PROCEEDINGS OF THE 19th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Medford, Oregon
September 1971

Proceedings of the 19th Annual Western International Forest Disease Work Conference

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COMMITTEE REPORTS AND WIFDWC BUSINESS

FOREWORD

The Nineteenth Western International Forest Disease Work Conference was held September 13-17, 1971, at the Red Lion Motel, Medford, Oregon. Over 100 members, wives and invited guests from Canada and the United States were in attendance. Members from Mexico were not able to attend.

The Conference was called to order on Tuesday morning, September 14, by Chairman, Joseph A. Baranyay. A very sincere and friendly welcome to the area was given by Mr. Rexford A. Resler, Regional Forester, for the Pacific Northwest Region, U.S. Forest Service, Portland, Oregon.

Very excellent local arrangements were made by Hart and Velma Bynum. They were assisted by Paul Aho, George Harvey, Dennis Creel and Larry Carpenter.

A very successful ladies program was arranged by Velma Bynum. Included were tours of the Medford Senior High School planetarium, Harry and David's gift fruit packing plant and experimental rose garden, Shakespeare theaters in Ashland and a visit to Jacksonville, a quaint town maintained in the aura of the 1800's.

The officers for the Nineteenth Western International Forest Disease Work Conference were:

Chairman	-	J. A. Baranyay
Secretary-Treasurer	-	D. A. Graham
Program Chairman	-	R. B. (Dick) Smith
Local Arrangements	-	Hart Bynum

OPENING REMARKS

Chairman Joseph A. Baranyay

Ladies and gentlemen, honored guests, it is my pleasure to call to order the Nineteenth Western International Forest Disease Work Conference. The continued increase in meeting attendance attests to the sustained interest and value these meetings hold for most of us. These Conferences have created an atmosphere of mutual interest and cooperation among western forest pathologists. Special welcome to new participants. Please join in to sustain the informal atmosphere which has become traditional for this meeting and be an active participant right from the beginning.

Unfortunately, I cannot simplify my opening remarks by stating that: My name is Joe Baranyay. I am the Chairman. Here is the program. The rest is up to you! The organization of this meeting had a stormy background due to our indecisiveness a year ago, when we accepted, without due regard to implications, Tom Laurent's invitation to Juneau. In early fall last year, I received warning notes from members that American participation would be minimal at a meeting held in Juneau. Since one of the ingredients of our successful meetings has been large membership participation, I felt it necessary to survey the opinion of the membership. After a lot of scouting, we checked all the possibilities related to a Juneau meeting and these with cost figures were presented to the membership for final decision. Tom Laurent helped me a great deal in this work and we are all thankful for his efforts which he carried out in the face of scuttling his early bid. The majority of the membership rejected the Juneau location on the basis of reduced participation and suggested a central western location. Hart Bynum invited the meeting to Medford, accepting the burden of local arrangements. And so, here we are! Thanks Hart and Velma for your hospitality and work which made the professional part of the meeting possible for us and added the interesting ladies' program for our better halves.

I owe sincere thanks to Program Chairman Dick Smith and his committee, John Staley and Clint Carlson, who undertook the difficult job of developing an interesting and stimulating program. After a survey of opinions (we could have done with some professional polsters), we decided to deviate somewhat from the old traditional panel type of program. With the revised approach, the invited papers, workshops and two panels cover about 50 percent of the topics compiled by the Interim Program Chairman last year. If we need to adopt a theme for this meeting, we can call it "Environmental Protection." We will hear stimulating speakers and with your active participation in the discussion, we have the assurance of a successful meeting.

It is my pleasure to ask Dave Graham to introduce Mr. Rexford Resler who has been kind enough to present the welcoming address.

WELCOMING ADDRESS

Rexford A. Resler 1/

Mr. Resler did not use a prepared text so only a few highlights from his statement are presented here.

He acknowledged the international concept of the Work Conference and stressed the importance of working together to solve mutual problems.

He expressed his appreciation for selecting Medford and the Pacific Northwest Region as the meeting place for the Nineteenth Conference and extended a warm welcome to all participants. This included an invitation to visit the National Forests, Research Station laboratories and experimental forests.

Mr. Resler presented new data and concepts on the fast-growing importance of our forest resources and pointed out that in order to meet future demands for wood products, recreation and other uses, we must solve our forest disease problems.

He expressed his concern that additional Forest Service personnel could not attend the Conference.

Increasing land manager participation at Conferences such as this would be of great benefit to all of us. Hopefully, the pressure of other business and workloads will permit more management people (both public and private) to attend in the future.

They can provide some very worthwhile input to the program from the land manager's viewpoint as well as point out what they see as the key forest disease problems of today.

1/Regional Forester, U.S. Forest Service, Region 6, Portland, Oregon

BREAKDOWN AND DECAY OF LOGGING SLASH AT TWO FOREST LOCATIONS IN THE SIERRA NEVADA OF CALIFORNIA

Willis W. Wagener[1/] and H. R. Offord[2/]

A 34-year study on the condition of unburned logging slash in the mixed conifer type of the central and northern Sierra Nevada of California showed that breakdown and decay occurred at a much slower rate than has been reported for softwoods in other regions of the United States. Conclusions are based on 324 piles or strips available for part or all of this extended study on the Stanislaus and Lassen National Forests.

Primary factors affecting slash breakdown are climate, compaction (by winter snows), checking (particularly marked in open, sunny spots), and decay by fungi. Secondary and minor factors in the physical break up of slash not measured in this study are insects, cattle and deer.

Temperature and moisture records over a space of some 18 years have been summarized to show the significance of high temperature and low moisture (both being limiting factors on the spread and growth of the common decay fungi) in retarding decay of coniferous slash in the areas studied.

Incense-cedar, sugar pine, ponderosa pine and white fir, in the order named, decayed at generally increasing rates. Large limbs or chunks of incense-cedar and sugar pine were especially durable. Most prevalent and most active decay fungi were *Polyporus abietinus*, *Fomes pinicola* and *Lenzites saepiaria*. The scarcity of *Polyporus anceps* (in the California areas studied) is an important element in the slow rate at which pine slash deteriorates.

In California a span of about 30 years was needed to bring about a transition of the fire hazard from extreme (immediately after logging) to a low rating comparable to the undisturbed forest. By contrast, studies on white pine slash in the Northeast equated this same spread in fire hazard conditions to a span of 17 years. In the South, the span was 6 years for hardwoods. In Douglas-fir type of the Pacific Northwest, tops and small logs under 2 feet in diameter showed 90 percent of wood volume decayed after 16 years.

1/(Retired) Forest Disease Research, U.S. Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

2/Forest Disease Research, U.S. Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

On the Lassen, 29 years after logging, a sample strip taken in scattered slash plots showed that residual wood approximated 57 percent of the original volume of the mixed pine, white fir and incense-cedar slash. Another quantitative measure of the breakdown and decay of slash is found in the records for subsidence in height of pile which showed about 85 percent reduction during a 30-year period. Pile subsidence was about 10 percent faster on the 123 piles on the Stanislaus than on the 83 Lassen piles, in part because of heavier snowfall in the Stanislaus area. Compact piles of slash, especially on north and northeast slopes in partial or better shade, decayed more rapidly than loosely piled slash in the same or drier environment. On open, sunny areas break-up of scattered or piled slash by checking is an important factor during the initial 10 years after logging.

