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REPORT ON

White Pine Blister Rust Control

1918

PUBLISHED BY THE
AMERICAN PLANT PEST COMMITTEE
4 JOY STREET, BOSTON, MASS.

WILFRID WHEELER, Chairman
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EXECUTIVE COMMITTEE

COMPOSITION OF COMMITTEE

The Committee is composed of four members from each State in the United States, and four from each province of Canada, and the personnel so far as practicable, consists of the Commissioner of Agriculture, State Forester, State Entomologist, State Pathologist and corresponding officers in the Provinces of Canada. Horticulture is generally included under Agriculture, but in some instances, there is a State Horticulturist, who is a member of the Committee.

The membership is limited to four from each State and Province and in each case the aim is to secure those officials who have most to do with plant pest control.

PURPOSE

The purpose of the Committee is to inform the public concerning dangerous plant pests, and to secure measures for their eradication or control. The chief object is to attack effectually, any plant pest in its incipient stages, before it has had time to become permanently established.

TO THE PUBLIC

White pine blister rust is a destructive fungus native to the Old World. It kills white pine and other five leaved pines by girdling. In 1915, the blister rust was found on currants and gooseberries in parts of New England. Foresters and pathologists immediately held a conference and organized the Committee on the Suppression of the Pine Blister Rust in North America, now reorganized as the American Plant Pest Committee, which at once secured Federal and State appropriations for fighting the disease. This brief publication summarizes the result of the third season's experiments and investigations.

TEN POINTS TO REMEMBER

1. The blister rust cannot spread from pine to pine. It destroys white pines only after a period of growth on currant and gooseberry bushes, and in *no* other way.

2. The destruction of *all* currant and gooseberry bushes (wild and cultivated, including flowering currants) is the only successful method of protecting the pines.

3. All known facts indicate that the maximum distance to which it is necessary to remove currant or gooseberry bushes does not exceed one-third of a mile, even under the most favorable conditions for infection. Under ordinary conditions a distance of 200 yards between white pines and currants or gooseberries will give much protection, probably sufficient to grow white pine commercially.

4. Pines of all ages are attacked, but the older the tree the longer it takes to kill it. Young pines, under 25 or 30 feet in height, should be given protection first to insure their reaching a marketable size.

5. Commercial planting of white pine is practicable, if care is taken to secure uninfected planting stock, and if *all* currants and gooseberries are destroyed in and around the planting area to a distance of not less than 200 yards, and preferably to at least 500 or 600 yards.

6. Whenever you see a *wild CURRANT or GOOSEBERRY bush, PULL IT UP,* and hang it up so that it cannot grow again. Go over your land systematically until it is clear. Be sure to pull up the bushes by the roots; do not cut or break them off or they will sprout again.

7. Cultivated black currants are especially susceptible to the disease, and cause very serious pine infection. In the infected regions, they should not be grown within one-third of a mile of white pines.

8. Spraying will not prevent or cure the disease on currant, gooseberries or pines.

9. If you suspect the disease on pines, currants or gooseberries, send specimens to your State Forester, State Nursery Inspector, State Agricultural Experiment Station, or the Office of Forest Pathology of the United States Department of Agriculture, Washington, D. C.

10. White pine is one of the most valuable and most useful commercial trees in North America. White pine growth on lands that would otherwise be waste has paid off mortgages, improved farms, and educated families. Its logging and manufacture provides employment for thousands of people. With heavy taxes to pay after the war, we cannot afford to lose our white pines.

RESOLUTIONS OF THE COMMITTEE, 1918

The fourth annual conference of this Committee was held on November 11 and 12, 1918, in the State House, Boston, Mass. Reports on the progress of blister rust control were made by the officials in charge. These reports are much too comprehensive to be given in detail, but a brief compilation, giving the principal facts presented, appears on the following pages.

The resolutions adopted by the Committee are:

1. This Committee re-affirms its position taken at previous meetings, that the responsibility for control of the blister rust must rest finally with the forest owner; but, in order to hold the ground already gained, and not to lose the benefits of the excellent work already accomplished in many places, it recommends that Federal, State and Provincial and other public appropriations for experimental, demonstration, control, and eradication work in the Eastern States and Provinces be continued, notwithstanding war conditions.

In the Western States and Provinces, the Committee notes with satisfaction that continued scouting has not revealed the presence of the blister rust; the Committee recommends, nevertheless, that scouting in these States and Provinces be kept up, and that State and Provincial appropriations be made and Federal appropriations continued to this end.

2. We recommend that each State may well have three or four district agents trained in educational propaganda, or especially adapted to carry it on, through whom personally the schools and the leading citizens in the various towns can be reached. We recommend that material for publication be prepared and distributed by the State Department having charge of the blister rust work in each state. We emphasize the educational importance of taking land-owners, children and others into the infected areas where practical control methods are being put into actual practice. We also recommend the holding of occasional State Conferences of workers, as a means of increasing efficiency.

3. It is the sense of this Committee that protection from serious injury of White Pine plantations in localities where Ribes* can be removed is practicable, as far as danger from blister rust is concerned. It is assumed that the trees to be used in all planting have not been exposed to blister rust and have not acquired the disease.

Note.—This resolution conforms with the resolution passed at the 1917 conference, which reads:

"In addition to eradication of Ribes within a pine area, this Committee is of the opinion from evidence so far obtained that in the future serious loss from a commercial standpoint is not to be expected if the area is surrounded by a Ribes-free zone one-third of a mile in width."

4. With the recent discoveries of the presence in this country of the European Corn Borer and the European Potato Wart disease in mind, the Committee is more than ever convinced of the immediate and pressing necessity for the exclusion from this country insofar as practicable of all materials likely to introduce dangerous pests. It therefore urges the Federal Horticultural Board to exercise its powers to the fullest possible extent.

The following recommendations of the Committee on Reorganization, Cooperation and Plans for Future Work were adopted:

1. That the activities of the Committee be extended to cover new and introduced pests of plants.

2. That the organization be known as the "American Plant Pest Committee."

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* Note. For the sake of brevity and convenience, the botanical name, Ribes, is used in this publication to designate all species of currants and gooseberries.

Status of White Pine Blister Rust Control In 1918

Compiled by Samuel B. Detwiler

UNITED STATES

NORTHEASTERN STATES. War conditions made it impossible to conduct blister rust work this year on the scale for which plans had been made. Scouting in 1916 and 1917 proved the blister rust to be generally prevalent in the white pine regions of New England and northeastern New York. Infection on currant and gooseberries this year was not as heavy as in the two previous years, apparently due to the dry season. Many new native pine infection centers were found but most of these are of small size. All indications point to a steady increase in the size and number of centers. A comparatively large amount of pine infection is expected in 1919, due to the heavy Ribes infection of 1916.

Field observations indicate that the bulk of the white pines are as yet free from this disease, but without the removal of adjacent currants and gooseberries it is only a question of time until great damage will be done to the pines. The situation in the Northeast demands that owners should not delay in uprooting wild and cultivated currants and gooseberries to as great a distance as possible (up to a third of a mile) from their stands of white pine. During the past season, many pine owners destroyed wild and cultivated currants and gooseberries with their own labor. Others were equally disposed to co-operate, provided such action would lead to the extension of definite control areas in the community.

Areas of young pine should receive first attention, since the development of the disease in such areas will prevent the marketing of the pine in question. However, it must not be forgotten that stands of mature pine are rapidly replaced by young growth. It appears from present knowledge that it will be well to scout a control area a second time after an interval of two or three years, to destroy Ribes which develop from seedlings and sprouts. After that it is hoped that the ground will not have to be covered again more than once in five years.

The prospects for practical blister rust control are favorable. Much has been learned about the best way of handling the whole situation. Proof is at hand that wild currants and gooseberries can be found and destroyed at a cost that is not prohibitive. Continuation of experiments in demonstration control areas will undoubtedly further reduce costs and increase efficiency. The return of men from the war will relieve the labor situation. Method and discipline count in pulling gooseberry bushes. Nothing but the best work will pay, and the way to insure this is to employ the best men available. All of the Northeastern States have distributed bulletins, circulars and posters and much educational work has been done at fairs and in the schools. This work should be continued for the purpose of extending practical control to pine areas as rapidly as possible.

MAINE. Most of the work was done in two demonstration control areas located at Kittery Point and Alfred. Both of these areas were covered for Ribes in 1917, but it was thought best to go over them again this year, as a check. A new control area was established in the town of Brunswick, surrounding an area of diseased pines.

Sixteen men were employed during the field season from June 1 to September 30. Six-men crews gave the best results. One acre of swamp at Alfred had 1470 wild gooseberry bushes, requiring 17 hours of man-labor to eradicate, and costing $3.78, the extreme figure. The average labor cost per acre was $0.30 at Alfred, $0.40 at Kittery Point, and $0.25 in the Brunswick area. A total of 4903 acres was gone over during the season and 92,000 Ribes plants destroyed at an average cost of $0.32 per acre.

Future efforts at Ribes eradication should be confined to the vicinity of tracts of young white pine, where the value of the timber will justify the expense of Ribes eradication. Local co-operative control should be encouraged and developed so far as possible. An average figure of $0.32 per acre would seem to be a fair one where Ribes are eradicated by individual landowners. Such an expenditure may well be recommended as protective insurance on young stands of white pine.

No compensation was paid for cultivated Ribes, as most of the plants were diseased and the owners made no claim. Blister rust was not found in any of the commercial nurseries inspected during the season. No general scouting was done, but 46 pine plantations containing more than 250,000 trees were inspected, and suspicious specimens found in two places.

NEW HAMPSHIRE. In 1917, out of 76 towns which contained considerable areas of pine timber land, 8 had infected pines, and 71 had infected currant and gooseberry bushes. In view of these conditions, each town was asked to make a certain minimum appropriation for control of the blister rust. Forty-three towns appropriated a total of $7,125.00 for the purpose. Projects were completed in 30 towns and 959,315 currant and gooseberry bushes were destroyed on 66,652 acres at an average cost of $0.39 per acre. An average force of 70 men were employed in field work from May to October.

Interest on the part of the private owners was evidenced by voluntary contributions of funds to pay for control work on their own property. In Peterborough alone $753.15 was thus contributed and resulted in the removal of currants and gooseberries from 2038 acres. Such interest on the part of private owners points to possibilities which are of fundamental importance in making plans for the future.

