MISTLETOE ON CONIFERS

by

EMIL JOHNSON

A THESIS

submitted to the

OREGON STATE AGRICULTURAL COLLEGE

in partial fulfillment of
the requirements for the
degree of

BACHELOR OF SCIENCE

June 1937

MISTLETOE ON CONIFERS

Contents

MISTLETOE ON CONIFERS

Introduction

During the early days of development in the United States our supply of virgin timber was thought to be inexhaustible. With this thought in mind, very little notice was taken of the inroads that fire, insects, disease and wasteful methods of logging and lumber manufacturing were making in our timber supply. When it became apparent that the timber supply would not last forever, means of decreasing unnecessary losses were sought.

Many of these losses have been decreased and are being decreased still more as better methods of eliminating them are discovered and developed. The losses which have been the most apparent have received the greatest share of attention.

Probably the reason that mistletoe in the conifers has not received more attention by the forester is because it is not as conspicuous as damage by insects, fire, or other agencies. Some species of mistletoe are very inconspicuous and their presence is not recognized until the trunks and branches become deformed.

Often our methods of cutting tend to favor mistletoe infection rather than to eradicate it.

Recently the forester has begun to realize that mistletoe is a serious problem in some forest regions. He has not, however, done very much toward its control. This is probably due to the high cost of control methods.

> "No one questions the expenditures of large sums for the control of fire. The effect of a heavy infection by mistletoe over large areas results in a great loss in increment, which, when coupled with other defects caused by the parasite*, is analogous in some respects to the immediate destructiveness of fire" (1).**

In spite of the high costs of control methods, mistletoe control will eventually have to be undertaken.

Species of Mistletoe Attacking Conifers

The two genera of Phorodendron and Razoumofskya include all the species which infect coniferous trees in the United States. Species of the genus Phorodendron are known as the true mistletoes and are most common on the hardwoods. However, a few species of conifers are infected by the mistletoes of this genus.

Species of the genus Razoumofskya attack conifers exclusively. These mistletoes are commonly known as the dwarf mistletoes, but are sometimes called the false mistletoes.

The distribution of the two genera is nation-wide. They occur wherever their hosts are found. Infection and damage, however, are the severest in Western United States.

General Nature of Mistletoe Injury

Mistletoe propagates itself by means of seeds. Each seed is covered with a mucilaginous substance which causes it to adhere to the first object with which it comes in contact.

---

* Mistletoe is not a true parasite, but is often called a parasite.

**The number refers to the literature cited. A list of the literature cited will be found on the last page of this paper.

> "When a lodgment is found on tender unsuberized parts of seedlings or of more mature growth, the young germinating plant penetrates the cortex and bast, and infection results." (1)

The root system continues to develop and from it comes the mistletoe plant.

The primary root, or sinker, penetrates into the cambium and wood cells as far as the tenderness of the newly formed wood tissues will allow. The sinker never goes any deeper than its first elongation. The part of the sinker which is in the cambium is capable of elongating, thus keeping pace with the increasing diameter of the host. Eventually lateral roots, developing from the primary sinker, are established. These may extend several feet in either direction from the point of original infection.

> "In some species the lateral root system elongates with the branch, keeping pace with the last third or fourth internode. Additional sinkers penetrate the deeper tissues of the bast, springing from the transverse and longitudinal root system, so that eventually a thorough infection of the entire circumference of the branch results." (1)

Infection is not confined to branches alone, but is quite common on the bole of the host. The sinkers follow the cells which offer the least resistance. In young stems the sinkers usually follow the medullary rays.

The root system of the mistletoe plant is in close union with the host tissue. "The phloem of the host is found to be in some species in direct union with the absorbing cells of the parasite." (1). The fact that mistletoe has chlorophyll tissue indicates that it does manufacture food and therefore, does not

have to depend on its host for food, but it is very doubtful if it manufactures all of its own food. It does, however, depend entirely upon the host for its water and inorganic material.

The most conspicuous results of mistletoe infection are the witches' brooms, swellings and burls on the infected host. Large amounts of elaborated food are used by the host in building up these abnormal growths at the expense of diameter and height growth. The roots of the parasite undoubtedly interfere with the food and water transportation systems of the host, thus disrupting the normal functions of the tree. In cases of heavy infection, the leaf surface of the host is greatly reduced. This reduces the size of the tree's food manufacturing plant, thus interfering with normal growth.