ISOGRAMS USED TO EXPRESS PYTHIUM AND FUSARIUM POPULATIONS IN NURSERY SOILS

K. W. Russell 1/

The Washington State Department of Natural Resources has been using isograms as a means of expressing Pythium and Fusarium populations in nursery soils. The nursery block is first sampled in three lines, spread across the bed sections with one sample in each section. This may be modified to four lines. Cultures are taken from the soil samples. Following 72 hours of incubation, the number of Pythium propagules per gram are determined and plotted onto a blank nursery block map. Then isolines are drawn on the map corresponding with the propagule distribution in the soil. A high, medium, and low range is used. Ranges of propagule variations will differ between nurseries. The result is a very easy to see and interpret picture of disease levels in each nursery block. These are filed in a book and kept as historical records of disease development both prior to and following fumigation. Fumigation recommendations are based on these maps. Hopefully, the isogram will serve to be useful in other diseases in the nursery as well. They are the best way to get the information across to the nursery manager.

1/Forest Pathologist, Forest Land Management Center, Washington Department of Natural Resources, Olympia, Washington

AEROBIOLOGY OF THE AECIAL STATE OF THE COMANDRA BLISTER RUST

John M. Powell [1]

Aerobiology concerns that phase of the life history of a pathogen when it is outside its host. This phase can be divided into release, dispersal and deposition. Comandra blister rust, Cronartium comandrae Pk., was chosen for aerobiological study because of its distinct pyriform shaped aeciospore. The aim was to establish when aeciospores were released, the pattern and distance of dispersal and how they were deposited. The main study was undertaken at the Kananaskis Forest Experiment Station, near Seebe, Alberta.

Release of Aeciospores

For establishing when spores were released from sporulating cankers, an impaction spore collector with 24 microscope slides was developed which sampled 13 ± 1 liter of air per minute (Powell and Morf 1967) at a point about 2.5 centimeters from the canker. The spores, deposited in a 5.4 square centimeter band on each slide, were counted to give number of spores per cubic meter of air each hour or day. Weather conditions at each collection site were measured with recording meteorological instruments maintained throughout the study. Many of these instruments were at the height of sporulating cankers, while others were maintained at standard recording heights.

Release of aeciospores occurred from mid-May to late August. Most of the aecia of a canker ruptured within a few days, giving a peak spore release period between late May and mid-June, after which there was a gradual decrease. Throughout the spore production season, minor peaks occurred as a result of the rupture of new aecia, but these lasted only a few days.

There was a marked diurnal periodicity of aeciospore release. High spore concentrations were trapped during 0800 to 1800 hours, with low concentrations generally between 2200 to 0500 hours. The rise from low to high concentrations was usually rapid, but the fall was relatively slow. On some days, there was evidence of a secondary peak around either 1000 or 1500 hours, there being a slight reduction in the spore concentration around 1200 and 1300 hours. The average daily and hourly spore concentrations varied considerably; for example in 1967, 2,543 spores per cubic meter were trapped per day, but only 514 spores per cubic meter in 1966 from the same canker. Maximum daily concentration during the study

[1]Canadian Forestry Service, Northern Forest Research Centre, Edmonton, Alberta

was 17,217 spores per cubic meter, but on more than half the days, fewer than 100 spores per cubic meter were collected. The highest hourly concentration observed from an individual canker was 128,200 spores per cubic meter.

Little release occurred when temperatures were below 7°C, when relative humidity levels were high, or when dew was present. Peak releases occurred when air temperatures were above 20° C and relative humidity levels were at their lowest. An increase in spore concentration typically coincided with the increase of atmospheric turbulence in mid-morning. Turbulence may be more important than either temperature or humidity alone. The number of spores released at any time depends on the ease with which they are detached from the spore mass and carried across the boundary layer of nonturbulent flowing air into the general circulation of turbulent air. The thickness of the laminar boundary layer varies with the wind speed and with the roughness of the adjacent surface; thus the higher the wind speed, the more easily spores can be picked up or blown off the surface by eddies that force their way to the surface, disrupting the laminar flow. An initial gust or higher wind speed, therefore, produces a greater spore concentration than an initial slower wind velocity, as a higher percentage of spores would be passively liberated from the aecia at the onset of stronger as compared with weaker winds. Generally, wind speeds of 0.5 meter per second on dry days were required for significant initial spore release. Some spores are released at lower wind speeds, but the relatively large pyriform aeciospores of C. comandrae (14 - 21 microns x 38 - 73 microns) are not easily removed from the aecia by light air movements.

Rain had varying effects on spore release. During two wet periods in 1965, there was little or no spore release, but this was not the case during three heavy rain periods near the beginning of the sporulation period in 1966. On the latter occasions there was a noticeable increase in the number of spores released with the onset of heavy rain, and its associated turbulence. A 61 millimeter rainfall that occurred around 1800 hours on May 30, 1966, a time outside the usual period of peak spore dispersal, increased the hourly dispersed spore concentration by about 25 times, and this was 5 times larger than the "normal" peak, which occurred around 0900 hours. With prolonged rain, the number of spores released was reduced. Similarly light, gentle rains tended to wash the spores out of the atmosphere and wet the infected surfaces, which effectively prevented removal of spores into the air.

Dispersal and Deposition of Aeciospores from Natural Point Sources

For spore dispersal studies from natural point sources, a variety of spore collectors were used at varying distances from sporulating cankers. In one series of tests vaseline-coated microscope slides were placed on the ground along eight radii around cankers with abundant sporulation. The slides were placed at distances up to 15 or 20 feet from the tree and exposed for periods of 4 to 10 hours. Exposed leaves of ground vegetation were collected at distances up to 30 feet, the area of each leaf was measured and examined for presence of spores. In other tests, unidirectional, wind directional and rotorod spore collectors were placed at distances up to 800 feet from spore sources.

No spores were collected at distances greater than 200 feet in these tests which, in some cases, lasted for the duration of the sporulation period, and employed collectors sampling air at an average rate of 60 liters per minute. Generally few spores were trapped at distances greater than 50 feet.

The pattern of dispersal and deposition on the ground near to a source showed a pronounced gradient, with a hollow curve, that is, the gradient of deposition near the source was very steep. Studies of deposition around a natural source 1 to 3 feet above the ground indicated that at distances over 6 feet from the source, less than 1 percent of the concentration at the first sampling point (3 inches) was deposited, and that there was a 90 percent reduction within 2 feet. The number of spores deposited per square inch of leaf at various distances from a sporulating canker showed a similar rapid decrease with increasing distance. The spore catch on leaves at 10 feet was nearly 99 percent less than at 1 foot, and no spores were observed at 20 or 30 feet. Spore collectors placed on eight radii, 1 foot above the ground, and 10 feet from a canker also 1 foot above the ground, for nine separate days, often failed to trap any spores. Only 8 of the 72 exposed slides had 6 or more spores deposited on them, and 14 of them had none. There was abundant dispersal from this canker as a spore impaction collector placed a few inches from the cankers, collected a daily average of 13,653 spores during the same period.