The demonstration control area started at Conway in 1917 was extended this year into the town of Bartlett. A total of 53,551 wild Ribes plants were pulled on 1790 acres at an average cost of $0.71 per acre. Scattered pine infections were numerous throughout this area; on 2 acres at Dundee, and 2.03 acres on the State road, all of the pines were generally diseased. On the entire area, 35% of the Ribes were infected with the rust. Daily records show that 48% of the bushes found in June were diseased—33% in July, and 29% in August. This area was carefully mapped to outline the forest types. Skunk currant predominated in all types except in fields and along highways, where there were more wild gooseberries. Cultivated Ribes were destroyed in the village of Lower Bartlett, 116 bushes being found, all of them infected. It is gratifying to report that no one demanded compensation.

Checks were made to determine how thoroughly the crews located and uprooted wild Ribes. Along 3200 feet of roadside, in dense undergrowth, 717 bushes were pulled the first time over the area, and only 5 bushes the second time. In a half acre of skunk currant growth 539 plants were found the first time and two when the area was gone over again. Careful checking was done on 77 acres of swampy land covered with hardwood brush 6 to 8 feet high, old slash, briars and berry bushes, which made eradication especially difficult. In spite of this, 34,752 bushes were found in the first working of the area, 46 bushes in the second, and none the third. These facts show plainly that wild currants and gooseberries can be found and destroyed by conscientious work.

VERMONT. Limited scouting in 1918 revealed the presence of well established native pine infection in the town of Barnett, and Ribes infection through Rutland, Chittenden and Addison counties. Diseased Ribes were also found at Shrewsbury, Goshen, Randolph, Newberry, Glover, and other points so widely scattered about the State as to indicate very general blister rust infection.

The undesirability of drawing upon the already greatly diminished supply of farm labor was the chief factor in limiting the work in 1918 to development of demonstration control areas. Four eradication crews of 6 men each were employed during May, June and July on control areas begun in 1917. At South Royalton, 7,313 wild gooseberries were pulled on 75 acres; 9% of the bushes were infected. On the Downer State Forest Farm at Sharon, 36,468 (99% prickly gooseberries) were removed from 473 acres surrounding the pine plantations. The high average cost of $2.47 per acre is due to the unusually large number of Ribes and the density of undergrowth.

The demonstration control area at Thetford was re-scouted. On 3,053 acres 25,025 Ribes were pulled, of which 93% were prickly gooseberry, 5% skunk currant and 2% cultivated currants. Costs ranged from $0.29 per acre in pasture to $1.79 in swamps. The average in 1918 was 8 Ribes per acre at an average cost for eradication of $0.85 as compared with 6½ bushes per acre, at a cost of $0.63 in 1917.

The importance of doing the work early in the season cannot be overemphasized. Wild Ribes leaf-out much in advance of other plants, and therefore are prominent early in the spring. The ideal procedure would be to begin

eradication work as soon as leaves begin to show plainly on Ribes and to complete it before other vegetation has a chance to hide the Ribes bushes. Under this plan, eradication costs would be lowered. The fairest example is in the working of pasture land. In May the average cost per acre was $0.25; in July it was $0.52.

MASSACHUSETTS. The policy for 1918 was to concentrate work in control areas. No general scouting was done as the rust was known to be prevalent throughout the State. Previous to 1918 diseased pines were found in 72 towns and diseased Ribes in 224 towns. This year infection was very plentiful on Ribes in the control areas, with scattered pine infection present. At the height of the season 8 eradication crews were in the field. The most effective crew organization was 5 men and a foreman. In some types 6 men could be used in the crew, but 7 men proved to be too many, as in thick growth the foreman could not satisfactorily check behind the crew.

The Barre demonstration area was extended from the beginning made last year. Skunk currants were very numerous in moist places, and wild gooseberries were prevalent throughout the area. On 8,095 acres, a total of 245,636 Ribes were destroyed, of which 73% were skunk currants, at an average cost of $0.60 per acre.

Two sections were chosen to obtain data on selective Ribes eradication. They were first thoroughly scouted by one man and in the first working the crew traversed only such areas as were thought to bear Ribes. Out of a total of 331 acres, but 53 acres were designated as free from Ribes. On these supposedly Ribes-free areas the crew found 686 plants, or 20% of the Ribes on the entire tract exclusive of 10,070 skunk currants which grew on 73 acres. This experiment indicates that in an area where wild Ribes are as generally abundant as in Barre, the crews should go over the entire area in close formation. Possibly some selective system can be worked out in which pine areas form the basis of selection rather than Ribes areas. Also, there are often large areas which are more than 1500 feet from any pine or are so thoroughly screened by vegetation that Ribes would have little or no effect and could well remain.

In the towns of Hanover, Halifax, Hanson, Pembroke, Marshfield and Duxbury, 110,957 wild Ribes were uprooted on 10,611 acres, at an average cost of $0.70 per acre. The swamps usually contain many Ribes and are full of briars which make work difficult. The upland growth is fairly open, and where there is a cover of scrub oak and blueberries, seems to be free of Ribes. The method of selective Ribes eradication, which was not successful under conditions in Barre, proved satisfactory in the Hanover area.

Under the recent law compensation was paid for 14,396 cultivated Ribes destroyed in 1917, at the average value of $0.36 per bush. One nursery was found to have a diseased pine. No other nursery was found to have pines or Ribes infected with blister rust.

RHODE ISLAND. The control area in the town of Coventry was enlarged in 1918 to include part of the town of West Greenwich. Two crews of six men each were employed early in the season, and later one crew. A total of 14,419 Ribes bushes were destroyed on 12,115 acres, averaging 1.1 bushes per acre. The area is 95% woods and brush, and contains 6,000,000 ft., B. M., of merchantable white pine, in addition to 2,800 acres of pine less than six inches in diameter, the whole conservatively valued at $176,000.

The amount of the white pine in the State is approximately 65,000,000 feet, worth $650,000; in addition, white pine reproduction has at least an equal cash value. Wild Ribes grow in fairly large numbers in swampy areas in every town in the State. No new pine infections were located this year but infected Ribes were found in each town. Approximately 3% of the bushes destroyed were infected.

Eradication costs averaged $0.28 per acre. This is 6 cents per acre less than last year's cost. The decrease is mainly due to careful scouting of the ground ahead of the crew to mark the boundaries of areas of Ribes growth. The results obtained show that in Rhode Island a high percentage of Ribes can be eradicated by covering only "Ribes areas." These are principally swamps, pastures, moist hardwood land, fence lines, roadsides, rocky ledges, stone walls, etc.

The crews at first re-scouted a portion of the territory covered each day.

On 15 check plots aggregating 35 acres, 1,009 bushes were found the first time, 51 bushes in re-scouting, and none the third time. This is an efficiency of 96.2%. Later, a more accurate system of checking was adopted. The supervisor accurately determined the number of Ribes in a plot. When the crew went over this area they had no knowledge that it was a test plot. Afterward, the supervisor counted the number of bushes remaining. In the 12 tests made during the season by this method, on a total area of nine acres the crew found 853 wild gooseberry bushes and the supervisor found only 21 additional bushes. This is an efficiency of 97%.

Checks also were made on the thoroughness of eradication in 1917. On five plots, aggregating 86½ acres, 848 Ribes were destroyed in 1917, and only six additional bushes, growing along fences and near stone piles, were found in 1918.

In pastures where sheep were kept no Ribes were found. Ribes were numerous in low land immediately adjoining, but none were found in the extension of the same swamp within the sheep pasture. Birds were seen to feed on fruit of wild Ribes and bushes that bore abundantly were completely stripped in less than two weeks. Apparently the majority of wild Ribes seeds are scattered by birds and squirrels. Judging from the abundance of wild Ribes fruit, comparatively few seeds develop into mature bushes.

About $700 was contributed by individual owners for uprooting Ribes from their pine areas, in co-operation with the State and Federal Governments. Compensation was paid for 103 bushes out of a total of 492 cultivated Ribes destroyed, at the rate of 31 cents each. The majority of people are willing to destroy their bushes for the welfare of the pines.

CONNECTICUT. On account of the war, it did not seem advisable to employ men for extensive blister rust work. The control area in the town of Norfolk was not continued this year, and no general scouting or definite crew organization was attempted. Only four men were employed outside of the Experiment Station staff.

Spraying experiments for the control of the blister rust were conducted on red and black currants. Results were nearly negative on red currants, because of lack of infection. On black currants, spraying gave nearly complete control throughout the season. However, such careful and frequent spraying had to be done that it is not considered to be a practical method of control. At Norfolk, Ribes infection reached its height following a period of hot, moist weather during the week of July 20.

The owners of two large pine plantations co-operated in eradication of Ribes. A crew of Italian workmen did especially efficient work. The attitude of property owners in the State has been favorable to the work. In the future, local co-operation will be extended as much as possible, with the expectation that ultimately the work will be turned over to private initiative, the State authorities only giving such assistance in supervision as is requested or found to be necessary.

NEW YORK. Scouting in 1917 indicated a general infection in Ribes throughout the northeastern portion of the State and widely scattered Ribes infection in central and western parts.

Limited scouting was done in 1918 and infected currants were found near Jamestown, Chautauqua county, eight miles from the Pennsylvania border at Adams, Jefferson county, and Nicholville, St. Lawrence county. A severe pine infection center of more than 100 acres was located at Wilmington Notch, Essex county. At Lewis, Essex county, the area of infected pines was found to extend 11 miles north and south, instead of six miles as determined in 1917. In Warren county diseased pines were found scatteringly over at least 10,000 acres. Two extensive pine infection centers were found near the village of Lake George and a number of smaller infections were found further north, and for some miles west of the lake shore. No infection on Ribes was found at Geneva in 1918, showing that the disease is still under control in that section.

This year over a million wild Ribes were eradicated on 15 areas totalling 29,337 acres. In addition to control areas, protection was given to white pine in State nurseries and plantations. The average cost of eradication was $1.46 per acre and required an average of 3.62 hours of man labor per acre. From May to October 302 men were employed, though not more than

200 were working at any one time. The best results were obtained from crews of moderate size, preferably six men and a foreman. The men were spaced six to 10 feet apart in the line, depending on the character of the growth. The tendency was to work too far apart rather than too close. The foreman checked the work in the rear of the crews.

Several types of Ribes diggers were developed in New York this year, and were used in a number of States, with good results. One had an eight inch head resembling a geologist's pick; one end was pointed and the other flattened for cutting. A heavy, two-toothed hook, resembling the claw of a carpenter's hammer, was welded to a piece of pipe, the latter forming a socket for a strong handle. This tool will stand great strain and is a valuable time-saver where large bushes grow. One or two men in each crew carried the heavy diggers, the other men being equippd with the lighter kind.

