks of various trees.

What are fungi? They are plants produced by spores and in this respect differ from seed-bearing plants. The ferns and the mosses are also spore plants and are higher in the scale of plant life than the fungi. The fungi include the moulds on bread, cheese, and preserved fruits; mildews, as the downy mildew causing the rot of the Irish potato; rusts on wheat; black-knot on the plum and cherry; mushrooms, edible and poisonous; yeasts; puff balls, etc.

The total number of plants of all kinds known to science is about two hundred thousand species. There are about fifty thousand species of fungi, and of this number about fifteen thousand belong to the sac-fungi (Ascomycetes). The sac-fungi are a very destructive form of fungus growth and produce a number of diseases on account of the fact that many of the species have the parasitic habit. In this division of fungi, there are the leaf-curl of the peach; the black-knot of the plum and cherry; many of the powdery mildews; the large morels, prized for food; the yeast plant, known to makers of bread and beer; the green mould on cheese, as well as the deadly chestnut blight. After the chestnut trees or sprouts have been killed by the blight, numerous other fungi will attack the dead wood. These must not be charged with the destruction of the tree or sapling. These are the scavengers that come to feed upon the dead and are known as saprophytes. Between thirty and forty different species of fungi are known to attack dead chestnut limbs, stumps, and logs.

PROPAGATION OF THE CHESTNUT BLIGHT.

The *Diaporthe parasitica* is propagated by at least two kinds of microscopic spores. One kind of spore is developed in minute sacs. Each sac contains eight spores and nature fills each tiny sac with the eight spores as uniformly as one finds four legs on a dog and two on a bird. These are sometimes called the winter spores. These spore-sacs are developed in minute flasks resembling carafes or long necked water bottles and are formed abundantly in the autumn. In this way the fungus tides over the winter. Another kind of spore more minute than the winter spore may be found in thread like masses in early spring and during the summer. These are called summer spores, or conidial spores. Conidial is derived from the Greek word meaning dust. Sometimes the thread mass or spores is more than half an inch in length. Such a thread will furnish millions of spores.

These two kinds of spores are different in origin but the same in power in producing the young plant. For the benefit of the microscopist it may be well to state, the winter or sac spores are sexual spores and the conidial or summer spores are non-sexual. It would take from five to six hundred of the tiny sacs placed end to end to measure one inch and about three thousand of the sac spores end to end to measure an inch, and of the minute summer spores eight to nine thousand. Both kinds of spores are produced by countless millions. A section of a limb twelve inches in length and one inch in diameter will furnish an ample supply of spores to infect all the chestnut trees in a county. The minute spores are carried by the wind, on the feathers of birds and the fur of squirrels, and find a lodgment where the bark is abraded and especially in the fork of the limbs or more tender branches. The spore immediately sprouts, and procures its nourishment from the new wood or cambium layer. These newly formed wood cells have very thin delicate walls and are full of sap. Thus the cambium furnishes the parasite with ample nourishment. The walls of the new wood cells are broken down by the growing parasite and the bark begins to change color from a healthy olive green on twigs and slender branches to a reddish brick color, and the parasite shows a tendency to girdle the limb or trunk. As soon as the girdle is complete, all nourishment is cut off from the parts beyond the infected portion. The result is the same whether the girdling is done with an axe, a saw, or by a parasite. Large trees are girdled and killed in two or three years. During the summer of 1908 many branches of chestnut trees showed signs of decay and the green leaves of spring withered long before the frosts of autumn had touched the foliage. So far we have spoken only of the growing fungus. Its work during this stage is carried on in and beneath the bark. It is technically speaking a hypophloeous disease. The next stage is known as the fruiting period. As the fungus grows it finally matures and develops the fruiting body, or rather fruiting bodies. Its growth is now outward, through the pores in the bark. In old trees the fruiting or spore producing bodies are in the long crevices or fissures of the bark. A piece of a limb kept in the laboratory where the changes in the weather will not affect it, will soon be thickly beset with small yellow pustules, resembling little yellow cushions of velvet. These are fruiting bodies of this parasite. Running through the pustule are some dark lines. These are the necks of the flasks or perithecia at the base of the pustule and are situated just beneath the outer layer of the bark. These flasks are lined with the eight-spored sacs. In early spring and during the summer the thread masses consisting of the summer or conidial spores will be found. These threads are dissolved and washed away by the rain and the spores are blown about by the wind. These developments

may be seen best on specimens in the laboratory. A common fruit jar, in which is placed a four or six inch piece of an infected limb, will, in thirty-six or forty-eight hours show signs of the fruiting bodies. First put the stick into water for two or three minutes then transfer it to the jar in which there is less than half an inch of water. The jar is closed and kept at summer temperature. A warm cellar is most convenient, since the fungus grows in the dark as well as it does in the light. In this way the writer has had an abundant supply during the past winter of fruiting pustules on limbs of the native chestnut, *Castanea dentata*; on the Japanese chestnut, *Castanea crenata*; and on the Paragon, which is probably a variety of the Spanish or sweet chestnut, *Castanea vesca*. From these specimens the two kinds of spores were at hand during the entire winter.