Dispersal and Deposition of Aeciospores from Experimental Point Sources

Results were obtained from two networks of spore collectors, one in an open, flat area and the other in a 10.5 meter high pine forest. In the open, spores were released at 1 or 5 feet above ground, and trapped on collectors at 1, 5 or 10 feet above ground on nine radii, set at 11.25^{o} intervals from the point source with collectors up to 150 feet from the release point. On the mid-line of the network, collectors were placed up to 400 feet from the release point. The collector network was set up for a southwest wind, the prevailing daytime wind direction. The experiments were only run on clear, warm days during periods of steady winds (1.62 to 6.28 meters per second) and during the hours around noon, which correspond to the optimum conditions and natural period of spore dispersal. One to five grams of dry spores were released, usually 3 grams, for periods varying from 4 to 30 minutes, the release rate being controlled by an air flow regulating unit. Wind, temperature and humidity conditions were also recorded. The spores deposited on a 13.5 square centimeter area of the exposed slide were counted.

The decrease in spore concentration with distance was very evident, being most marked in the 1-foot releases. In one experiment with a release at 1 foot, no spores were collected more than 35 feet from the source, and no spores were dispersed upward to a height of 10 feet. Generally with a 5-foot release, the maximum concentration sampled occurred at a distance of 20 feet and at a height of 5 feet (higher maxima would have occurred at this height at 5 and 10 feet from source if samplers had been present). However, when wind speeds were lower, the maximum concentration occurred at a 1-foot height at the 20-foot distance rather than at a 5-foot height, or at the 5- and 10-foot distances rather than at 20 feet. With higher wind speeds, more spores were deposited on the samplers at the 10-foot height, illustrating that spores may be carried upward by air turbulence. Lateral spread of spores extended to at least 45° on either side of the mean wind direction at distances of 10 and 20 feet from the source in almost all experiments. With low-level sources there appears to be more lateral than vertical spread, which contributes to an increased probability for early deposition and to a decreased probability for long distance spore dispersal. Spores were only collected during one test at the 400-foot point on the mid-line, three times at 300 feet and five times at 200 feet. In the ten tests, few spores were collected beyond the 100-foot samplers.

For release of Cronartium aeciospores in a sampling network in a forest environment, I wish to thank Gilbert Raynor of the Brookhaven National Laboratory. He released 3.14 grams of spores on August 28, 1968, at a point 95 meters inside a 10.5-meter pine forest at a height of 1.75 meters with the wind blowing toward the edge. The spores were emitted simultaneously with ragweed pollen and Lycopodium spores for comparison, and were trapped on a parallelogram-shaped sampling grid extending for 100 meters through the forest. Fifty-six rotoslide samplers were located at a height of 1.75 meters with others on towers at 4 or more heights, the major ones being at 3.5, 7.0 and 14.0 meters, within or above the forest. Along the centerline only, additional samplers were mounted at 0.5 meter, while deposition was recorded at ground level. Measurements of wind speed, temperature and turbulence were taken simultaneously in, over and outside the forest. Wind speeds near the release point were between 0.27 and 0.52 meters per second in the forest during the 50-minute release period, but were 1.80 to 2.55 meters per second above the forest.

Normalized concentration patterns were established using the volume of spores sampled at each sampling point, the sampler efficiency and the output rate which was estimated to be 1.75×10^5 spores per second. As with experiments in the open, there is a fairly rapid decrease of spore concentration with distance. At the source height, concentrations decreased by about two orders of magnitude between the release point and the forest edge, with the spores dispersed in a typical plume pattern from the release point. At the higher sampling levels, the sampled concentrations were lower, which can be better seen from vertical profiles of spore concentrations along the three lines with towers. In the vertical, spores decreased about one order of magnitude to the forest crown. These concentration profiles show that considerable numbers of spores were carried up and out of the forest. However, such concentration patterns give a somewhat misleading impression of numbers of spores above the forest. Because of much greater wind speed above the forest, the number of particles there is considerably greater than concentrations would indicate, due to the greater volume of air passing each sampling point. To compensate for this, one can multiply the concentration at each point by the air passage to give a normalized flux through a two-dimensional area around the point. Such an analysis changes the magnitude of the number of spores carried through and out of the forest, although the pattern of dispersion remains similar, except in the area close to the forest crown.

In this test the dispersal of the Cronartium spores did not differ greatly from that of the Lycopodium spores or ragweed pollen. The only real difference was the greater deposition of Lycopodium spores, although the deposition patterns were similar for all three. Deposition, to the ground and foliage, was a more important removal mechanism than impaction. In the forest, where wind speeds and turbulence are greatly reduced, a spore cloud will undergo rapid depletion by sedimentation as it travels from the source, which helps explain the very steep gradient of deposition. In another study C. comandrae aeciospores were shown to have an average velocity of 3.23 centimeters per second in calm air. Thus dry spores released from a canker 1 foot above ground would take only 10 seconds to fall this distance in calm air. If spores "escape" from a forest stand, then they will be carried over greater distances or depleted less rapidly because of the increase of wind speed and turbulence, causing deposition by impaction to become more important than sedimentation.

Discussion and Conclusions

Some important implications can be drawn from the release and dispersal studies, when these are related to conditions known to be favorable or unfavorable for retaining spore viability and for spore germination. The environmental factors affecting aeciospore viability and germination were companion studies to those reported here, and have also been studied by Krebill (1968). The normal diurnal pattern of aeciospore release was for spores to be dispersed on dry, warm sunny turbulent days between 0800 and 1900 hours. Such spores, if deposited on suitable alternate host plants, were deposited in conditions which were generally unfavorable for germination and retention of viability. Spores dispersed at the onset of rain, or in dry conditions just before rain would encounter favorable conditions for germination. When such conditions occurred in the first portion of the sporulation period, then large numbers of viable spores found favorable germinating conditions, but if such conditions occurred later in the spore production period, much lower percentages of viable spores were available for dispersal. During periods of light rain when spores became wet, there was no spore release, also these spores soon lost their viability on drying. Therefore, on only a few occasions in any one sporulation period were there conditions favorable for spore release, retention of viability and for germination.

The initial steep gradients of spore deposition, especially within a forest, indicated that unless suitable host plants were growing within a radius of about 200 feet from the sporulating cankers, the chance of spores reaching susceptible host material was poor. The majority of cankers occur within 3 feet of the ground, the odd canker occurs at heights above 15 feet and the chances for greater dispersal from these cankers would be high, but still only in the order of hundreds of feet. If spores "escape" the forest stand under thermally unstable turbulent conditions, they will be dispersed to considerable distances. However, their chances of being deposited at greater distances in a viable condition are reduced through exposure to heat and light, as during the peak periods of dispersal around midday heat and light intensities are close to maximum.