The demonstration control area of 9,344 acres, is located in Warren county and includes the village of Chestertown. A large portion is wooded and is typical of the best white pine growth in New York. Ribes infection was abundant and diseased pines were found to be generally distributed. Wild Ribes were plentiful throughout the area, averaging 32.7 per acre, at an average labor cost for eradication of $1.14 per acre. The foremen of the crews were paid $3 per day, and the other laborers $2.50 per day. According to checks made during the season, 92% of the bushes were pulled. There is no doubt that more than 92% of the Ribes leaf surface was removed.

Observations on the sprouting of Ribes confirm the opinion generally held that wild gooseberries do not sprout if the crown is completely removed. Skunk currant and swamp black currant have underground stems which form a nucleus for a new plant if not removed. The use of Ribes picks is essential if the crown and roots are to be entirely removed and sprouting prevented. If the soil is not shaken from the roots when Ribes bushes are pulled, or if the bushes are not hung up to dry out, they will occasionally continue growth. On two acres from which 253 bushes were pulled and thrown on the ground, four had sent up healthy shoots the following year. Bushes with matured fruit, especially in moist ground, must be carefully destroyed or the fruit removed to a safe place; otherwise an unusual number of seedlings will result. There is no doubt that many (if not most) Ribes seedlings perish from drouth and winter-killing but enough survive to make it necessary to re-scout a control area after an interval of two or three years.

Local co-operative control was carried on at Lake George, and Schroon Lake. The Lake George Association subscribed $4,772.50, and has stated that additional funds will be forthcoming when needed. The outlook for this kind of work is encouraging. Ultimately the owners of pine must bear the whole expense of protecting it from the blister rust, and the financial help now asked of them is a step in that direction.

The State Department of Agriculture, in 1918, found infected Ribes in two nurseries, and 11,000 black currants were destroyed. One nursery already under quarantine had a single diseased pine. Each nursery in the State has been inspected two or three times during the season and the surrounding territory was also examined. A total of $629.65 was paid for cultivated Ribes destroyed in the State in 1918.

PENNSYLVANIA. A total of 2,097,063 pines and 37,134 Ribes were inspected this year. A few infected pines were found in two plantations near Reading, and in one near Penllyn. One infected pine was found in a nursery near Philadelphia. No Ribes infection has ever been discovered in the State. Both wild and cultivated Ribes were intensively inspected for several miles around each infected pine plantation. The three infected localities are far removed from native pine and rigid inspection for the next few years should eliminate the disease.

NEW JERSEY. Three diseased pines were found in a nursery near Morristown, and one in a nursery near Red Bank. The latter also contained diseased black currants and additional infected black currants were found at three other points near Red Bank. Diseased pines were also found in an ornamental planting near Clementon. All diseased pines and Ribes leaves were destroyed and a strict quarantine is maintained on infected nurseries.

SOUTHERN AND CENTRAL STATES. In states south and west of Pennsylvania, including Delaware, Maryland, Virginia, West Virginia, North Carolina, Ohio, Illinois, Indiana, Iowa, Kentucky, Tennessee, Missouri, Kansas, Nebraska, South Dakota and North Dakota several thousand plantings of white pine were inspected as well as nurseries growing white pines but no disease was discovered. Particular attention was paid to inspection in the vicinity of former infections in Ohio, Indiana, Iowa, and South Dakota, and in tracing shipments from diseased nurseries.

LAKE STATES. In Michigan, eight men made 759 inspections in 71 counties. In addition to 240 acres of pine plantings, over 534,000 pines were examined. The blister rust was found this year in only one locality. This was in Birmingham, Oakland county, on French-grown white pines in a nursery and on one pine transplanted from this nursery to private grounds. The infected trees were destroyed, as were all of the trees of this French importation growing in the nursery block. There was no recurrence of infection in or around the nursery near Pontiac, Michigan, where infected pines were destroyed last year.

In Wisconsin, prior to 1918 the rust had been found only in Polk county. This year about 50% of the northern half of the State was scouted in addition to 279 individual inspections of pine plantings, and pine in nurseries throughout the state. The results of this season's survey show that the disease is present in 10 counties—Polk, Burnette, Washburn, Barron, Rusk, Dunn, Pepin, Shawano, Clark and Marathon. Over 45,000 infected Ribes and 746 infected pines were found in 15 groups scattered over 50 sections in 28 townships. No infection was found in nurseries.

Native pines were found severely infected near Rice Lake, in Barron county; at Lewis, in Polk county; and near Falun, in Burnette county. Partial eradication of Ribes has been accomplished in two of these areas and it is expected that all pines in the disease centers will be destroyed before next Spring. A heavy infection on Ribes in the Menominee Indian Reservation at Keshena apparently indicates a serious pine infection at this point, but it has not yet been located.

In Minnesota an extensive survey between the St. Croix and Mississippi Rivers as far north as Duluth failed to bring to light any rust centers in native pine woods other than those found last year. However, the rust reappeared at 7 former infection centers, viz.: Afton, Pine City, Rock Creek, Franconia Creek, Rush Lake, and at two places near Harris. All of these points are in the St. Croix Valley, within 12 to 15 miles of the eastern boundary of the state. Eradication of Ribes has been carried on over approximately 1200 acres in the Rush Lake area. All known plantings of white pines and all nurseries having white pine were examined, and the disease was found in plantings at Rochester and Chisago City. In both places all of the planted stock was destroyed. Diseased pines were also found in a planting at Lake Vadnais, Ramsey county. The area known to have blister rust is smaller by five counties than was the case last year.

Present knowledge indicates there is no possibility of completely eradicating the disease in Wisconsin, and this naturally affects the plan of work in Minnesota. In both states, however, it is believed that increased efforts along the line of present activity will prevent rapid general infection of pines, thus giving time to develop control methods adapted to conditions in this region. In both Wisconsin and Minnesota it is the policy to remove all of the pines in and adjacent to pine infection centers and also, so far as possible, to eradicate Ribes in the vicinity of infections.

A school campaign in the three Lake States, in September and October, resulted in reports on planted pines, currants and gooseberries, from several thousand school children. No disease was found by this method of scouting. In Minnesota, blister rust exhibits were made at the State Fair and 10 county fairs in the northern part of the State. Posters have been widely distributed in white pine regions, through Postmasters and State Forest Rangers.

WESTERN STATES. West of the Great Plains less scouting was done this year than in 1917 owing to the impossibility of securing adequate assistance. However, thousands of pines, currants and gooseberries purchased from Eastern nurseries were inspected, without finding any evidence of the blister rust.

Great interest is being shown in the far western states in preventing an

Summary of Ribes Eradication on Demonstration Control Areas, by Types, 1918

AVERAGE NUMBER OF RIBES PER ACRE

Demonstration Control Area	Total Area. Acres.	Av. Ribes All Types.	Old Pine.	Young Pine.	Mixed Pine.	Hard-woods.	Brush.	Swamp.	Skunk Currant Areas.	Pasture and Fields.	Misc.
Alfred, Me.	2,848	23.0	39.0	21.0	20.0	4.0	46.0	1,470.0		14.0	19.4
Kittery Point, Me.	1,500	6.2	3.0	4.0	7.0	20.0	9.0	24.0		5.2	20.0
Brunswick, Me.	554	27.0	31.0	0.0	70.0	22.0	52.0	567.0		1.0	6.0
Bartlett, N. H.	1,790	28.4	2.6	.6	5.3	18.6	68.3		451.3	5.3	
Thetford, Vt.	3,053	8.2	7.5	1.9		12.9	9.5	51.0		2.4	
Sharon, Vt.	473	77.8		.9	5.3	28.9	281.0	1,069.0		10.5	
Barre, Mass.	8,095	30.3	15.5	4.1	44.2	31.9	20.6	113.6	10,377.3	3.2	
W. Greenwich, R. I.	12,115	1.4	0.0	0.0	1.5	.4	0.0	5.5		.2	1.2
Chestertown, N. Y.	9,344	32.7									

AVERAGE LABOR-COST PER ACRE

AVERAGE COST OF RIBES ERADICATION PER ACRE (DOLLARS)

Demonstration Control Area	Total Area. Acres.	Av. Cost All Types.	Old Pine.	Young Pine.	Mixed Pine.	Hard-wood.	Brush.	Swamp.	Skunk Currant Areas.	Pasture and Fields.	Misc.
Alfred, Me.	2,848	.30	.34	.41	.27	.27	.33	3.78		.32	.15
Kittery Point, Me.	1,500	.40	.37	.51	.33	.37	.47	.86		.29	1.61
Brunswick, Me.	554	.25	.26	.14	.31	.27	.41	1.05		.12	.25
Bartlett, N. H.	1,790	.71	.61	.52	.76	.68	.72		3.08	.34	
Thetford, Vt.	3,053	.85	.87	1.45		.87	.89	1.79		.29	
Sharon, Vt.	473	2.47		.99	.95	2.39	7.28	19.16		.70	
Barre, Mass.	8,095	.60	.51	.65	.85	.68	1.10	1.10	13.38	.26	
W. Greenwich, R. I.	12,115	.31	.23	.17	.27	.25	.37	.51		.11	.29
Chestertown, N. Y.	9,344	1.14	1.20	1.25	1.20	1.10	1.40	1.60	1.45	1.00	

invasion of blister rust. The hope of saving the western white pine forests from infection lies in the enforcement of the Federal and State quarantines against five-leaved pines and Ribes.

DOMINION OF CANADA

During 1917 only southern Ontario and Quebec were scouted for blister rust, and the disease was found to be quite widespread. In view of the western situation and the danger of transmitting the disease to the western continental pine area, it was deemed advisable in 1918 to scout for the blister rust on currants in northern Ontario and in the western part of Canada. Limited surveys were also made in Quebec and New Brunswick.

In **Quebec**, 3 men scouted in September, 1918, finding abundant disease in Portneuf County on the north shore of the St. Lawrence, but none in the Ottawa Valley or along the International boundary.

Northern Ontario was scouted from Rainy River District (just north of Minnesota) east to North Bay on Lake Nipissing, without finding any trace of the disease. Reports through schools from 291 Ribes plantations in Nipissing, Perry Sound, Sudbury, and Muskoka Districts, and Haliburton County; and a thorough examination by the Agricultural Representative of the Canadian Copper Company at Sudbury, revealed no sign of the rust. At Caernarvon in Haliburton County, the northern limit of the disease in 1917, there was no sign of rust this year.