Foreign chestnut trees sometimes attain an immense size, and are quite common in the south of Europe, in Spain, Italy, Switzerland, and Germany. The fruit or nut which is two or three times the size the American nut is much used as an article of food. The large kernel is frequently ground into meal and is used to thicken soups, and even bread is made of the chestnut flour. The largest foreign chestnut tree is on the slope of Mt. Etna, in Sicily, and has a circumference of 190 feet, and is known as the "Castagno di cento cavalli," the chestnut of one hundred horses.

There is no lack of opportunity for spores to find an entrance beneath the bark of a chestnut tree, large or small. The wood is brittle and the storms of winter leave many broken twigs and limbs. The small boys and older nut gatherers have clubbed the trees and left many a scar. Insect borers and woodpeckers have made openings in the bark in many places. The forks of the branches seem to be favorite places for the lodgment of spores. In a young tree ten or more points of infection have been observed at the break of the bark in the forks of the limbs.

The propagation is readily carried on wherever there is a supply of spores. The transportation and ready access to the cambium wood cells are well provided. On Long Island an isolated tree, more than a mile distant from any chestnut growth was infected.

IMMUNITY OF OTHER TREES.

All the other forest trees seem to be immune. There are fungus growths of the saprophytic type on all forest trees. Abundant spores of another species of fungus were found upon the branches of several oak trees. The trouble was limited to the under side of the branches, and there was no tendency on the part of the fungus to invade the new cells of the cambium or to girdle the branch. An examination of

THE CHESTNUT BLIGHT AS FULLY
DEVELOPED BY INCUBATION.

(From a Color Photograph.)

the locality revealed the fact that it had been swept by fire a year or more ago and the under side of the limbs had been injured. The fungus was merely doing scavenger work, and living upon decayed vegetable tissue. Many times questions have been asked about the horse chestnut, *Aesculus hippocastanum*. The common horse chestnut or buckeye is a near relative of the maple and is quite unlike the oak, chestnut, and beech, belonging to the same natural order, *Cupuliferae*, from the fruit being contained in a cup or burr. Another question,—is the chestnut oak immune? It is just as immune as any other oak. Up to this date the writer has not found the deadly chestnut fungus on the chestnut oak, sometimes called rock oak, or *Quercus Prinus*, L. Hundreds of the chestnut oaks have been examined and although growing side by side with diseased chestnut trees, no case of an infected oak has been discovered.

The variety of chestnut called the Paragon, is quite susceptible to the disease. While the Japanese variety or species is not immune, it is certainly more resistant than the native or the Paragon. In one locality eleven Japanese chestnut trees were in a perfectly healthy condition and bore abundance of fruit in the summer of 1908, although in the immediate vicinity there were many native trees all badly infected. Within one hundred yards of these eleven trees there was a Paragon infected in several different places. In a nursery of twelve or fifteen hundred young Japanese chestnut trees, there were many young native chestnut seedlings from five to ten feet in height. It was almost impossible to find a native tree free from the infection. On the other hand many of the Japanese were immune, yet on an extended examination some five or six of the Japanese were infected, and under hothouse treatment developed a rich supply of spores. Evidently an orchard of Japanese or Paragon chestnut trees can be made profitable and the trees kept in a healthy condition with reasonable care.

ESTIMATED VALUE OF PROPERTY DESTROYED.

The statistics furnished by the United States government show that for the year 1907 over 600,000,000 board feet of chestnut lumber were cut. Valued at \$17 per 1,000 the total value would be about \$10,000,000 for one year. Besides, there were over \$3,000,000 for chestnut cross-ties. Much timber is used in the mines, and also for fence posts and telegraph and telephone poles, and by cabinet makers. The tanneries also use many cords of chestnut wood. The market value of the nuts is no inconsiderable item. In 1908 it would appear, the output of all kinds from the chestnut forests of the United States would aggregate \$22,000,000. Should the chestnut blight become as prevalent and virulent as on Long Island, and advance as

rapidly over the country as it has moved eastward on the Island, it is only a matter of a few years when this source of income will be reduced many millions per annum.