How much these results can be related to other spore states of this rust or other pine stem rusts is not fully known. Urediospores of C. comandrae have a similar diurnal release periodicity to the aeciospores (Powell, unpublished data), and may retain their viability for several days (Krebill 1968). Krebill (1968) found that C. comandrae basidiospore production occurred only rarely, either at night or during periods of high humidity. Similarly, the basidiospores of C. ribicola and C. fusiforme, like most other basidiospores, are released at night (Van Arsdel 1967; Snow and Froelich 1968), and therefore, encounter different environmental conditions than spores released during the day. Their dispersal patterns can, therefore, be quite different from spores dispersed under daytime turbulence. Most daytime dryspore forms have a forenoon or afternoon release periodicity (Gregory 1961) and, therefore, the aeciospores of other pine stem rusts probably have a similar release periodicity to those of *C. comandrae*. Aeciospores of some rusts, however, have a well marked nighttime or early morning periodicity (Kramer et al. 1968; Pady et al. 1968, 1969). The comparative dispersal experiments of Raynor (1970), referred to before, and those of others using various spores or particles (e.g. Fritschen et al. 1970) indicate that similar dispersal patterns can be expected during the day. Deposition under similar conditions, however, would vary because of different spore sizes and densities causing different settling rates, and because of varying impaction efficiencies.

REFERENCES

Fritschen, L. J., C. H. Driver, C. Avery, J. Buffo, R. Edmonds, R. Kinerson and P. Schiess
1970. Dispersion of air tracers into and within forested area: 3. U.S. Army Electronics Command, Atmospheric Sciences Lab., Fort Huachuca, Arizona. ECOM-68-G8-3. 44 pp.

Gregory, P. H.
1961. The microbiology of the atmosphere, Leonard Hill Ltd., London. 251 pp.

Kramer, C. L., S.M. Pady, R. Clary and R. Haard.
1968. Diurnal periodicity in aeciospore release of certain rusts. Trans. Brit. Mycol. Soc. 51: 679-687.

Krebill, R. G.
1968. *Cronartium comandrae* in the Rocky Mountain States. U.S.D.A., For. Serv., Intermountain For. & Ra. Exp. Sta., Res. Paper INT-50. 28 pp.

Pady, S. M., C. L. Kramer and R. Clary
1968. Periodicity in aeciospore release in *Gymnosporangium juniperi-virginianae*. Phytopathology, 58: 329-331.

Pady, S. M., C. L. Kramer and R. Clary
1969. Aeciospore release in Gymnosporangium. Can. J. Bot. 47: 1027-1032.

Powell, J. M. and W. Morf
1967. A 24-hour impaction spore collector. Can. J. Plant Sci. 47: 222-224.

Raynor, G. S.
1970. Dispersion into and within forests. pp. 120-121. In Powell, J. M. & C. F. Nolasco (Eds.) Proc. 3rd Forest Microclimate Symp., Kananaskis, Alta, Sept. 1969. Can. For. Serv., Calgary, Alta.

Snow, G. A. and R. C. Froelich.
1968. Daily and seasonal dispersal of basidiospores of *Cronartium fusiforme*. Phytopathology 58: 1532-1536.

Van Arsdel, E. P.
1967. The nocturnal diffusion and transport of spores. Phytopathology, 57: 1221-1229.

EUROPEAN MISTLETOE, VISCUM ALBUM (LORANTHACEAE), AN UNUSUAL PARASITE IN CALIFORNIA

William O. McCartney [1]

Viscum album L., the true mistletoe of European lore is a comparatively new parasite to the United States. It was identified by J. T. Howell from a specimen (Rose, Jan. 2, 1966, CAS) collected near Sebastopol, Sonoma County, California. This was a rediscovery of this species in California, since it was collected on an apple tree in the Sebastopol area as early as 1920 (Gilbert, Apr. 1920, CAS). Nearly 10 years later another collection (Ball, 1929, DS) was identified by Roxana S. Ferris. These collections have been overlooked in the published floras.

Surveys made between January 27 and March 3, 1966 by the California Department of Agriculture and the Sonoma County Agricultural Commissioner personnel indicated that 219 host plants at 55 locations were found infested with *V. album* in orchards, yards, fence rows, and street plantings in a 16 square mile area within and northwest of Sebastopol. The infestations varied from heavy in small, poorly cared for orchards and street trees, to light in commercial apple orchards.

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[1] Plant Pathologist, California Department of Agriculture, Bureau of Plant Pathology, Sacramento, California

Recent surveys in 1970-1971 ascertained the intensity of the mistletoe on individual host trees. New hosts for the region were discovered. Robert F. Scharpf and Frank G. Hawksworth assisted William O. McCartney in cooperation with the Sonoma County Department of Agriculture in the winter of 1970-1971. Three hundred and six infested host plants were found with the parasite in Santa Rosa - 3 trees; Graton - 12 trees; Sebastopol - 75 trees; and Sebastopol and vicinity - 216 trees.

Establishment of V. album on American trees has apparently escaped general notice because of its similarity in form, habit, and general appearance with Phoradendron flavescens (Pursh) Nutt., American mistletoe. Both species are prized for their pearly white berries (Gill and Hawksworth, 1961; Spaulding, 1956).

Growth and fruit set of infested apple trees may be reduced (Gill and Hawksworth, 1961) and the infected trees tend to decline sooner. Enlarged overgrowths or swellings on some of the branches attached were observed on infected "Santa Rosa" plum trees at the points of attachments of the parasite. The excessive weight of the mistletoe plants on Acer macrophyllum caused limbs to sag, and break during strong winds.

Hosts on which V. album were found in this area in 1966 are: Acer macrophyllum, A. saccharinum, Aesculus california, Betula verrucosa, Carya sp., Crataegus oxyacantha, Malus sylvestris, Prunus salicina, "Santa Rosa" plum, Robinia pseudoacacia, and Salix sp.

Since 1966 seven newly discovered genera of European mistletoe hosts in the Sebastopol area are: Diospyros, Pyracantha, Alnus, Fraxinus, Ulmus, Populus, and Sorbus.

New hosts found in 1970-1971 were Japanese persimmon, pyracantha, red alder, native ash, chinese elm, pussy willow, weeping willow, crab apple, poplar, and European mountain ash.

A description of V. album can be found in Tutin (1964). The natural range of V. album is in the temperate parts of Eurasia. Birds appear to be major factors in its spread, the mistletoe thrush and the waxwing being the main kinds. Martins, doves, and starlings are also known to cause its spread.

The following key will serve to separate the American and European mistletoes:

Inflorescence of 6-30 flowers in axillary spikes, 1.5-5 mm. long; mature berries 4-5 mm. in diameter . . . . P. flavescens

Inflorescence of 3-5 flowers in a small terminal cyme; mature berries 6-10 mm. in diameter
. . . . <u>V</u>. <u>album</u>

The Eurasian forms of <u>V</u>. <u>album</u> are variously treated as forms, varieties, subspecies, or species, but there is no general agreement as to their status and relationships (Tutin, 1964). The dicotyledonous form, <u>album</u>, frequently parasitizes apples, probably its most common host, but it also occurs on some 15 other families of angiosperms. <u>Pinus</u> and <u>Abies</u> are parasitized by other forms of <u>V</u>. <u>album</u>.

Gill and Hawksworth (1961) reviewed direct control measures which include physical removal of the infected trees or parts by burning, poisoning, or burning, and chemical treatments designed to kill the endophytic system.

