

test its accuracy, it has proved a very satisfactory and efficient method of detection, and will continue to be our chief mode of detection.

The Forest is well equipped with a very complete and extensive supply of fire fighting equipment all of which is kept in the very best condition so that it will always be in readiness when fires occur. Many tool caches are located conveniently thruout the Forest and are equipped to supply from five to twenty-five men. At the Supervisor's headquarters sufficient outfit is on hand to equip from five to thirty men crews, all of which is packed and labeled for immediate transportation when fires occur. The entire fire plan of the Forest is outlined to such an extent and every detail is covered so thoroly that the greatest amount of efficiency will result when fires are reported. This with immediate action, and sound judgment on the part of the Forest force when the smoke is reported is absolutely necessary where travel conditions must continue to be slow at the best, away from our few miles of good roads.

The co-operation in protection which has been received and is being received from the Minnesota State Forest Service, the logging operators, and other Forest users has been wonderfully valuable to this severely burned area. The co-operation thus received has done much to prevent the complete destruction of the remaining mature timber and has saved the very desirable young reproduction growing so abundantly on previously burned areas. Such co-operation will be needed more urgently in the future and the personnel of this Forest will continue to lean heavily on this most valuable good will of the Minnesota State Forest Service, Forest users and others.



## WHITE PINE BLISTER RUST.

C. J. Baker ('20)

The white pine blister rust is a destructive disease of five needle pines. It is caused by a parasite fungus and like some other rusts, it requires two distinct host plants in order to complete its life cycle. These are first, the five needle pines and second, the cultivated and wild currants and gooseberries.

The disease came to this country from Europe through imported white pine seedlings, a few as early as 1900 but in great numbers in 1909. The seedlings were widely distributed before the presence of the disease was discovered. At present it is most abundant in the New England States and also Ohio, Indiana and Minnesota.

White pine blister rust finally kills the attacked trees or parts of them and if they are twenty-five years of age or less they are liable to be entirely killed. If the tree is older than this the top shoot or some branches will be killed when attacked. The greatest damage, however, is done to the young reproduction or to young plantations or nurseries, but if the disease becomes very prevalent, it is obvious that mature trees may be seriously crippled if not killed by it. There are twelve American five needle pines and nine foreign ones, any of which will take this disease.

In the eastern part of the United States the danger from this rust is very great in that Eastern white pine is a very valuable species. The present stand of mature eastern white pine has been estimated at approximately \$186,000,000. Beside the present value of the mature timber, it is of great importance because nine-tenths of the reforestation work in the north-eastern states is done with this species. In the area worst affected by gypsy moth this species is being planted almost exclusively, for it is most valuable which is not seriously damaged by this insect. In many sections of this country, white pine is the most valuable for future forests. Its loss would be felt keenly for no other tree is a good substitute.

If the disease is not eradicated or at least checked it will finally spread naturally from Minnesota eastward and from Canada to Georgia and Alabama. If this takes place there will be little hope of coping with it unless public opinion becomes very highly aroused. Unless complete authority is given state officials to take measures to stamp out this serious disease, it will escape and probably become a permanent menace to the country.

In the western forests two of the most important lumber species are threatened by white pine blister rust. These are

sugar pine and western white pine, the combined estimated value of the mature stand being \$240,000,000. Both of these species have been seriously attacked in Europe but are little grown in our eastern states where blister rust is present. So we cannot estimate the damage the disease would do to these trees in this country. These two species reproduce readily and everything points to the fact that they will form a very important part of the future forests. Reforestation in the United States may largely be done with these species.

The danger from white pine blister rust would be great if it once reached the Pacific coast or Rocky Mountain regions for it has been found by experiment that the ribes in these localities are susceptible to the disease. Conditions are such in these native forests, that if they once become infested it would be practically impossible to control the disease.

These western forests, however, are separated from the infected eastern ones by the Great Plains so that the only way which the rust could reach them would be through shipment of diseased nursery stock. Therefore it is of extreme importance that these shipments be prevented. It is urged that all five needled stock be grown from seed in the locality where the trees are to be planted, and that the states co-operate in enforcing proper quarantine laws.

The most characteristic symptom of blister rust on pines is the presence of irregular swellings in the bark, especially at the lower branches if the tree is small. In large trees the condition is similiar, the swellings commonly extending to the base of smaller side branches and sometimes into the latter. Often this swelling is not tapering but very irregular, the bark having a disrupted appearance with rounded swellings at leaf scars. Trees three or four years of age are often stunted by the disease so that they appear abnormally compact. This is not so evident upon larger trees while occasionally but rarely the leaves upon the affected parts become yellowish. These affected parts finally die and become noticeable as they stand upright and do not droop as in the case of frost or certain insect injuries. The work of the white pine weevil may be confused with that of blister rust but the former usually kills only the top lead shoot down to the first branches, while the latter usually kills the entire top of the tree and side branches as well.