Southern Ontario was not thoroughly scouted this year except in the Niagara Peninsula; here the rust was found to be plentiful as usual, being reported in 50 out of 92 plantations. There are further reports from near St. Williams in Norfolk County (119 miles from Port Huron, Mich.) and Lindsay (Victoria county), Bowmanville (Durham county) and the Carillon Region near Montreal.

Scouting for the disease on Ribes was carried on during the latter part of the summer in **New Brunswick, Manitoba, Sackatchewan, Alberta, and British Columbia**; no rust was found.

Mr. W. J. K. Harkness reported that in Manitoba out of every 10 country farm houses, 4 have wild Ribes (always black currants, 1 to 25 plants), I has

cultivated Ribes (2-18 black currants, 2-25 red currants, 2-12 gooseberries) while the other 5 have no Ribes whatever.

In Saskatchewan, west of a line north and south through Regina, there is a much larger percentage of people growing cultivated Ribes (in about the same number per farm as in Manitoba). In the towns and cities of both Provinces there are very few plantations of Ribes, these being practically confined to three of four market gardeners in each town who have 25-200 black currants, 25-200 red currants and 12-25 gooseberries. (Excepting Prince Albert, where Ribes are grown in a great number of private gardens). In many of the small towns no Ribes are grown.

Wild Ribes (black currants) are quite continuous from Ontario to Saskatchewan, occurring in practically every part of Manitoba, growing in the woods, along the streams and ravines, as well as under partial cultivation in about 40% of the farm gardens. In southern and central Saskatchewan there are very few wild Ribes, but along the Northern ravines and woods, over the Pasquia Hills around Prince Albert and Battleford, they are quite prevalent, as well as being grown in many of the farm gardens of this Northern district. Apparently wild Ribes are continuous through Saskatchewan from Manitoba to Alberta, by way of Prince Albert and Battleford.

Since the blister rust is admitted to be ineradicable from Ontario and Quebec at present, three small control areas were established in these two Provinces, to determine whether white pine can be grown successfully in areas where the disease is present. These areas are representative of the sections known to be affected by the disease; No. 1, with abundant native and wild Ribes, is on the Niagara Peninsula near Fenwick; No. 2, with scattered wild Ribes in woods and a few cultivated bushes around farm houses, is at Bowmanville on the north shore of Lake Ontario; and No. 3 representative of the forest situation where there are wild Ribes but no cultivated ones, is at Carillon, near Montreal.

The rate of eradication of Ribes per eight hour day per man varied from 1.44 to 9.60 acres for Control Area No. 1; from 0.58 acres to 1.75 acres in Area No. 2, and from 1.12 to 5.97 acres for Area No. 3. The average number of wild Ribes per acre ranged from four to 81 in Area No. 1; from 29 to 738 in Area No. 2; and from 10 to 197 in Area No. 3. Attempts were made during the course of the work to estimate its efficiency in various ways. The number of Ribes removed in the check, in efficient work should not be more than 2 or 3 per cent. of the total number of Ribes found, where the plants are at all plentiful.

The system of covering ground in Ribes eradication which will give the best results must be worked out for each gang of men and will somewhat depend on the nature of the ground. Various methods have been tried, from the four man cover and one man check system, down to one man cover and one man check. In the latter system each man checks what the other man has covered. For careful work it would appear that the two man cover and one man check has great advantages.

Scientific Research and Field Investigations in 1918

Investigations in the United States Department of Agriculture

By Dr. Perley Spaulding

The following statement is a summary of the reports given at the meeting by members of the Office of Forest Pathology, Bureau of Plant Industry, U. S. Department of Agriculture.

The scientific studies of white pine blister rust in 1918, were carried on principally at Block Island, R. I.; Kittery Point, Me.; North Conway, N. H.; and Lewis, N. Y. One person was kept throughout the season at Block Island, one at Kittery Point until the latter part of July, two at North Conway all the season and three the latter part of the season, two at Lewis practically all the season. At North Conway, Dr. H. H. York, of Brown University, had charge of the work, and at Lewis, Dr. L. H. Pennington, of Syracuse University, had general oversight of the investigations.

Special efforts were made by means of spore traps and by scouting to

get definite information on the distances that spores may be carried. Currents of air are evidently the chief agents of distribution of these spores. Aeciospores were found in traps at an altitude of 2,700 feet above the nearest known source of the spores which was five and one-half miles distant. Spore traps 20 feet above the fruiting cankers caught many more aeciospores than did traps at either side or below, showing the extreme lightness of these spores.

The investigations at North Conway and Lewis have shown conclusively that the spores produced upon pine are much more widely distributed than has been previously supposed. A considerable amount of data from other localities and previous years tends to support this fact. These spores are spread for miles, starting scattered infections upon Ribes over great areas. It was also found that a larger percentage of these spores germinate than is the case with any of the others. Moreover, they retain this power of germination for a period of some weeks. All these facts taken together show that the disease spreads far and wide by means of the spores produced upon pine.

On the other hand it was found that the early summer stage upon Ribes is not widely distributed as had been previously supposed. In the work at North Conway and Lewis with spore traps, as well as other experiments for the purpose, the uredospores were found one to three hundred yards distant. They retain their power of germination a somewhat shorter time than do the spores upon pine. This experience with *Cronartium ribicola* is exactly parallel to that of other investigators with the other species of *Cronartium*. It is possible that a season of more moisture may give us somewhat different results with the spread of the uredo stage. This, however, remains to be seen.

The season of 1918 was one of drouth through the latter part of the summer at Lewis where special attention was given to observations upon the spread of Ribes infections. A study of the generations of uredospores made at Lewis show that a period of several rainy days is followed in due time by a new generation of these spores. In 1918 only seven distinct generations were produced at Lewis.

Studies upon the spread of the disease from Ribes back to pine are not in as satisfactory a condition as with the two preceding stages. McCubbin's data published a year or so ago was to the effect that heavy infection of pines did not take place at any great distance from the Ribes, a distance of one or two hundred yards being the limit. Our limited observations show somewhat similar results. At Lewis, N. Y., viable sporidia were not abundant during the warmer part of July and August. They were very abundant during September and thereafter. Sporidia were found frequently upon spore traps near infected bushes but not at a greater distance than two hundred feet even when infection was very heavy. In no case was infection found upon pines as far as two hundred feet from Ribes.

The width of the Ribes-free zone necessary to protect pines will vary from 100 to 600 yards according to conditions. The width of this zone is largely to be governed by topographical features, direction of the prevailing winds at the time the sporidia are produced, humidity, age of the pines, exposure and specie of Ribes (i. e., whether in open places or screened beneath vegetation), and the composition, height and density of the vegetation between Ribes and pine. Tests made by Dr. York and his assistants show that the sporidia produced upon the telial columns are very short lived—being hours rather than weeks in duration. This indicates that moisture conditions (favorable or unfavorable to the development of the spores on the pines) may determine very largely the amount of pine infection and the distance to which Ribes can infect pines. While they are apparently of such a nature as to be easily blown about, this shortness of life may prove to be a factor in determining the width of the Ribes-free zone for protecting pine areas. It is believed that under ordinary conditions the width of this safety zone may be considerably less than one-third of a mile and yet a merchantable stand of pine be secured within a protected area. A large scale experiment has been made in the region of general infection for the purpose of securing definite data on this point in a practical way.

It is believed that the over-wintering of the fungus in the uredo stage

upon Ribes has been demonstrated. Dead leaves, which were heavily infected last fall and which had remained on or under the bushes all winter, were secured early in the spring (March) and positive results were obtained when inoculations were made with the uredospores remaining upon them. (Published in Phytopathology in December, 1918, Vol. 8, No. 12, pp. 617-619.)

Healthy white pines, planted on Block Island in the spring of 1916, among heavily infected Ribes, produced a number of blisters in the spring of 1918, making an incubation period of 18 months. In a pine plantation near Lake Clear Junction, N. Y., the disease has been prevalent since 1902, with several cases of apparent primary infection, at least one of which had not fruited prior to 1917. This is an incubation period of 15 years and illustrates the persistent nature of the dormant disease in the pines.

A Cronartium upon Ribes has been known to occur in Colorado for a number of years. It has been considered by some to be the same thing as the European white pine blister rust in the Eastern States. Investigations carried out during the past two years under the direction of Dr. G. G. Hedgcock have shown that it is distinct from **Cronartium ribicola** and it has been named **Cronartium occidentale.** It does not attack the five-leaved pines but is known to attack only the pinon pines, **Pinus monophylla and Pinus edulis.** It has been found to range from the southern portion of Wyoming into Arizona and New Mexico. A comparative statement of the characters of this and of **Cronartium ribicola** is published under title of "Pinon Blister Rust" in Journal of Agricultural Research (Vol. 14, No. 10, pg. 411-424, September, 1918).

Investigation in the Canadian Department of Agriculture

By Dr. W. A. McCubbin

The field laboratory of Plant Pathology, Division of Botany, in the Dominion Department of Agriculture, in the summer of 1917, made a determination of the rate of fall of uredospores in still air. The conclusion was drawn that the spores could be carried long distances, since they fall through still air at the rate of about eight feet in five minutes. The same apparatus was used in the spring of 1918 to determine the rate of fall of aeciospores. It was found that the rate of fall was practically the same, that they fell a little over eight feet in about seven minutes. It is therefore apparent that we may expect a very wide distribution of aeciospores. In this connection it may be stated that an estimate was made of the probabilities of aeciospore dispersal from the Fonthill district. It was calculated that if the aeciospores in this neighborhood were distributed over a circle of 10 miles radius there would be about 25 spores per square yard.

In addition to the above, Geo. H. Duff of this laboratory has continued his work on the effect of light. He has found that sunlight, deprived of its ultra-violet content by filtering through glass has a neglible effect on artificial germination, even with exposures of five hours. Both aecidiospores and uredinospores readily fall victims to ultra-violet radiations, however, at an exposure of two and a half minutes to the radiations from a source whose ultra-violet energy may be represented by 38. The ratio of the ultra-violet energy of the sun to that of this source has been found, by one worker, to approximate 16.38, and since others have shown that a rough direct relationship exists between the ultra-violet energy of a source and its physiological effect, it is concluded that a comparatively short exposure (10 to 15 minutes) to full sunlight would be sufficient to inhibit artificial germination. It is recognized that this does not necessarily postulate inability to infect, and that since it is operative only during the day, this factor cannot be considered as of prime importance.