REFERENCES

Gill, L. S., and F. G. Hawksworth.
1961. The mistletoe, a literature review. Tech. Bull. U.S.D.A. 1242.

McCartney, W. O.
1968. European mistletoe, <u>Viscum</u> <u>album</u>, an unusual phanerogamic parasite in California. Vol. 52, No. 3, Plant Disease Reporter, pp. 198-201.

Spaulding.
1956. Diseases of North American forest trees planted abroad. An annotated list. Agri. Handbook No. 100, U.S.D.A.

Tutin, T. G., et al.
1964. Flora Europaea. Vol. 1, Cambridge Univ. Press.

A PRELIMINARY SIMULATION MODEL OF POPULATION CHANGES OF DWARF MISTLETOE IN PONDEROSA PINE AND SOME QUESTIONS IT RAISES

Mary Ann Strand[1]

Many foresters now consider that eradication of mistletoe from stocked acres is not possible and are resigned to live with some degree of mistletoe present. It would, therefore, be useful to be able to predict future infection distributions for purposes of damage estimates and decisions concerning silvicultural practices, as well as to make general statements about the expected progress of the disease.

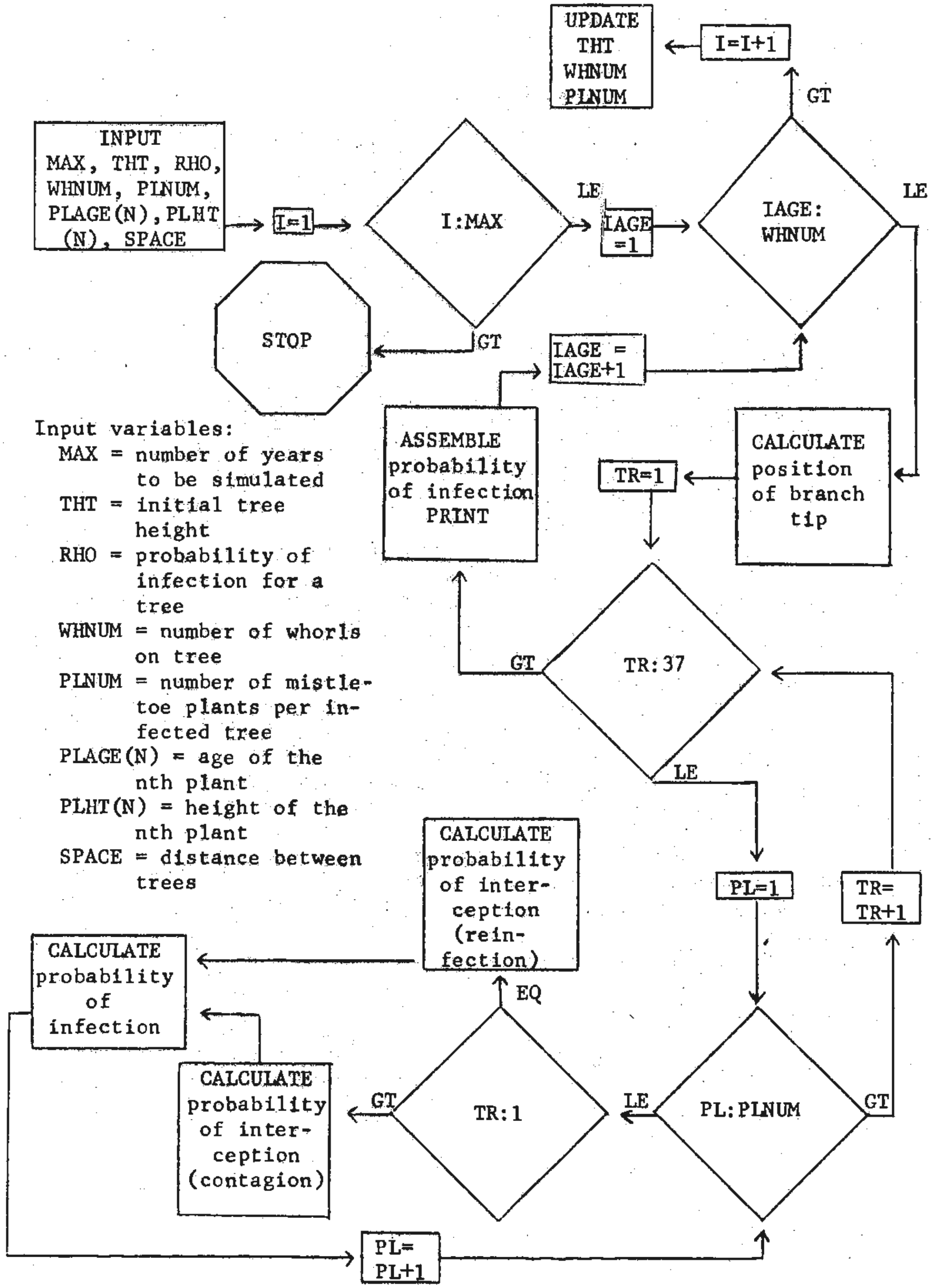
This investigation concerned western dwarf mistletoe (Arceuthobium campylopodum Engelm. f. campylopodum) on ponderosa pine. I attempted to describe in mathematical terms the process of mistletoe seed production and flight and infection establishment. The description takes the form of a simulation model written in Fortran IV computer language. It traces the distribution of the probability of new infections occurring on a typical tree through time. The tree population suitable to the model is young growth pine, ranging from 10 to 30 feet in height. The resulting simulation model was used to predict the infection probabilities for several cases of interest and to make inferences about the process of mistletoe disease spread and intensification. Concepts of the formalized pine stand modeled arose from the thinning studies of J. D. Barrett. Numerical values describing mistletoe behavior were largely from the unpublished studies of L. F. Roth.

Several specialized terms are used in the model and these must be defined before the model is discussed. Target and suscept are used synonymously to indicate the foliated portion of a branchlet from its bud tip to the last needle. It is assumed that all infections occur within this range. Seed and plant refer to the dwarf mistletoe in accordance with common usage. Tree always means the ponderosa pine. The process of transferring infection by means of seed dispersal from one tree to another is termed contagion. Reinfection is the alternative process of infection resulting from inoculum produced by plants hosted by the same tree; this is also termed intensification by some.

The model consists of four major submodels: tree growth, mistletoe seed production, seed dispersal, and infection establishment. The tree growth model provides the structural information concerning target size, position, and number; the seed production

[1] Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon

Figure 1.--Flow Chart of the mistletoe infection simulation model.



model relates the amount of inoculum present to plant age; the probability of a branch receiving a seed is established by the seed dispersal model which includes both reinfection and contagion subunits; and the subsequent fate of the branch is provided by the infection establishment model. Each submodel provides input for the next forming an interlocking set as illustrated by the flow chart in figure 1.

A discussion of the details of the model is inappropriate at this time, since in the half hour allotted to this talk you could not absorb the mathematical intricacies of the simulation. However, I would like to discuss the problems encountered in modeling, the results, and some of the questions it raises.