The fruiting bodies of the parasite furnish a most certain symptom for the detection of the disease. They form upon the thickened bark in the spring from the later part of April until the middle of June, depending upon the weather conditions and the locality. At first, these bodies thrust themselves out through the bark forming whitish blisters as large as a child's finger nail which are usually somewhat longer one way than the other. Aft-

er a few days the outer membrane breaks and the top falls off and exposes the bright yellow dusty spores inside. After a few weeks these are completely blown away from the cavities, the white membrane also disappears leaving only the rounded hollow which has a whitish, granular appearance. These are very characteristic and as easily distinguished as the fruiting bodies. On young trees the disease girdles the trunk by killing the affected bark in which case the bark becomes scaly while on the green parts it is still smooth. Sometimes after being girdled a tree will live for several years, the part above the canker growing until considerable swelling has been produced. The fruiting bodies form each spring both above and below the dead area the disease progressing each year until two or three feet from the original point of entry.

On ribes the parasite attacks only the leaves and has two distinct forms which may be found on either the currant or gooseberry or both. The summer form occurs on the lower surface of the leaves in the form of a small, mealy, powdery, bright-yellow masses no larger than a pin head. Upon shaking the leaf this material is set free and forms a yellowish cloud. This type of the parasite may be found from the middle of June until the leaves fall being most common in July and August.

The autumn form of the disease occurs as short, hairy outgrowths about a quarter of an inch in length generally arranged in small circles. They may be scattered or so abundant as to form a hairy coating on the entire under surface of the leaves. These hairs are brownish in color but in moist weather become a grayish brown. Both of these forms occur upon the lower surface of the leaf and must be examined on that side for the symptoms do not generally show upon the upper surface.

The white pine blister rust found upon pines is called *Peridermium strobi*, while the form found upon ribes is known as *Cronartium ribicola*. The parasite has a very complex life history and has a large number of related fungi.

An incubation period follows the infection of pines which may vary from one to six years or more no visible symptoms of the disease being noticeable. Then the bark begins to swell and the healthy green color changes to a yellowish to a reddish color. On these yellow patches small drops of a clear, sweet tasting fluid are pushed out of tiny openings. This liquid is found to contain great numbers of spore bodies the function of which has not been determined. These spores are called *pycnospores*. After they are produced the real fruiting bodies push themselves out thru the swollen bark and appear as white blisters already described. After a time these break open and the bright-yellowish powdery masses of spores are set free. These reproduce the disease by attacking the leaves of ribes and not by attacking pines upon

which they have no effect. In most cases after fruiting, the bark is killed where fungi entered but sometimes it remains alive a year afterward. Each spring a new crop of these spores are produced, which are set free to infect ribes leaves. These spores are known as aeciospores or peridermium spores.

Distribution of these spores is done mostly by the wind but may be done by small animals. The spores attack ribes leaves; unless the weather is very dry enough moisture is usually present. They send their root like tubes into the soft tissues of the leaves, the roots spreading within. With the most favorable amount of moisture and best weather conditions, it requires twelve to fourteen days to produce a new crop of spores. These appear upon the lower surface of the leaves in the form of tiny masses, hardly larger than a pinhead of very fine, orange-yellow powder. One of these masses is formed by the infection of a single peridermium spore. These new spores are called uredospores and are quite different from those on the pine. These spores unlike the pine spores can reinfect the leaves of ribes and therefore this is called a repeating stage. This repetition goes on the remainder of the season, a new crop of spores being produced every two weeks. The amount of progress made by the parasite during this time depends upon the amount of ribes near the infected one. This stage of the disease is generally found from June first until the leaves fall.

After the latter part of July another form of fruiting body and spores are formed upon gooseberry and current leaves. The new form appears in groups of from three to twelve short, stout threads about a quarter of an inch long and generally arranged in circles. Upon these threads teliospores are produced and unlike the uredospores cannot reattack the ribes leaves. They must attack the bark of the white pine, germinate and grow in the inner bark during the incubation period. This pine infection must take place in late summer or fall and if conditions are favorable pycnosporangia may be produced the next spring. This completes the life cycle of the parasite.

In the work of controlling the disease, special emphasis has been laid upon separating the two host plants, since each is dependent upon the other in the life cycle. State officials must have authority to destroy such current or gooseberry bushes as they deem necessary. Without adequate state laws, little can be done in the way of eradicating this disease.