A survey of pine infection areas was made in order to obtain evidence as to the actual damage which has been brought about by the disease. This survey covered 35 plantations in three districts, and involved the examination of 14,428 young pine trees, 10 feet in height and under. In the Niagara district the disease was most prevalent. In the 22 woodlots examined here the disease was found in 19. Out of the 11,579 pines examined 270 were found to be diseased. This gives an average of 2.3% infected trees, and is

apparently very small. It is to be noted, however, that the highest record percentage of infection was 33.54 and in at least two other cases where the percentage is 20 or under, the estimate was made in woodlots from which a very large number of young trees had been removed.

From our knowledge of the disease here in past years which gives a fair idea of the time the disease has been present in each locality it would seem that under average conditions the disease attacks about 1% of pines per year. This is extremely low when one considers the Ribes situation in the Niagara Peninsula, and from it one may obtain cheering prospects for future control measures. In the 10 plantations examined at Oakville, where the disease has been present since 1915 at least, only one diseased pine was found out of 2,249 examined, and in Simcoe county where a center of infection had existed since 1912 at least, no diseased pines could be found in the three plantations examined, covering 600 pines.

It is apparent from the results of this survey that three factors are concerned in infection of pines:

(a) The nearness of cultivated Ribes, particularly black currants.
(b) The number of wild Ribes present.
(c) The moistness of the situation.

It has been found that on swampy land wild Ribes are plentiful, luxuriant and become infected very completely, while on higher and drier situations, they are less plentiful and the infection is often negligible.

Artificial Infection of Ribes Species and White Pine With Cronartium Ribicola

By Dr. G. P. Clinton

The observations reported here are the more interesting of the varied investigations on the life history of Cronartium ribicola carried on during the past two years by the writer and his associate, Dr. Florence A. McCormick, at the Connecticut Agricultural Experiment Station.

1. Artificial Infection of Ribes Species Grown in Crocks.

Out of 140 inoculation experiments with 29 species and varieties of Ribes, infections were secured in one or more instances with all but five. The aecial spores were successful in 68 out of 86 tests and the uredinial in 30 out of 54. Very similar results have already been reported by Spaulding and Gravatt. The most convenient method of producing successful and abundant infection was by use of small Ribes plants grown in ordinary greenhouse crocks, with superfluous branches and leaves removed. For infection with aecial spores, spores from infected white pine were shaken off into a battery jar containing eight to 10 inches of water. By placing tissue paper over the top of the crock to prevent falling out of the earth and then inverting and immersing the plant in the water, the upper and lower sides of the leaves were abundantly covered with spores. The plant was then placed in a moist chamber or Wardian case for a few days, and later was more exposed in the greenhouse. Usually within eight or 10 days the uredinial sori began to show on the leaves. On some hosts, especially on Ribes nigrum, the leaves eventually became abundantly covered with these while in others, only an occasional sorus appeared.

(2) Artificial Infection of Detached Ribes Leaves in Petri Dishes.

The most successful way was to wash the leaves well in running water, and then place a single leaf in the top of the petri dish, partially filled with water, with the lower side up and held above the water by glass rods or suspended on rubber bands stretched across the bottom dish. After the spores had been scattered on the exposed surface of the leaf, the covered dish was placed in rather bright light. The water tends to collect on the cover thus keeping the leaf moist, with conditions very favorable for spore germination and infection. By this method it was possible to trace the germ tubes of both aecial and uredinial spores through the stomates into the leaf tissues, showing that infection takes place in this manner rather than by directly piercing the epidermis. By this method out of the 35 different Ribes species in 95 tests tried,

25 species were infected; with aecial spores 24 out of 36 tests, and with uredinial spores 40 out of 59. Infection was, on the whole, even more abundant than by immersion, considering the number of spores used. Immature sori were seen within 6 days and 22 hours after aecial spores were placed on the leaves; while on the plants in crocks 7 days and 18 hours was the earliest record. Success was obtained in maturing several other rusts on leaves in petri dishes, and it is believed that this method merits further attention by mycologists.

(3) Infection of Pines Through the Leaves.

It has been an open question how the pines are infected from the telial stage and what are the earliest visible signs of infection, since it is only after a year or two that botanists have been able to surely recognize infected plants through the swollen stems. To determine this point, experiments were carried on chiefly in the greenhouse with plants one to three years old, and under conditions where they could be watched very closely. The first infections were made in the fall of 1916, and were not closely watched, but six months later definite yellow spots showed on certain of the leaves and there was, as well, a slight swelling of the stems. This suggested infection through the leaves, and the infections made in the fall of 1917 were watched more closely with the result that **the first visible signs of infection were these same yellow spots on the leaves** before any sign of swelling or discoloration of the stems. Infections made in the fall of 1918 have absolutely confirmed these observations. Magnified by a hand lens, infection of the leaves was detected by these yellow spots even before they were large enough to be seen by the naked eye; and, in one case, was found **within 25 days after the telia with sporidia were placed on the leaves.** The spots are quite characteristic in color, **being a golden yellow,** in contrast with the whitish, greenish-yellow or reddish-brown spots so common on leaves. At first they show only on the side of infection and directly under the stomates, but with time form a distinct band around the leaf, rarely over a quarter of an inch long. It has been definitely determined that infection of the pine needles takes place through the stomates.

Microscopic sections have shown these golden-yellow spots always to be filled with a sclerotial mass or masses of mycelium more or less closely surrounding the fibro-vascular system. In time, strands of mycelium can be found running lengthwise near the bundles down the leaf into the stem. These cause no discoloration of the leaf. The spots may occur any place on the leaf and there may be more than one to a leaf, if infection has been fairly abundant. Infection may possibly take place through other parts of the plants than the leaves, though as yet we have not been successful in our attempts to secure infection through the young stems, unopened buds, etc.

Within six months after infection we have had the plants oozing out the pycnial spores, which is much earlier than noted heretofore, but as yet we have had no plants mature the aecial stage. This may be due to the fact that most of our plants, being young, have been killed by the fungus, so that we have had none under observation that have been infected two years and only half a dozen that have been infected over a year.

Progress of Experiments for Destroying Ribes with Chemicals

By Dr. W. S. Regan

Tests begun in 1917 to determine the comparative economy and efficiency of destroying Ribes by chemical means, while still incomplete, have given encouraging results. Under ordinary conditions, hand pulling appears to be most practicable, but in certain cases the chemical method offers distinct advantages over hand work. This applies especially to areas of dense skunk currant growth, to large firmly-rooted wild gooseberry bushes and to Ribes growing in stone walls and among rocks, where it is difficult to uproot the plants and cost of hand pulling is excessive.

Undiluted fuel oil applied as a fine spray to foliage and twigs has proved the most satisfactory foliage spray. A single thorough application of fuel oil produces defoliation and under favorable conditions it penetrates the bark and kills the plants. Ribes growing in direct sunlight are acted upon more rapidly and are more certain to be killed than those growing under shade. Since

skunk currants usually grow in shade, a single fuel oil treatment cannot be relied upon to kill all of the plants. The area must be gone over twice, possibly three times, to destroy new shoots and plants that survive earlier treatment. In direct sunlight about 4 days is required to defoliate skunk currant, while in shade, it requires from 12 days to two weeks. If rain occurs shortly after the oil is applied, the foliage is killed but buds and twigs are much less injured. Individual plants vary in resistance.

Other less effective foliage sprays tested include sodium arsenite, salt solution, kerosene and several compounds submitted by the Sterling Chemical Company. One of the latter offers promise and may later be improved. Even in 1 to 60 strength, it killed the foliage of skunk currants in 5 hours and in sunny exposure, 1 to 40 strength killed the foliage in 15 minutes. A heavy rain five hours after treatment did not affect its efficiency. However, this spray requires constant agitation to insure uniform killing effects, does not cling to the glossy leaves of plants growing in sunlight long enough to kill them, and has little effect on buds. For these reasons, fuel oil is superior.

A number of tests were made with liquids and oils applied at the base of bushy Ribes plants (such as red and black currant and wild gooseberries) so as to thoroughly drench the crown. Dip oil has given most satisfactory results in this method; a single treatment may result in the death of a plant, but many factors over which the operator has no control may interfere with the efficiency of the treatment. It has not yet been determined whether this method is cheaper than spraying the foliage.

Summary of the White Pine Blister Rust Situation

By Dr. Haven Metcalf

1. The work to date has proved that wild currants and gooseberries can be found and destroyed. The cost per acre is low—cents rather than dollars—and will not compare with the cost of the damage if the bushes are permitted to remain and spread infection to the pines.

It appears that even under war conditions the local eradication of Ribes is financially practicable. Under peace conditions the cost of such eradication will inevitably be materially lowered.

2. The demonstrated low cost of Ribes eradication is sufficiently encouraging to warrant the resumption of the planting of white pine in the East. It must be clearly understood and noted, however, that such planting should only be undertaken with seedlings of known antecedents which are beyond all possibility of doubt free from the blister rust. Ribes must be eradicated from the planting area in advance of the planting; and the plantations kept free from Ribes during subsequent years.

3. It is evident that in the East more and more stress must be laid upon local control. The response of private owners, towns and associations, in the way of active financial support is most encouraging.

4. The results of continued research on the disease are on the whole encouraging. The now demonstrated fact of over-wintering of the disease on Ribes, both in the field and in a dry condition, has confirmed the wisdom of State and National quarantines. The distance of spread from Ribes to pines is more often less rather than greater than has been supposed.

5. Continued scouting in the far West has failed to demonstrate a single case of introduction of the blister rust. While this fact is encouraging, the scouting must be continued both by the United States and Canada. The value of the 5-needled pines in the West, mainly sugar pines and western white pine, is approximately $177,000,000. This amount of property is worth saving.

6. Quarantines both State and National, which are now enforced against the trans-shipment of pines and Ribes must continue to be rigidly enforced for an indefinite period.

7. We may congratulate ourselves, not on the measure of success with which our work has been carried out the past season but upon the fact that we have been able to work at all. The loss of men due to the draft, to war industries, the difficulties of housing and lodging, general increased expense of the work, the poor quality of much of the available help, and during the last two months the epidemic of influenza—all have greatly increased the difficulties of our work.