Since it is a dangerous practice to believe one's models, I will begin by pointing out some of the problems and limitations of the simulation. During the course of model formulation, numerous unsolved problems arose which may limit the reliability of the model as a simulator of reality. They concerned all phases of modeling from conceptualization to data adequacy. The simulation is strongest in terms of conceptualization and incorporation of measured values in the seed dissemination submodel and probably weakest in seed production and reinfection submodels.

A problem of most concern to biologists is that no controlled experiments were made to test the results of the simulation. Certainly the use of actual conditions for inputs of 3 of the 7 cases simulated will be an advantage to future testing.

At key points in the disease spread process, there was inadequate knowledge to facilitate realistic modeling. For example, although reinfection is believed to be an important factor in disease spread, no information concerning the fate of seed falling below the plant level was available. Since it was found that 61 percent of the seed fall below the mistletoe plant, it might be expected that some infections would result. Also, the mechanism, whether by direct hit or ricochet, by which seeds land on a particular branch is not known. Thus, the effect of differences in the tree crown can only be deduced by correlation.

For plant fertility a deterministic model relating the number of seeds produced to plant age was used. Variability is great. Only 311 plants, ranging in age from 4 to 28 years, were evaluated. A large proportion of plants produced no seed. This brought the means down to the lower end of the seed production range. The submodel does not reflect the inoculum potential of the female mistletoe plant. However, the simulation model as formulated did not allow the entry of probabilistic statements concerning seed number.

The model shows that very few seeds are discharged so that they are oriented toward any given branch. If plant is 12 years old, it produces, according to the model, 303 seeds. Of these seeds 27 percent escape the crown in free flight or 41 of them. If the target is 9 feet from the seed's source and is 0.5 foot wide, then the chance of a seed being oriented toward that target is $0.5/(18\pi)$ or 0.0088. Thus, of the 303 seeds produced by the plant only .72 seed would escape the crown in free flight and be oriented toward a particular branch 9 feet away. This aspect of the model is deterministic and does not take into account the inherent variability of the population with respect to seed production, escape potential, or directional orientation.

It might be argued that the simulation model has been an attempt to model the data available rather than the system. This is probably true. At the beginning of this project it was hoped--perhaps naively--that the simulation would be of direct practical value. Thus, it was my intent to include as many documentable values as possible and to avoid the necessity of including dummy functions for which there were no biological reasons or which could not be supported with experimental results. Certainly the conceptualization of the process of disease spread has suffered for this decision. The exclusion of aspects of variability in key processes probably limits the value of the simulation as a predictive tool for expected infections. However, this failing does not necessarily negate the value of the simulation as a means of gaining insights into the expected trends and of formulating hypotheses concerning the infection process.

To assess the effects of different spatial relationships between source and target on different trees, the probability of infection of one susceptible branchlet by inoculum from one source at varying heights and distances was computed. When the target height is greater than that of the mistletoe plant, the probability of infection decreased with an increase in spacing distance in a pattern resembling a decay curve (Figure 2). However, if the target is below the inoculum source, there is a peaked curve which broadens and flattens as the difference between their heights increases (Figure 3). The highest probability is found for source/target distances between 7.5 and 15.0 feet.

Seven cases were examined using the complete simulation model; these included three tree spacings (9, 13, and 18 feet) with two moderate levels of infection (2 and 4 plants per infected tree) simulated for 5 years and one with a heavy infection level (15 plants at 9 feet spacing) simulated for 10 years. The results were examined to assess changes in (a) the probability of infection with respect to tree spacing within the hypothetical

Figure 2.--Probability distributions for infection of one branch tip by one plant at distances from 5 to 35 feet where (a) branch height - plant height = 0 and (b) branch height - plant height = 4 feet.

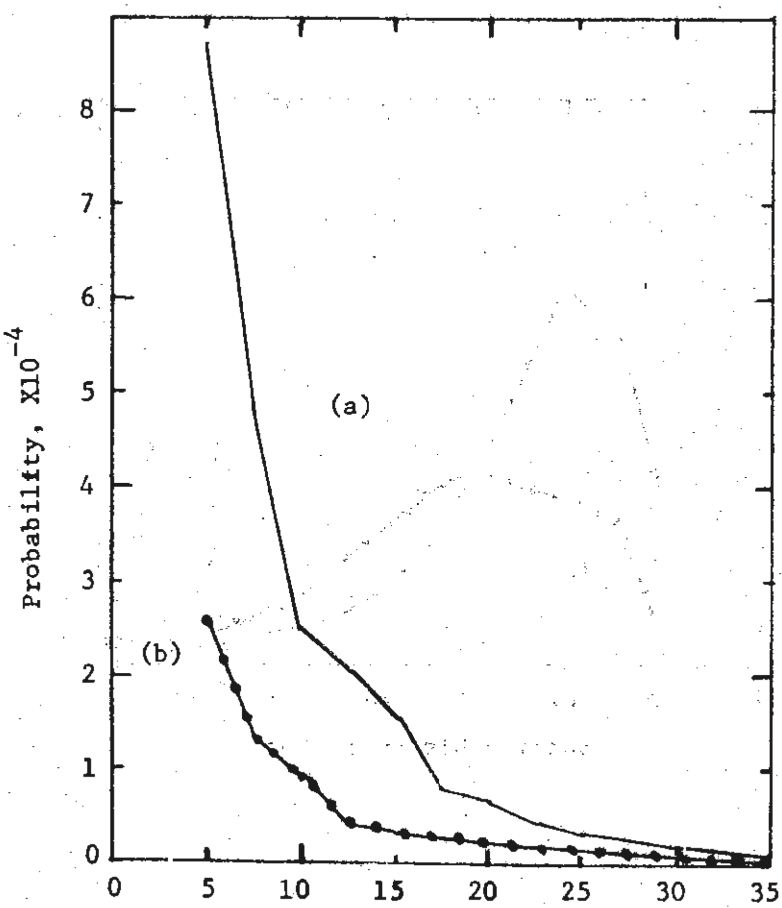


Figure 3.--Probability distributions for infection of one branch tip by one plant at distances from 5 to 35 feet where (a) branch height - plant height = -1 and (b) branch height - plant height = -4.