Mistletoe Injury to Young Trees

The young seedling may become infected during its first year if a seed of the parasite happens to become lodged on a favorable place. Normally infection will not take place on growth over six years old. This indicates that any part of a tree less than six years old may become infected. Past studies show that most of the infections in young reproduction are on the main stem. Studies also reveal that young trees thus infected rarely grow into merchantable material. As the young tree grows, only those parts which are less than six years old

are susceptible to infection. The mistletoe which becomes established on the young tissues of the tree continues to thrive even though the tissue upon which it is located becomes very old.

The retarding of growth by mistletoe on young trees is shown by measurements made on ponderosa pine in Spokane County, in Washington.

> "Two representative plots of one acre each, consisting of infected and uninfected reproduction and representing all age classes, were selected. The site was level bench land with a sparse stand of merchantable-sized trees. Some of these trees were severely infected with mistletoe ((Rayoumofskya Campylapoda (Engelm.) Piper)) and were the source of infection of the reproduction. The young trees were well distributed over the area and were dominant." (2)

The ages of the trees ranged from four to ten years. Heights were measured of 77 infected trees and 213 uninfected trees. The average height for the infected trees was 44.72 centimeters and 57.87 centimeters for the uninfected trees. On the average, the uninfected trees were 13.15 centimeters greater in height for all age classes. During the measuring it was noted that the internodes and terminal and lateral buds of the main shoots were shorter on the infected trees.

This study was followed by a similar study in the Missoula River region near Missoula, Montana. It dealt with Douglas fir infected with Razoumofskya douglasii Engelm.

> "For this study trees were selected over an area without recourse to sample plots. The only point adhered to was the selection of trees on the same type of site, condition of growth, and an average age of 18 years." (2)

This study was based on 50 infected and 50 uninfected trees. The results of the measurements showed that the average height growth for the last four internodes was much smaller for the infected trees. The length and breadth of the terminal bud was also smaller for the infected trees.

> "The foregoing results clearly demonstrate the effect of the formation of brooms and burls on the storage of food material in the terminal buds and shoots. It is a well-known fact that in the terminal bud are stored the elaborated food materials for its early development the following season. If this food material is reduced in amount by its becoming localized in other parts of the tree, the growth of the main shoot must be necessarily retarded, and the bud itself will form earlier in the season and be much reduced in size. Two yellow-pine trees, each eight years of age, one with a conspicuous infection with broom formation, the other entirely free from infection, were carefully observed to determine this point. The former not only started the elongation of the main shoot nine days later than the other tree, but ceased to develop altogether at the end of the first month. The shoot of the uninfected tree continued to elongate for two months and showed a gain of 11 inches over that of the infected tree." (2)

These studies indicate how seriously mistletoe retards growth and the normal functions of the young tree.

Infection on the Branches

Infection on branches results in a swelling which is the first step in the development of the witches brooms. It may take several years after swelling has started for the witches broom to develop, but in most species it will eventually show up.

In some species of trees the branches of the witches' brooms are very long and make them very conspicuous, while in

other species they are hardly noticeable. Sometimes the brooms become so great that the whole crown of the host becomes one mass of large witches' brooms.

Some of the brooms become so severe that branches to which they are attached die. After the abnormal branching has started "The mistletoe plant may die out entirely on very old brooms, especially those of yellow pine, but the stimulus to abnormal branching may continue" (3). The added weight of the broom often causes the branch to be broken off in heavy wind storms or when soaked with rain or ladened with snow and ice. This is particularly serious in western larch. When the branch is broken off, a series of branches may develop from the trunk around the base of the broken branch. These almost always become infected and form brooms and burls on the trunk.

> "Excessive brooming is a common feature wherever larch occurs and is the chief cause of injury to the species. In some localities in the Blue Mountains of Oregon and parts of Idaho and Montana, where this mistletoe is common, a normally formed larch is seldom found. Instead of the symmetrical, conical crown so characteristic of the normal tree, the crown develops under the influence of the parasite into a denuded spike, bearing only a few ragged branches. When it is recalled that practically every larch in these regions, from pole size up, is more or less infected and seldom attains a normal size, in many cases being killed outright, some notion may be had of the seriousness of the effect of the parasite on its host." (3)

Branch infections have a very marked effect on diameter growth. One tree having one huge broom showed a marked increase in the radial dimensions of its annual rings after the broom was broken off by the wind.

Branch infections also tend to increase the diameter growth of the branches.