REPORT ON

White Pine Blister Rust Control

1919

PUBLISHED BY THE
AMERICAN PLANT PEST COMMITTEE
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A. W. GILBERT, *President*
HARRIS A. REYNOLDS, *Secretary*

WHITE PINE BLISTER RUST CONTROL IN 1919*

By SAMUEL B. DETWILER

The Fifth Annual International Blister Rust Conference was held at Albany, New York on December 8-9, 1919, under the auspices of the American Plant Pest Committee. Foresters and pathologists representing the New England States, New York, Pennsylvania, Wisconsin, Minnesota, and Canada were present. The sessions were full of interest, and left no doubt that practical and effective measures for the control of white pine blister rust have been developed during the past four years of experimental work. A summary of the report follows:

1. Experiments conducted on an extensive scale since 1916 demonstrate that white pine blister rust can be controlled locally by destroying wild and cultivated currant and gooseberry bushes within a comparatively short radius of the pines. A distance of 200 to 300 yards is sufficient to prevent serious damage under average forest conditions. This reduction of 50 per cent in the minimum width of the safety zone hitherto recommended, is based on the results of four years' scientific and practical field studies.

2. Unskilled laborers can be quickly taught, under trained supervision, to find and destroy at least 95 per cent of the wild currant and gooseberry bushes in going over the ground once. The State crews made 642 checks to determine the thoroughness of eradication, going over the areas repeatedly until no bushes could be found. A total of 246,254 bushes, or 96.4 per cent, were uprooted in the first working, 8095 bushes in the second working, 905 in the third, 125 in the fourth, and 10 in the fifth time over the ground. Federal and State inspectors made many

*Paper read at the meeting of the American Plant Pest Committee, St. Louis, Mo., December 29, 1919.

additional checks which prove that the crews destroy an average of more than 95 per cent of the bushes in the first working of an area.

3. Wild currants and gooseberries do not reproduce rapidly in an area that has been worked by an efficient crew. Thorough checking on 2485 acres in 8 separate tracts previously gone over by eradication crews, showed that on an average acre, 62 bushes (95.5 per cent) were destroyed in the first working and 3 bushes in the second working. Of the latter, two bushes were missed in the first working, and one bush developed from seeds or sprouts. Bushes missed by the crews usually are small plants growing in underbrush. Such plants have less leaf surface than the average plant; therefore the total percentage of protection to the pines is considerably greater than the total per cent of currant and gooseberry bushes destroyed. Judging from data at hand, control areas usually should be gone over again 5 to 10 years after the first working.

4. No new pine infections could be found in 1919 on four control areas on which currants and gooseberries were destroyed in 1916 and 1917. This demonstrates that eradication of currant and gooseberry bushes is successful in controlling the blister rust. The crews working in 1916 and 1917 missed a greater percentage of the bushes than crews using the present improved eradication methods and implements. The results show that even though every bush is not removed, enough can be destroyed to insure practical control.

5. The cost of eradicating currant and gooseberry bushes in the North-eastern states in 1919 averaged 42 cents per acre for labor, or 54 cents including supervision. In 1918, the average cost, including supervision, was 66 cents per acre. In the New England States, the average labor cost was reduced from 44 cents per acre last year to 24 cents per acre this year. This low cost was obtained by employing scientific methods in locating wild currant and gooseberry bushes. Costs are expected to be still further reduced in areas where wild bushes are very numerous, as a result of successful experiments in destroying such bushes by spraying them with chemicals.

6. Blister rust infection on pine in the northeastern states is increasing rapidly. A strip survey in one locality in New Hampshire indicates that one-fourth of the pines on an area of 72 square miles are already infected with the rust. The disease is widespread in Minnesota, Wisconsin, Ontario, and Quebec. There is abundant evidence of the destructiveness of the blister rust to merchantable trees as well as young white pine stands. This destruction is caused by infected currant and gooseberry bushes near the pines. The longer such bushes remain, the more rapidly pine infection increases. After several years, all of the trees becomes infected and gradually die. Timber owners in infected regions who do not destroy currant and gooseberry bushes within 200 to 300 yards of their white pine stands will suffer serious loss.

7. Assistance to individual pine owners, towns, and associations in protecting pine areas from the blister rust is given by the New England States, New York, Wisconsin and Minnesota, in cooperation with the

United States Department of Agriculture. In 1919, about $10,000 was subscribed for cooperative eradication of currants and gooseberries by individuals and associations in New York. In Massachusetts, local cooperators furnished $1,075. In New Hampshire, 53 towns voted appropriations totaling $8,514, and 34 individuals and firms subscribed $2,053 additional. The interest of the public in blister rust control is further evidenced by the fact that this State destroyed 21,171 bushes of cultivated currants and gooseberries belonging to 1,023 owners, and only 3 owners insisted on compensation for their bushes. The others willingly gave their currants for the safety of the pines.

8. Owners of young white pine stands in infected regions should hasten to remove currant and gooseberry bushes (both wild and cultivated) within at least 200 yards of their pines, to prevent greater damage than has already occurred. The blister rust is an insidious disease. A tree usually is severely diseased before the infection becomes noticeable. Cultivated black currants are especially susceptible to the blister rust, but all kinds of currants and gooseberries will cause serious damage to white pines if the bushes are not destroyed before they are infected. Each year these bushes will cause rapidly increasing damage, since each year they become more and more heavily infected from the adjacent diseased pines. At the present time the blister rust is just beginning to make rapid headway. If owners of white pine in infected regions uproot currant and gooseberry bushes now, they can save their pines. A few years delay will mean serious loss. It is a simple and practical precaution to destroy the currant and gooseberry bushes before they destroy the pines. The demonstrated effectiveness of this method of control justifies pine owners in uprooting currant and gooseberry bushes on a large scale.

9. Cultivated currants and gooseberries should not be planted in localities where white pine is an important tree. The laws of some states prohibit the planting of such bushes without permission from state authorities, except in areas designated as "currant growing districts." White pine plantings are a safe investment if currant and gooseberry bushes are first destroyed within 200 to 300 yards. The cost of protection may be reduced by selecting planting sites as far removed from cultivated currants and gooseberries as possible, and where the wild bushes are naturally few or absent. Cultivated black currants may cause loss if within a mile of the pines.

10. White pine blister rust has not been found in the western half of the United States or western Canada. The abundance of wild currants and gooseberries in the sugar pine and western white pine forests would make control of the blister rust difficult, if not impossible, in most localities. The principal safeguard of these valuable western forests lies in the strict enforcement of the Federal quarantines prohibiting shipment of 5-leaved pines, and currants and gooseberries to points west of the Great Plains.

RESOLUTIONS

Adopted by the Fifth International Blister Rust Conference, Albany, N. Y., Dec. 8 and 9, 1919

WHEREAS the white pines are the most valuable forest trees in North America in respect to high stumpage value, rapid growth, general utility, ability to reproduce naturally, and ready adaptability for forest and ornamental planting, constituting a timber crop with an annual value of not less than $80,000,000, and representing a total value in excess of $1,100,000,000, and

WHEREAS, the white pines are seriously menaced by the white pine blister rust, an imported parasitic disease which attacks pines only after an intermediate growth on currant and gooseberry bushes, and

WHEREAS, it has been demonstrated that the blister rust can be controlled by destroying wild and cultivated currant and gooseberry bushes in and adjacent to pine stands, and that such bushes can be found and destroyed at low cost.

THEREFORE, the Fifth International Blister Rust Conference urgently recommends the complete destruction of all Ribes* within a distance of 200 to 300 yards of native and planted white pines in regions where blister rust is present or within dangerous proximity. This Conference further recommends a vigorous campaign for planting white pine by individuals, corporations, municipalities and state agencies on non-agricultural lands with proper precautions against infection by the blister rust.

Owing to wide variations in the distance that spores spread from Ribes to pine, due largely to the nature of the vegetation intervening between the Ribes and pine, and to weather conditions, it is impossible to establish a fixed width of Ribes-free zone which will be equally applicable to all localities. Therefore, it is the opinion of this Conference, based upon recent investigations that a Ribes-free zone of 200 to 300 yards in width will be sufficient to insure the commercial growing of white pine under average conditions. It is also recommended that white pine should not be planted in the locality of large plantations of Ribes, especially cultivated black currants. This Conference urges that where white pine is to be planted or protected from blister rust, that federal or state agents who are qualified to judge conditions be called upon to determine the width of the zone necessary to protect the pine before the eradication is begun.

BE IT FURTHER RESOLVED:

That the planting of Ribes be discouraged in pine growing districts and that the policy of segregating pine growing and currant growing districts be defined and enforced by competent authorities.

That the cultivated black currant is a menace and that legislation be enacted declaring it a nuisance in white pine regions.

That this Conference re-affirms its position taken at previous meetings, that the responsibility for control of the blister rust rest finally with the forest owner; but, in order to hold the ground already gained, and

*NOTE: For the sake of brevity and convenience, the botanical name, Ribes, is commonly used to designate all species of currants and gooseberries, both the wild and cultivated bushes.

not to lose the benefits of the excellent work already accomplished in many places, we recommend that Federal, State, Provincial and other public appropriations for experimental, demonstration, control, and eradication work in the Eastern States and Provinces, be continued, notwithstanding post-war conditions.

That, in the Western States and Provinces, the Conference notes with satisfaction that continued scouting has not revealed the presence of the blister rust; the Conference recommends that scouting in these States and Provinces be kept up, and that State and Provincial appropriations be made and Federal appropriations continued to this end.

That an accurate knowledge of the location and amount of white pine in the country is essential as a basis for our plan of protection. We, therefore, urge that Congress make an appropriation sufficient to cover such a survey; and suggest that this survey be combined with the survey of pulpwood resources which is being advocated by the Newspaper Publishers Association, and by the American Pulp and Paper Association.

That a bulletin containing a report of this Conference be published and distributed under a method similar to that used last year.

That this Conference urges that the American Plant Pest Committee be continued; that it provide a sub-committee on the white pine blister rust; and that it provide for its future financial support.