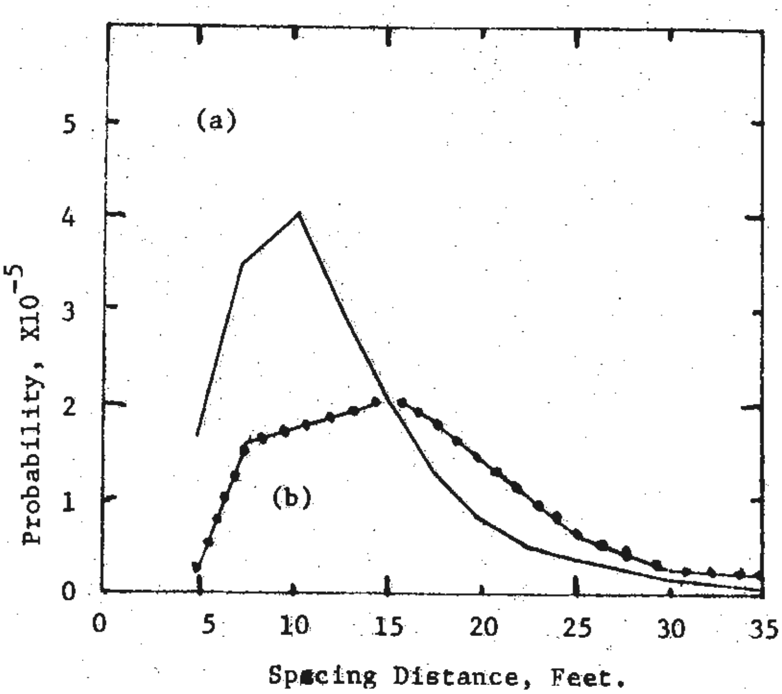
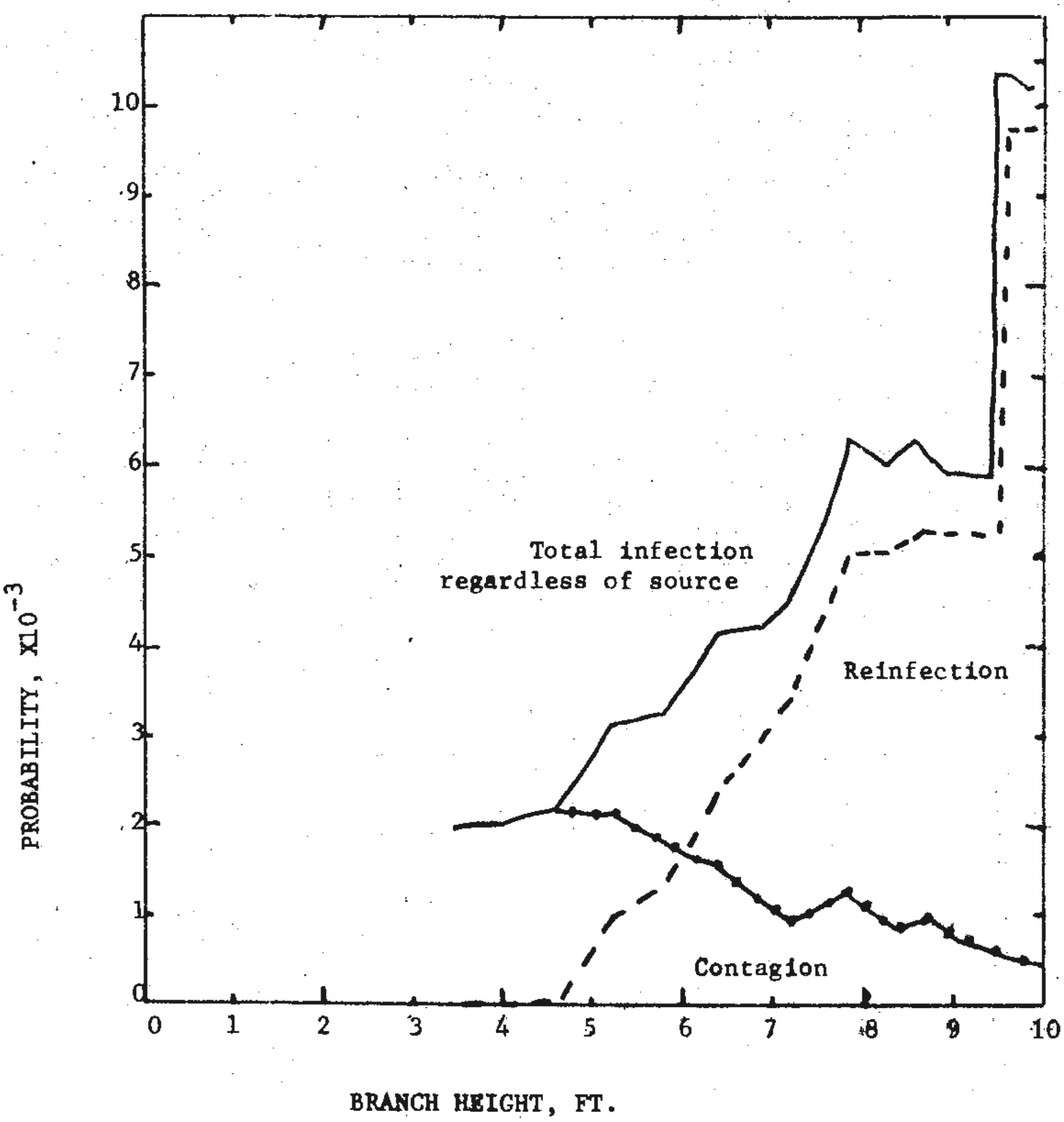


Figure 4.--Distribution of probability of infection for the crown of a representative tree during the first simulated year where trees are spaced 9 feet apart and there are 4 infections per infected tree.



stand, branchlet target height, infection level, and time and (b) the expected number of new infections. It was found that at heights above the lowest source of inoculum the most important contribution to the probability of infection was from internal reinfection (Figure 4). The probability of infection due to contagion is closely related to the amount of inoculum produced on the infected trees. The probability of reinfection decreases as the crown volume around a given height becomes larger and the foliage becomes sparser. The mean probability of contagion decreased with an increase in spacing 14 percent per foot from 9 to 13 feet and 12 percent per foot from 13 to 18 feet. No new infections were expected for any of the cases.

Some general results from the simulation may be used to make pine management suggestions. The simulation suggests that the plants highest in the crown are the most important ones with respect to both reinfection and contagion potential. Selective thinning should discriminate against trees with infections at the greatest heights and pruning of mistletoe plants in the lower part of the crown is of no practical value. It may also be demonstrated that trees growing under optimum spacings for tree growth can outgrow their infections.

After reviewing the modeling effort, several questions might be raised. Is reinfection as important a part of the mistletoe disease spread process as the model indicated? Can trees outgrow their infections? Does contagion contribute significantly to increase in mistletoe plant height? What is the fate of seeds trapped below the level of the mistletoe plant within the host crown? By what mechanisms do variations in crown characteristics (volume, shape, density) affect the reinfection process? These questions cannot be answered by simulation, but only by experimental evidence.

YOUTH SPEAKS--

with middle-aged comments by

J. R. Parmeter, Jr.[1]

The panel "Youth Speaks" was an attempt to explore possible changes in the sphere (or perhaps cube) of forest pathology that may have crept up on WIFDWC members while they were out shaving. Youth is a relative term, and it became obvious that "youths" in forest pathology tend to be older than your average, run-of-the-mill youth. It was with some difficulty that the moderator, applying such leverages as are available to professors, induced Jim Byler, John Muir, and Mike Srago to pose as members of the younger generation. Janet Andersen qualified without cavil.

The discussion, launched by the incisive questions of the perspicacious but modest moderator, quickly took off in all directions, as is customary at WIFDWC meetings. The result was a cross-fertilization of ideas, apparently involving bipolar, tetrapolar, and n-polar systems that defy analysis.

The bulk of the discussion, if such can be said to exist, revolved around (or at least milled around) minor deficiencies in our educational system, including arbitrary administration, inflexible requirements, inept instructors, irrelevant course contents, redundant course structures, unstimulating thesis problems, and other slight flaws in an otherwise first - water jewel. Dissenters were quick to parry these assertions by pointing out that that's the way things have always been and that current youth lacks the discipline to do work they don't like, to study subjects that don't interest them, and to recognize that experienced pathologists are the best judges of what an experienced pathologist should be.