Infection on the Trunk

New infections on larger trees takes place only on the portion less than six years old. Once established, the parasite may thrive indefinitely. Trunk infections usually result in the formation of burls around the point of infection.

As time goes on the burl tissue enlarges until the central part of the infected wood dies, thus leaving an open wound.

Some of the burls are rather inconspicuous. The presence of these can be detected by a slight swelling, roughened bark and the presence of the mistletoe plant. The parasite distorts the grain of the wood in the burl and makes it somewhat spongy.

Excessive resin flows accompany infections on the branches and trunk. "The resin flows on the bole are usually indicative of the decline of the tree; in fact trees with marked resin-flow cankers usually die in a relatively short time." (4)

When infection on the trunk has become heavy, the portion above the infection becomes weaker and may eventually die causing a spiketop. Such a condition is very common in some infected tree species.

In 1910 a study was begun near the Fort Valley Experiment Station to determine some of the effects of mistletoe on its host. (4) The study was based on 58 young vigorous ponderosa pines ranging from 125 to 150 years in age and 33 ponderosa pines which were older and out of the "black jack" class. At the beginning of the study, diameters were measured with a diameter tape 4.5 feet above the ground. Total height measurements were made with a Forest Service standard hypsometer. Each tree that was measured was tagged so that it could be identified at a later date. In 1915 each tagged tree was again measured.

When the results were tabulated they showed that the healthy uninfected black jacks increased 0.81 inches in diameter while the heavily mistletoe infected trees only increased 0.12 inches during the five-year period. The healthy older trees increased 0.70 inches in diameter, but the heavily infected older trees increased only 0.12 inches during the same length of time.

The healthy black jacks increased 113.7 cubic feet in volume, but the infected trees increased only 8.3 cubic feet in volume during the five-year period. In the older trees, the volume increase was 75.0 cubic feet for the healthy trees and 8.0 cubic feet for the infected ones.

These results clearly show that diameter and volume growth is enormously reduced by mistletoe infection.

Effect of Mistletoe on the Foliage

The parasite has a very serious effect on the foliage of the host. Usually fewer leaves are present; they are shorter and are somewhat lighter in color. A study made of ponderosa pine foliage reveals some very interesting results.(4) The results from two trees 83 years of age will be given for comparison. One tree was free from mistletoe while the other was heavily infected. The measurements taken indicate the following results: DBH outside bark 15.2 inches,* 8.1 inches**; total height 49.0 feet, 26.0 feet; total volume 22.50 cubic feet, 3.55 cubic feet; width of crown 22.0 feet, 8.5 feet; length of crown 42.0 feet, 18.5 feet; mean average length of leaf tufts for entire crown 6.1 inches, 4.2 inches; mean average length of leaves for entire crown 5.5 inches, 3.5 inches; total number of leaves for entire crown 837,093, 262,015; and leaf surface for the entire crown 545,606.6 square inches, 110,321.8 square inches.(4)***

The above comparison shows why growth of an infected tree is retarded. With a reduced food manufacturing plant, the tree manufactures much less food than it normally would. Some of this food is used in building up abnormal growths, thus reducing still more the amount of food that can be used for normal height and diameter growth.

---

* The first figure in each set of two will refer to the uninfected tree.

** The second figure in each set will refer to the infected tree.

***The figures used were taken from several tables in reference (4).

Mortality Due to Mistletoe

There is considerable controversy whether mistletoe does or does not cause the death of infected trees. A study to determine mortality was conducted in ponderosa pine for a period of five years.(4) The study was carried out on a plot of 456 acres stocked with black jack and yellow pine and ponderosa pine. At the end of the five year period 2.2 percent of the total number of black jacks and 3.4 percent of the total number of yellow pine had died. Of the 2.2 percent of the black jacks, death was caused to 26.4 percent by mistletoe, 25.0 percent died from mistletoe and insects, 5.5 percent from mistletoe and porcupines, 1.4 percent from mistletoe and suppression, 0.4 percent from mistletoe, porcupines and insects, and 31.3 percent died from all other causes. Of the 3.4 percent of dead trees in the older class only 4.8 percent were killed by mistletoe and insects while 95.2 percent were killed by all other causes (4).

These figures show quite conclusively that mistletoe is responsible for a large percentage of the mortality in infected areas.

Mistletoe Injury and Fungous Attack

When broomed branches are broken from the tree, an open wound is made. This is an excellent entry court for wood destroying fungi. Young burls are not serious as entry courts for fungi because they are generally pretty well pitched over. Later on, however, dead wood may become exposed, thus allowing

the fungi an opportunity for infection.