ESTIMATE OF STAND OF 5-NEEDLED WHITE PINES IN NORTH AMERICA, 1919.*

UNITED STATES:			
Eastern States	14.5 billion ft.	at $12.00 per M ft.	$174,000,000
Lake States	9 " "	at 15.00 " " "	135,000,000
Inland Empire	23 " "	at 3.25 " " "	74,750,000
Sugar Pine	38 " "	at 3.50 " " "	133,000,000
Total	84.5		$516,750,000
CANADA:			
Western Canada	2.5 " "	at 2.00 " " "	5,000,000
Eastern Canada	60. " "	at 10.00 " " "	600,000,000
Total	62.5		$605,000,000
GRAND TOTAL NORTH AMERICA	147 " "	at 7.63 " " "	$1,121,750,000

REPORTED VALUE OF WHITE PINE LUMBER F. O. B. MILL.*

UNITED STATES: (1918):			
(Eastern) White Pine	1,672,383 M ft.	at $30.59 per M ft.	$51,158,793
Western White Pine	274,605 " "	at 31.07 " " "	8,531,352
Sugar Pine	111,800 " "	at 28.26 " " "	3,159,468
Total, U. S.	2,058,788 " "		$62,849,613
CANADA (1917)			
(Eastern) White Pine	771,119 " "	at 24.09 " " "	18,578,718
Western White Pine	20,473 " "	at 20.45 " " "	418,710
Total, Canada	791,592 " "		$18,997,428
GRAND TOTAL NORTH AMERICA	2,850,380 " "	at 28.71 " " "	$81,847,041

* "Data for United States furnished by the U. S. Forest Service, and for Canada by Mr. Clyde Leavitt, Chief Forester, Canadian Conservation Commission. Except for western Canada, the figures given for white pine stands are based on inadequate data, but represent the best approximation possible from existing information."

SUMMARY BY STATES AND REGIONS

Compiled by SAMUEL B. DETWILER

Maine. Work was done during the season on control areas at Brunswick, Alfred, and Kittery Point. A reduction in cost was achieved through advance scouting to locate wild currants and gooseberries. A man thoroughly acquainted with the growth and habits of these plants went over the control areas ahead of the crews and located the places where wild currant and gooseberry bushes were sufficiently numerous to make it economical to have crews do the work. In the rest of the control area, the scout pulled the bushes as he found them, leaving the areas free from Ribes. Advance scouting is practical only when Ribes grow more or less in colonies, or in certain definite places.

More than 50,000 acres were mapped to determine the exact location and character of the white pine growth in order to advise owners on the best means of protecting the pine from blister rust. On 46,000 acres in the towns of York and Kittery, 4458 acres of pure and mixed pine was estimated to have a value of $669,504. The owner of white pine should protect it from the blister rust, just as he protects his timberland from fire. The Forest Commissioner at Augusta stands ready to plan cooperative blister rust control work with any organization or individual.

New Hampshire. In 1919, 53 towns appropriated $8,514.25 to cooperate in blister rust control. In addition, 34 persons, firms, and associations contributed $2,053.65. Control work was carried on in 49 towns and the entire area of three towns was cleared of Ribes.

It was possible to make a decided increase over the work done in 1918, by improved field methods and more intensive training of the field force. Approximately 2,000,000 currant and gooseberry bushes were destroyed on 163,413 acres, at an average cost of 20 cents per acre, a decrease of 19 cents per acre over the cost of 1918.

Extensive areas of severely infected pines exist in New Hampshire. In a 41-acre pine lot at Littleton, containing a total of 5442 white pines averaging 6 inches in diameter, 3014 or 55 per cent of the trees are infected with the rust. This infection is entirely due to wild gooseberries, which average 30 bushes per acre. The oldest infection found on pine in this region is estimated to have started in 1906, or 13 years ago. Strip surveys a rod wide, totaling 22⅝ miles in length, recently were run out north, south, east, west and southwest from this pine lot across the surrounding country. Out of 2896 pine trees growing on these strips, 25.5 per cent have been attacked by the disease. In addition, 1461 pines were inspected in 33 widely scattered quarter-acre plots, and 41 per cent were found infected. Thus, in an area 8 miles wide and 9 miles long, a total of 9,799 pines were examined and 4,359 trees, or 44 per cent, found diseased. Since the strip lines give a fair average, it appears that at least one-fourth of the pines in 72 square miles covered by the survey in the Littleton region are infected with blister rust. On another strip line 30⅞ miles long, run from Lisbon to Woodsville and Piermont, 2.4 per cent of 6,758 trees were diseased. This shows that infection is progressing rapidly, and that pine owners should lose no time in

destroying currant and gooseberry bushes in the vicinity of their pines.

A pine survey made in Dover and Kensington shows that out of a total area of 24,153 acres, there are 6,578 acres of pure and mixed pine estimated to have a total value of $313,358. The State Forestry Department, at Concord, cooperates with pine owners, towns, and associations in controlling blister rust, so far as appropriations permit.

Vermont. It is estimated that approximately 25 per cent of the native pine in the towns of Ryegate, Barnett, and Waterford are infected with blister rust. Infections were also found in native pines at Newbury, Fair Haven, Hubbardton, and Bristol, and in pine plantations at Lyndon, Enosburg, Plainfield, Orange, and Cabot. Infections on currants and gooseberries indicate a general scattering of the disease over the State.

Experimental eradication of currants and gooseberries was continued in 1919 on areas at Sharon, Ryegate, and Fairlee. Mapping of the white pine area has been started to aid in formulating a policy for control of the disease. Pine owners who wish to protect their pine will be given the services of a trained man from the State Forestry Department, at Montpelier, to oversee the work of uprooting currants and gooseberries.

Massachusetts. Blister rust has been found distributed throughout the State. Control work was carried on in Templeton, Gardner, Westminister, Ashburnham, Hubbardston, North Andover, Petersham, and Marshfield. In the three latter towns large control areas were worked. Intensive scouting this season revealed that no pine infection had taken place at Lenox and Ipswich after the Ribes were destroyed in 1916.

Three cooperators subscribed $1075 for cooperative work, and the State Forestry Department cooperated to the extent of $500 in removing Ribes from the vicinity of state plantations. The State Department of Agriculture, 136 State House, Boston, offers advice and cooperation to pine owners who desire to protect their stands from the blister rust.

Rhode Island. It is estimated that 11,000 acres of young pine and 11,000,000 feet B. M. of merchantable pine were protected in the area from which Ribes were eradicated in 1919, the total value being $300,000. During the past season the cost of eradicating currants and gooseberries was 11 cents per acre, compared with a cost of 27 cents in 1918. This reduction in cost was due to the use of the advance scouting method of locating wild Ribes. The state supervisor laid off 65 check plots in advance of the crews and without their knowledge. The crews found and destroyed 2566 Ribes and overlooked 113 bushes; an efficiency of 96 per cent.

The annual height growth of 836 wild gooseberries averaged 5 inches for four years. Gooseberry bushes in exposed sites on fairly dry soil averaged 3 inches growth per year. Bushes in moist sites with about an equal amount of sun and shade grew 5 to 6 inches per year. Such bushes did not bear fruit until they were 6 to 8 years old. Gooseberries growing in very dense, shaded sites grew 7 to 8 inches per year during the first three years. No bushes were found in such a site that were over four years old; they appear to be either shaded out or winter killed.

The State Board of Agriculture, at Providence, will assist pine owners in blister rust control projects.

Connecticut. The only eradication area consisted of 2500 acres located in the towns of Colebrook and Norfolk where Ribes eradication had been carried on in previous years. Six plantations where rust had been found on pine previously were inspected in 1919. They were located in Litchfield, Groton, Greenwich, and Middlebury.

In Pomfret where an infection was found on pine in 1917, a small area was cruised to get rid of some escaped Ribes. In order to observe the spread of the disease from the pine infection center, a block of about 30 square miles was very carefully scouted and the location of all Ribes was mapped. Another area of about 30 square miles, similar to the one in Pomfret and for the same purpose, was laid off in Branford in 1918. This was carefully rechecked this year.

The State Agricultural Experiment Station, at New Haven, gives assistance and advice to pine owners relative to blister rust control.

New York. The blister rust is generally distributed throughout the Adirondack region. There are a number of areas of badly infected pine. Outside this area of general infection, the disease was found on currant and gooseberry bushes in 14 counties.

One of the outstanding features of the year's work was the favorable attitude of pine owners as shown by the extent to which they cooperated with the Conservation Commission in protecting their property. In addition, several owners removed the Ribes from their land and bore the entire expense. Another feature was the steady improvement made in Ribes eradication. Checking proved that good crews leave only the smallest and least dangerous bushes, and that on areas worked the previous year, less than 10% of the original number of bushes remained. Ribes leaf counts show that when 87% of the bushes are removed, 97% of the leaf surface is destroyed. The leaves of 2194 bushes were counted in this test. In the first working, bushes bearing 94,429 leaves were destroyed. In three subsequent workings only 3094 leaves were found.

Control work began May 1 and continued six months. During this period over 400 laborers were employed. They removed a total of 2,181,286 wild Ribes from 23,194 acres in 22 separate areas. Most of the areas worked this year were unusually rough and difficult territory. The advance scouting method was not employed. Of the total acreage protected, 14,807 acres were privately owned lands on which individual owners or associations have actively cooperated in controlling the disease by paying one-fourth the cost of the work. Advice on blister rust control methods and cooperation may be obtained from the Conservation Commission, at Albany.

New Jersey. General and intensive scouting throughout the State resulted in the finding of one patch of diseased black currants near Red Bank. All of the bushes were destroyed. No diseased pines were found.

In Pennsylvania, Maryland, Virginia, and West Virginia, blister scouting was restricted to suspicious pine plantations, cultivated Ribes in their vicinity, and to a general survey of such sections of these states as seemed most likely to harbor the disease. No blister rust was found, although many thousands of pines and Ribes were inspected. The relative scarcity of the host plants in Pennsylvania and New Jersey will aid materially in delaying the spread of the disease southward.

Minnesota and Wisconsin. In these states, the blister rust is so widespread that it is beyond hope of general eradication. The area of general infection is approximately 150 miles long by 100 miles wide, extending from the latitude of St. Paul to a few miles north of Duluth and on both sides of the St. Croix River for a width of from one to two counties. Scattered infections were found also in southeastern Minnesota, and an isolated infection in eastern Wisconsin, reported last year, again appeared.

Pine eradication near Rice Lake, Grantsburg, and Lewis, Wisconsin, in March and April, was successful in checking the spread of the rust and this phase of the work will be continued for the present. The only new serious pine infection center discovered in Wisconsin is in northeastern St. Croix county and all white pine in the heavily infected area are being taken out.

Ribes eradication was carried on at Rush Lake, Taylors Falls, Grasston and Dalbo, Minnesota, over an area of 2,440 acres, and 156,304 wild currants and gooseberries were destroyed.

The policy of stimulating local control of the disease by cooperative eradication of Ribes around valuable white pine stands has been agreed upon. Ribes eradication will be started first on State lands. Advice and cooperation in blister rust control may be obtained in Minnesota by consulting the State Entomologist, University Farm, St. Paul; and in Wisconsin by applying to the State Entomologist at Madison.