The number of chestnut trees on an acre of natural woodland has been counted in New York, New Jersey, and in Pennsylvania. In some counts there were from forty to fifty chestnut trees to the acre disregarding any tree under two or three inches in diameter. In Somerset and Morris counties, N. J., an average of thirty chestnut trees to the acre would be a low estimate for many pieces of woodland. The damage already done by the chestnut blight in the States of New York, Pennsylvania, and New Jersey would not be less than \$12,000,000; and when the special value from location on lawns and the aesthetic value in landscape features are considered, two or three millions could be added to this estimate.

REMEDIAL TREATMENT.

Let us notice the conditions in the life history of the chestnut blight. It is a vegetable growth and in its development, the threads penetrate the delicate cells of the newly forming cambium. Summer spores are produced from early spring to late autumn. On the approach of winter, the winter spores are developed in sacs and the sacs line the flasks or perithecia, and in this way tide over the severest cold in the resting stage.

In the case of a large tree, if it is infected at several points it would be advisable to cut it down at once. All the branches and the loose bark should be burnt. The wood may be used for various purposes. If allowed to stand, it furnishes millions of spores, and the wood is greatly injured on account of the attack of saprophytic fungi of various kinds and also certain insect pests. Young trees are destroyed in one or two years after becoming infected. The girdling process is soon accomplished and the cutting and burning of such growth is recommended. First, all undergrowth about the chestnut trees should be removed. An examination of the trunk will soon reveal the healthy or living condition of the new wood beneath the bark. If the layer beneath the bark is destroyed, the extent of injury up and down and around the trunk can be ascertained. If only a limited area has been destroyed, the dead portion, bark and dead wood should be cut away and the wound covered with tar. If only a few limbs are attacked, their removal should not be delayed, if the tree is considered worth treatment. Cover all wounds with tar. The two discouraging features about any treatment arise, first from the difficulty of finding all infected spots on a large tree, and second, many owners of woodland will not give attention to the matter.

A few neglected trees will supply enough spores to infect all the

trees for miles around. When the spore has found a lodgment in the layer of new growing cells beneath the bark, only the greatest care will prevent the growth and maturity of the fungus. No forest tree develops sprouts or coppice more abundantly than the chestnut, unless it is the basswood. If the tree is much infected almost invariably the blight will be found on the coppice about its base. A chestnut stump will aid the investigation, for it is sure to be surrounded with an ample supply of sprouts. The bark of an old tree has deep crevices or fissures. In these fissures in the bark of old trees the fruiting bodies are found. If the layer beneath the bark is dead, the deepest part of the fissure should be examined for rows of little red tubercles. Here is where the microscopist finds the sacs with their eight spores, as well as masses of summer spores. By tapping on the thick bark with a hammer, the muffled sound will indicate where the bark is dead. If the area is small it can be cut away and the place tarred.

Many suggestions have been made about injecting some chemical that would enter into the circulation and destroy the fungus. So far nothing of practical value in this line has been accomplished. There are fungicides but if used in sufficient strength to kill the growing fungus, the treatment is about as injurious to the tree as is the disease. Trees kept free from undergrowth and frequently inspected and by cutting as soon as the infection is observed, may be saved and kept in a healthy condition. Chestnut groves and orchards may be protected by careful inspection and prompt treatment. If a tree is badly infected its removal is advised. All bark should be burned at once. The bark of the stump well down into the ground must not be forgotten.

While spraying hundreds of forest trees is out of the question, yet grafted trees in groves or orchards may be benefited by spraying, and a limited number of young chestnut trees on a lawn may be so treated. In the Zoological Bulletin, Oct. 1, 1907, page 190, Prof. H. A. Surface says of the Lime-Sulphur Wash; "It is a fungicide as well as an insecticide and cleans up many of the disease germs, such as those causing leaf curl, leaf spots, rusts, mildews, apple scab, and other diseases of leaves or fruits." The Bulletin of March 1, 1909, contains all necessary information on spraying. Many spores may be washed away, but this infection is protected because it grows beneath the bark and is scarcely touched by spraying.

Trees have been treated by using cotton saturated with Bordeaux mixture. Small bunches of raw cotton saturated with Bordeaux and wrapped in burlap have been tied in the forks of the limbs. To be effective, it would be necessary to treat every fork of the limbs and twigs in this manner and also abraded bark on any part of the tree.

Whether the blight will spread inland must remain a problem for

further investigation. At present it appears to be following the coast. On woodland in several localities in Pennsylvania its existence can be shown, yet it can not at present be considered a discouraging menace. On the other hand should the disease spread from tree to tree as is now the case in certain localities in New York and New Jersey, every available measure should be adopted to prevent the propagation of spores by cutting the trees and burning all infected bark.