> "From cutting areas on the dry bench lands of northern Idaho, 540 mistletoe-infected living larches were examined. Out of 600 mistletoe burls found on these trees, 278 were inhabited by serious wood-destroying fungi, and other unimportant species."(3)

The fungi occurring most frequently were Trametes pini, Fomes laricis and Polyporus sulphureus. It is assumed that the fungi entered through the burl because in most cases it was found directly in the burl tissue. In practically all cases the decay had no connection with decay sometimes present in other parts of the trunk.

In burls on ponderosa pine, the bluing fungus has been found to be rather common.

Increased Fire Hazard Due to Mistletoe

The broomed branches which are broken from the trees accumulate on the ground around the bases of the infected trees. When dry, these brooms are very inflammable. This increased volume of fuel on the forest floor increases the possibilities of fire starting just as slash after logging does. When a fire does start, the increased amount of fuel will give a ground fire enough heat to kill many more trees than it would under ordinary conditions.

> "Many forest fires result from lightning striking trees which have a large amount of dry wood either on the lower branches or at the top. One of the most common effects of mistletoe is to cause the top of the tree to die. We have here another direct relation of mistletoe to forest fires."(1)

The resin flows caused by burls are very inflammable and have a tendency to hold fire for a long time, thus burning out a large portion of the bole. Trees thus weakened are often broken off by wind storms

The wind broken trees along with broomed trees which have been killed by fire or have died of mistletoe infection and new accumulations of brooms on the ground increase the amount of fuel for future fires.

Mistletoe Injury and Insect Attacks

Authors disagree when writing about the relation of mistletoe injury and insect attack. Weir states that,

> "In point of general insect attack it has been noted that the beginning of an infestation may start with trees badly suppressed by mistletoe. The fact that trees heavily suppressed by mistletoe have a weak flow of sap causes them to be first selected by certain forest-tree insects. For this reason mistletoe areas form centers from which infestation may spread."(3)

Along with these statements he lists several species of bark beetles which are usually very numerous in mistletoe infected areas.

On the other hand Doane, in his recent publication, states that,

> "Heavy mistletoe infection in pine may gradually slow down the growth, but records do not indicate that such trees are more susceptible to bark-beetle attack than non-infected trees."(9)

It is a known fact that many bark beetles and other forest insects attack weakened trees first. Therefore, in

spite of some contrary opinion, it would seem that mistletoe infected trees would be more favorable to forest insects.

Effect of Mistletoe on Seed Production

Experiments conducted with seed from cones produced on mistletoe brooms of Douglas fir, larch and lodgepole pine showed that germination was on the average ten percent lower for these than for seed from cones produced on uninfected branches of the same tree.(3) Other experiments indicate that seeds from cones on infected trees have a germination of 17 percent below that of seed from cones taken from vigorous healthy trees.

Some difficulty was encountered in securing enough seed for the experiment from cones on the brooms because such cones have a tendency to be sterile. "With the increasing age of the broom the seed production falls off, until, as it is with most species, no cones are produced at all."(3) The cones on the brooms are usually aborted, and often infested with cone and seed-destroying insects. Seeds from such cones, if produced at all, are usually smaller than seeds from normal cones. Heavily infected trees have a tendency to produce only a small amount of seed during normally heavy seed years, and very little if any, during normally light seed years.

Genetics may be very important in silvicultural considerations.

> "The experiments of Zederbauer indicate that trees grown from seed collected from intermediate, suppressed, and weakened trees are less resistant to disease than trees grown from seeds produced by dominant and vigorous trees." (4)

It would be well to try similar experiments to determine if trees grown from seed produced on mistletoe infected trees are more susceptible to mistletoe infection than trees grown from seed of healthy trees.

Effect of Mistletoe on Esthetic Value

Whenever infection becomes established in recreation areas, the esthetic value is bound to be reduced. Trails through timber distorted by burls and witches' brooms certainly do not present a scene which would appeal to the recreationist. Lake shores covered with mistletoe infected trees are not as inviting as similar shores covered with vigorous well-formed trees.

Besides detracting from the scenic value, the infection creates more debris on the recreation area. Increased fuel on the forest floor in recreation areas greatly increases the fire hazard because of the heavy use that such areas receive.

Effect on Merchantability

Mistletoe infection on the branches stimulates diameter growth of these members. This results in larger knots in the bole of the tree. The increased size of the knots sometimes lowers the grade of lumber that can be produced from infected trees.