Michigan. The rust was found at Birmingham, Oakland County, on one tree from a local nursery. Though the disease has appeared in the past at three other places in the county, there was no recurrence at any of these places.

Other States in Central West. Blister rust scouting was carried on in 13 other states, but no signs of the rust were discovered. Two violations of the Federal quarantine were found in Oklahoma, shipments of gooseberries being received by one nursery from Alabama and by another nursery from Iowa. A single violation of this quarantine was also found in Nebraska, where a nursery had purchased 1,000 pines from an Illinois nursery. These violations have been reported to the Federal Horticultural Board.

Rocky Mountain and Pacific Coast Regions. White pine blister rust has not been found in the Far West. Scouting for the disease began in 1917. The work has been aimed toward (1) locating and inspecting every blister rust host plant that has entered this territory from a region where the disease was present; (2) searching for violations of

the Federal quarantine against shipping 5-leaved pines, currants and gooseberries west of the Great Plains; and (3) general scouting for the disease. During the past three seasons, about 7,000 imported white pines and several hundred thousand imported currant and gooseberry plants have been inspected. Limited scouting for the disease on wild plants has been done in each western state. A Cronartium found on Ribes in Utah, Colorado, Nevada, California, Arizona and New Mexico has been identified as C. *occidentale,* the alternate stage of a peridermium occurring on the pinyon pines. This rust is harmless to white pines.

Sixty-five species of Ribes are indigenous to western North America. Out of this large number can be found species adapted to nearly every site condition occurring in these regions. The constant occurrence of these Ribes would afford unbroken chains for the dissemination of white pine blister rust.

If the sugar pine and western white pine are to be kept free from this disease, five-leaved pines, and currant and gooseberry plants from infected regions must be kept out of the West, as provided by quarantines in both the United States and Canada. Several violations of the Federal quarantine have been discovered in the Rocky Mountain States. A single diseased shipment of either pine or Ribes may result in enormous losses in the Far West, both to private and government holdings.

SUMMARY OF RIBES ERADICATION DATA
NORTH EASTERN STATES, 1919

STATES	Acres Cleared of Ribes	Total No. of Ribes Pulled	No. of Ribes per Acre	Labor Cost per Acre
Maine	9,216	333,775	36.2	$0.48
New Hampshire	163,414	1,681,090	10.2	.21
Vermont	2,460	96,749	39.3	.93
Massachusetts	10,849	204,196	18.8	.71
Rhode Island	40,481	46,197	1.1	.11
Connecticut	2,500	31,000	12.4	.93
New York	23,194	2,181,286	94.0	2.19
Totals	252,114	4,574,293	18.1	.42

Scientific Research in 1919

Conducted by the Office of Investigations in Forest Pathology

By DR. PERLEY SPAULDING

The investigations of 1919 were carried out in a manner similar to those of the previous year, being conducted principally at North Conway, N. H., and Lewis, N. Y. At the former place, Professor H. H. York of Brown University had direct charge of the work, and at the latter, Professor L. H. Pennington, who represented the State College of Forestry of Syracuse University, a cooperating institution. Special efforts were made this season to determine the distance of distribution of the different forms of spores of the blister rust.

Professor York, in New Hampshire, found that the aeciospores may apparently be blown for a distance of 15 or 20 miles, and be carried upward 5,000 feet and retain viability. Viable aeciospores were collected upon the summits of Moat Mt. (3,200 feet), Carter Dome (4,800 feet), and Mt. Carrigan (4,700 feet). It appeared that these spores in some cases must have been blown across the Presidential Range, indicating that mountain ranges are not an obstacle to the spread of this disease. Viable urediniospores were caught in traps 3,200 feet from their sources of origin, while similar spores caught at a distance of 3,400 feet failed to germinate. Under

a heavy cover of black alder, viable sporidia produced on skunk currant were caught only up to a distance of 75 feet. None were caught in traps directly over the plants but above the screen of shrubbery. Viable sporidia from cultivated black currants were caught in traps 600 feet distant in an open meadow. Sporidia were caught in traps 2,400 feet from their source of origin but failed to germinate. The sporidia which germinated were caught during a period of high humidity, while those caught at 2,400 feet, but which did not germinate, were caught on a clear windy day. Tests of the longevity of the sporidia showed that they remained viable for a period of *less than ten minutes* where the humidity was 90 and the temperature 22 to 25 degrees C. Professor York concluded from these results, that the character of the vegetation intervening between the Ribes and pines, and the climatic conditions are vital factors in the distance that sporidia may communicate the disease.

Professor Pennington, working in the Adirondacks, used spore traps for determining the distance of distribution of spores, but also had a chance to make studies of the actual distance that infection had spread in pines from Ribes at various points in the Adirondack region. Apparently, the general conditions existing in the Adirondack section were not quite as favorable for the distribution of spores as they were in the White Mountain section. Viable sporidia were obtained up to a distance of 180 feet. Sporidia which did not germinate were caught up to 300 feet from their source. Studies of natural infections in pines in nine different places, and where infection came from definitely located bushes of *Ribes cynosbati, rotundifolium,* and *glandulosum,* showed that serious infection occurred up to less than 200 feet from the Ribes. The amount of infection of pines depends upon weather conditions, and may be light in some seasons but very heavy in others. Cool, moist situations, protected from winds, favor infection of pine. Intervenng barriers of vegetation tend to limit infection. In general, it may be said that under given conditions the number of infections in pine varies directly with the amount of Ribes leaf surface and inversely as the square of the distance from Ribes.

Investigations on the cutting out of infections in pines were started in 1917 by Posey and Gravatt. Ninety-six infections were thus treated. The majority were located on small branches but a number had run back into the larger branches or main trunk of the tree. The age of the wood infected ranged from 5 to 14 years. The infections were cut out at varying distances from the edge of the visibly discolored bark, ranging from about 1/4" up to 6". Enough time has elapsed since these infections were removed for the disease to reappear at the edges of the cuts if it is going to. In brief, it may be said that where the cut was made at 1 1/2" distant from the visibly affected part, the disease has not again reappeared.

Investigations of the blister rust have now been carried on for a decade. At first we were in almost total ignorance of the practicable bearings of this disease. Naturally mistakes have been made, largely because we were unable to make personal investigations of the outbreaks in Europe. Damage to old trees results in an unexpected manner, — namely, from infections upon lateral branches running backward into the main trunk. Trees up to one foot in diameter at the point where girdled have thus been infected.

Our studies of the distance of distribution of the various spore forms and of the distance that infection has actually occurred upon pines from known infected Ribes indicate that the Ribes-free-zone should be, under average conditions, 200 to 300 yards in width. It should be much more where conditions are exceptionally favorable for transfer of the spores from Ribes to pine, i. e. near large bodies of Ribes, where there is no screen of vegetation over the Ribes or between the Ribes and the pines, or in exceptionally humid situations. The cultivated black currant, *Ribes nigrum,* should not be allowed in an infected pine district because of the special danger from it.

The insidious spread of this disease in a given locality cannot be overemphasized. Over-wintering by means of aeciospores in old cankers on living pines, and also by means of urediniospores upon dead infected Ribes leaves has been proven. Special attention should be given to the fact that quantity of infection of pines rests to a great extent upon the volume of spores produced by the infecting currants. In other words, the efficiency of eradication of Ribes depends upon the relative reduction of Ribes leafage, upon which directly depends the quantity of spores given off to infect pines.

Artificial Infection of Pines with Cronartium Ribicola

Conducted at the Connecticut Experiment Station

By Doctors G. P. Clinton and Florence A. McCormick

This is a report of the results of artificial infection of pines along the same lines as was reported a year ago in Bulletin 2 of this committee. Successful inoculations have been made on over 150 young pines, something like 10,000 distinct infections having been secured. These experiments show that infection takes place through the stomata of the leaves. The first visible sign of the infection is a minute golden-yellow spot centering over the lines of the stomata on the lower side of the leaf. Under greenhouse conditions these became evident within three months after inoculation. Infection takes place within 48 hours. Leaves up to two years of age have been abundantly infected. Infection within a leaf is indicated by the formation of a peculiar swollen body within the stomatal cavity in the leaf, from which a single hypha runs downward and soon gives rise to relatively large sclerotial bodies. Then the mycelium extends into the vascular bundle of the leaf and follows downward until it reaches the twig. Progress down the leaf and into the twig is apparently quite rapid under conditions favorable to plant growth. Trees of *Pinus excelsa, flexilis, koraiensis, cembra, densiflora, austriaca, resinosa,* and *sylvestris* were inoculated without success. No infections have developed beyond the pycnial stage upon any species except *Pinus strobus.* Early stages of infection have been secured upon *lambertiana* and the two pitch pines. *pinea* and *sabiniana.* Tests have not yet been made with the pinon pines, *P. edulis* and *monophylla.* Details of these experiments were largely published in Bulletin 214 of the Connecticut Agricultural Experiment Station.

The Destruction of Ribes by Chemical Means

By Dr. W. S. Regan

Three years' study of various chemicals for killing currant and gooseberry bushes has been made, to discover a cheaper means of destroying these plants than by hand pulling. Fuel oil and dip oil have given good results.

DIP OIL. (Twenty-five per cent cresol; fifty cents per gallon) was used straight or diluted with fuel oil. One treatment of dip oil (straight) applied to the top or crown of bushy species of Ribes kills in the majority of cases. Dilutions with fuel oil of 1 to 5 or 1 to 8 appear most satisfactory for the treatment of skunk currant areas, but two or more treatments are required for a complete kill.

Dip oil (straight) applied to the tops kills the Ribes foliage in from about half an hour to a few hours, regardless of exposure to sun or shade. Crown treatment alone usually kills the plants slowly, often requiring several weeks, or even months. The efficiency of dip oil appears to be little affected by rain, the absence of foliage, or season of application, so long as the treatment is thorough.

FUEL OIL. (Light grade, 36.3 degrees Beaume, fourteen cents per gallon) gives best results when applied to entire top and crown. One treatment will frequently kill bushy species; but often two treatments, rarely three, are required. In the case of areas of skunk currant, three or more treatments will usually be required to obtain a complete kill. Dip oil and fuel oil are not poisonous to animals, and do not injure other vegetation if reasonable care is exercised. Where wild currant and gooseberry bushes are large and numerous, or grow in walls and stone piles where hand pulling is difficult, spraying with fuel oil should result in a material saving in cost, although combination with dip oil appears preferable. It does not appear to be economical to treat small plants of the bushy species, which are easily pulled by hand. One and three gallon brass compressed-air sprayers are satisfactory for applying the oils.