The burls on the trunk are spongy due to the presence of the mistletoe plant sinkers. It is not uncommon for the burls to be discolored, pitchy, checked, and decadent. Infection

causes curly grain, thus reducing the strength of the wood in the burl.

All these defects make a burl highly undesirable in a sawlog. Sometimes it is possible to cut out the burls when bucking the tree into sawlog lengths. Many times the burls are as much as ten feet long and are so close together that the whole tree is undesirable for lumber.

Some figures on mistletoe damage are available from Europe where intensive forest management is practiced. One European article states,

> "That loss is far from being negligible is shown for instance by reports from the Black Forest and Alsace where cull, on account of mistletoe in silver fir, often amounts to ten to 15 and even 22 per cent." (5)

These European forests have been under management, therefore, it is logical to assume that some of the mistletoe has been eliminated. By considering such an assumption as a fact, it is reasonable to further assume that in our unmanaged American forests the percentage of cull caused by mistletoe is much greater than in Europe.

Methods of Seed Dissemination

Seed dissemination is different for each genera. In the genus Phorodendron, birds feed on the berries and are the chief disseminaters of the seed. Some of the mucilaginous coated seeds adhere to the beak of the bird and are often brushed off on another tree by the bird, where the seed causes an infection if favorably located.

The genus Razoumofskya depends mostly on the force which expels the seed from the capsule for a distance of several yards and wind for dissemination. The expelling force cannot spread seed very far, but if combined with a heavy wind, seed is carried for a considerable distance. Birds apparently are not an important factor in spreading this genus. This is probably due to the rather unattractive appearance of the seed.

Conditions Favorable to Mistletoe

Mistletoe infection seems to be most common on the poorer sites. Heavy infections are usually found in regions of light rainfall, low absolute humidity, wide range of temperature,rapid evaporation and an abundance of sunshine. As a rule most of these conditions, if not all of them, are common to the poorer sites. Therefore, it seems like these conditions are favorable to infection and development.

Suggested Controls of Mistletoe

Prevention has always been much better than a cure, therefore, the first consideration should be of prevention. This is best accomplished in the forest nursery. Young seedlings in a nursery may become infected, and due to the latent period in the development of the parasite, may be shipped out as healthy trees before infection becomes apparent. All infected trees within a mile or so of the nursery should be removed in order to provide a sanitary environment for the seedlings.

Where infection has gained a foothold plans must be made for control. The first logical step is to make an effective survey of all the mistletoe infected forest area. The zones of greatest infection can be quite easily determined because the parasite seems to follow a distinct type of stand, topography, and to a certain extent, climate. The survey should include details of types, age classes of infected material, degree of infection and relation to topography. The spread can be kept track of by a periodic or yearly reconnaissance. Areas of heavy infection can be indicated by colors on the map. Surveys of the nature just mentioned can often be made along with a timber survey. If a timber survey has already been made, or one is not apt to be made in the near future of the area in question, it may be well to run a survey for mistletoe alone, provided that the necessary funds are available.

Every infected area is a problem area having its own particular problems which have to be unraveled in considering control methods. Therefore, it is impossible to work out a satisfactory control method which can be applied to all infected areas. Instead several methods are suggested--by combining, a combination can be worked out to fit a particular case.

Where a single tree or a few trees are infected, pruning may be the solution. In Spokane, Washington, ponderosa pine

trees had been infected. The property owners followed some suggestions made by Weir (6) and cut out all the branches bearing mistletoe and showing swellings so characteristic of early stages of infection. Three years later the parasite was still present in a very few cases. These infections were cut out. As far as is known the parasite has been eliminated.

On the National Forests where small sales and free use permits are issued to local people, control methods can be worked in very nicely. This can be done by required removal of only infected material.

Where timber sales are made in infected areas, a clause in the agreement should require the purchaser to cut down all marked timber whether merchantable or not. All infected timber should be marked for cutting. If a large share of the marked infected material is unmerchantable, some arrangement should be made with the purchaser to pay him for the cost of cutting and disposing of this material. This procedure would eliminate all the larger trees which are infected, but the smaller infected trees would still remain to spread the parasite.

Realizing that the uncut infected young material is still a problem, a pine operator wanted to determine if it was practicable to select seed trees and rid them of mistletoe by pruning.

> "To this end a great many were trimmed up, every branch which showed infection being lopped off close. Saplings with the parasite on the main stem were considered hopeless, as to clear them of the plant effectually would

> girdle the tree, and accordingly they were not used in the experiment. Some trees were selected in such isolated locations that it was supposed they could not possibly become reinfected from their closest neighbors. It was realized, of course, that the young trees might be already infected in places that had not as yet become noticeable. We wished to know to what extent this might be so. A recent examination three years after the pruning shows that practically every tree was in fact so infected, and has since the pruning developed mistletoe." (7)

This clearly shows that the parasite cannot be eradicated by one pruning. In California some studies on mistletoe control have been conducted. Some of the unpublished results show that there exists a latent period between the establishment of the mistletoe in the host and the appearance of the characteristic swellings and external shoots.

> "In ponderosa pine this may be as long as six years, during which time the mistletoe is present without any visible external indications. In some of the control operations that have been undertaken in past years this feature was not realized and there was, therefore, considerable disappointment when large numbers of new infections appeared after all visible mistletoe plants and swellings had been removed from the stand." (8)

This recent discovery indicates why the last pruning operation just discussed did not eradicate the mistletoe. The pruning operation conducted in Spokane seemed to be quite successful three years after the pruning. However, since the discovery of the latent period it is doubtful if the eradication was complete.

The recent discovery need not discourage pruning as a means of control. With the added information, mistletoe can be eradicated by pruning.

Pruning alone is probably feasible only on single or small groups of trees, but a combination of removing the large infected trees and pruning the smaller ones seems to be applicable to many of the infected areas. In applying such a control of method it is well to consider the following points:

1. Cut all infected trees which cannot be easily pruned from the ground.
2. The reproduction should be of more or less uniform size and not too large for ease in pruning from the ground.
3. Pruning should be done before the mistletoe seed matures.
4. Remove all the infected branches.
5. Remove all suppressed infected and misshapen trees.
6. Cut all trees with infections on the main stem.
7. Mistletoe bears seeds three to five years after the external shoots appear. Therefore, a second pruning should follow after three years to remove all infections which have become noticeable.
8. Prune again three years after the second pruning to remove all infections which have been covered by the latent period.

This method would work very well in conjunction with a timber sale.

Some areas may be so heavily infected that cutting and burning clean is the only means of eradicating the parasite with the least cost.

Another possibility which presents itself is that of developing a mistletoe resistant race of each susceptible

species. In ponderosa pine a few trees have been discovered in heavily infected areas which do not have a single infection (10). Further study may reveal that these trees are of a race which is mistletoe resistant. Resistant races could be used in planting in infected areas.

Up until this time no intensive control methods have been practiced. Probably the cost of such work has been the prohibiting factor. Regardless of cost, mistletoe control will have to be practiced in certain areas if producing forests are to be maintained in these areas.

Conclusion

Many of the discussions and facts brought out pertain to specific species of mistletoe on specific hosts. Information is not available on all species of the parasite or their hosts. It is assumed that the discussions and facts presented will hold more or less true for those species and hosts which have not been included.

Literature Cited

(1) Weir, James R.

1916. Some Suggestions on the Control of Mistletoe in the National Forests of the Northwest. Forestry Quarterly V. 14, no. 4.

(2) Weir, James R.

1918. Effect of Mistletoe on Young Conifers. In Journal of Agricultural Research, V. 12, no. 11.

(3) Weir, James R.

1916. Mistletoe Injury to Conifers in the Northwest. U. S. Dept. of Agri. Bul. 360.

(4) Korstian, Clarence F.

1922. The Western Yellow Pine Mistletoe. U. S. Dept. of Agri. Bul. 1112.

(5) Von Tubeuf, K. Review E. P. Meinecke

1923. Monograph of the Mistletoe. Journal of Forestry, V. 21, p. 622-3.

(6) Weir, James R.

1923. The Control of Mistletoe by Pruning. Journal of Forestry, V. 21, p. 504-5.

(7) Perry, Walter J.

1922. Can Mistletoe Be Eradicated by Pruning? Journal of Forestry, V. 20, p. 627-8.

(8) Wagner, Willis W.

1937. A personal letter from Dr. Wagner, who is the pathologist in charge of the Division of Forest Pathology in San Francisco, California.

(9) Doane, R. W. (and others)

1936. Forest Insects, p. 15.

(10) Bates, Carlos G.

1927. Better Seeds, Better Trees. Journal of Forestry, V. 25, no. 2.