The educators noted that all was the fault of employers, who unreasonably set job standards and demand that graduates know everything and that they be authorities on whatever field of work the employer is pushing. Employers countered with the suggestion that the real fault lay with educators, who perpetuate a myriad of courses and requirements to protect their own vested interests. At this point, youth found it difficult to get a word in edgewise. The overall thrust of the discussion seemed to indicate in general that problems in study, education, and employment are mainly the fault of students, educators, and employers.

1/Department of Plant Pathology, University of California, Berkeley, California

At the risk of appearing presumptuous, your moderator would like diffidently to suggest that the discussion may have provided some reason to suspect that present educational programs and present job requirements in some instances may not be entirely perfect and that possibilities seem to exist for small compromises and wee modifications that might in some degree increase the flexibility of the education-employment system without doing intolerably painful violence to intellectual standards or to work productivity. The nature and direction of such compromises and such modifications is, of course, grist for a future WIFDWC mill, but we may perhaps in the interim look to Laugh-In for inspirational guidance: as they say, "Different strokes for different folks."

BENOMYL UPTAKE BY SEQUOIADENDRON GIGANTEUM AND CONTROL OF BOTRYTIS CINERIA

Arthur H. McCain[1] and Vivian M. Muir[2]

One hundred *Sequoiadendron giganteum* (Lindl.) Buchh. seeds were planted in U.C. mix (50 percent fine sand, 50 percent peat and nutrients) in 4-inch clay pots. Germination was approximately 35 percent. Four pots were treated with 53 milliliters of a suspension of 0.940 gram Benlate[R] (50 percent benomyl) per liter (0.0498 gram per 4-inch pot). This rate is equivalent to 1 pound per 1,000 square feet. The control plants received 53 milliliters water. Seven weeks after planting, two pots of each treatment were sprayed with *Botrytis cineria* spores from colonies on potato-dextrose-agar (PDA) slants. All pots were covered with polyethylene bags. After 18 days, bags were removed and the plants were rated. Both inoculated and noninoculated, nontreated plants were severely infected. In fact, most of the nontreated plants were dead. All the plants in the benomyl-treated pots were free of Botrytis infection.

The tops of the plants were bioassayed for methyl benzimidazole-carbamate (MBC) using D.C. Erwin's method (1). The juice from the tops of the treated plants contained 50 parts per million MBC.

REFERENCE

Erwin, D. C.
1969. Methods of determination of the systemic fungitoxic properties of chemicals applied to plants with emphasis on control of Verticillium wilt with thiabendazole and Benlate. World Review of Pest Control 8(1):6-22.

SIMULATED STAND PROJECTIONS IN DWARF MISTLETOE-INFECTED STANDS

Frank Hawksworth[3] and James Stewart[4]

A series of yield equations has been developed for both ponderosa pine and lodgepole pine stands. These will give yields for several different levels of management (control) as well as no management (do nothing) in stands with various infection intensities.

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[1] Department of Plant Pathology, University of California, Berkeley, California

[2] Department of Plant Pathology, University of California, Berkeley, California

[3] Forest Research Pathologist, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado

[4] Project Leader, Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon

PANEL I. AIR POLLUTION IN RELATION TO FORESTS

Clint Carlson, Moderator [1]

OXIDANT AIR POLLUTION DAMAGE TO FORESTS OF THE PACIFIC SOUTHWEST

Paul R. Miller [2]

Photochemical oxidant [3] damage to vegetation initially involved only a few square kilometers in Los Angeles county in 1942. Twenty years later, the affected area had grown to 10,000 square kilometers locally and 30,000 square kilometers statewide. Two factors are responsible for this phenomenal increase: First, emission of the two raw materials necessary for the formation of oxidant in sunlight, namely nitrogen oxides and hydrocarbons--75 percent or more from automobiles--has increased faster than the population has increased. Second, the downwind area covered by a given oxidant concentration has increased much faster than the corresponding emission rate increase (2).

These two factors, particularly the latter, explain how conifer forests are damaged as far as 80 miles downwind in the south coast air basin in California as well as at other forested sites downwind from San Diego and Fresno in other air basins (4).

Recent studies in southern California have confirmed that the mountains themselves aid in the transport of polluted air to the forest. The daytime upslope flow acts in conjunction with the onshore breeze which pushes the polluted air inland from the megalopolis. The same studies have shown that the longest daily

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[1] Division of State and Private Forestry, U.S. Forest Service, Northern Region, Missoula, Montana

[2] Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, Air Pollution Research Center, University of California, Riverside, California

[3] The terms photochemical oxidant and total oxidant describe the complete mixture of oxidant compounds in "smog." More than 90 percent of this mixture capable of precipitating iodine from 2 percent potassium iodide is ozone (O_3). The remaining fraction is peroxyacetyl nitrate (PAN) and its homologues.

duration of severe oxidant concentrations is found at midslope (3,000 - 4,000 feet) in the chamise chaparral zone. However, visible damage is not easily recognized on these species while immediately above (5,500 feet) conifers show severe damage. The difference in plant response may be partially conditioned by the temperature and vapor pressure gradient during the daily period of maximum oxidant concentration (5).

In the San Joaquin Valley air basin, the transport of polluted air is not as directly influenced by marine air flowing inland as in the south coast air basin. Here, the daytime upslope flow of air into the Sierras is the dominant factor which causes penetration of oxidant polluted air into higher Sierra valleys (e.g., Mineral King Valley, 7,500 feet) which demonstrate both transported (afternoon) and locally produced (morning) oxidant peaks (6).

The most severe oxidant damage is to ponderosa and Jeffrey pine and the greatest intensity of injury to these species is in the Angeles and San Bernardino National Forests as well as on state and private lands east of San Diego. Aerial photography has been used to evaluate damage in both National Forests. For example, of the 160,950 acres of ponderosa-Jeffrey type within the San Bernardino National Forest boundaries, 46,230 acres had heavy damage; 53,920, moderate damage; and 60,800, light or no damage (10).

Observations in one heavily damaged area between 1969 and 1971 revealed 8.1 percent mortality of ponderosa pine during 24 months. During the same period, there was a significant decline in tree condition among 160 other intensively examined ponderosa pines (7). Other observations have indicated even greater mortality and in most cases the weakened trees had been killed by the pine bark beetles (1).

The amount of growth suppression of sapling ponderosa pines by chronic exposure to oxidant was demonstrated by enclosing about 12 trees in greenhouses provided with clean, carbon-filtered air in one house and ambient smoggy air in a companion house. These treatments have been in progress since 1968. The badly damaged trees placed in filtered air recovered completely as evidenced by more annual needle whorls retained, longer needles, and shoots. The trees in smoggy air have continued to decline in health, surviving from year to year with only one annual complement of damaged needles (8). If air pollution could be controlled tomorrow, a phenomenal improvement in the condition of even severely damaged trees could be expected immediately.

The correct diagnosis of the early symptoms of oxidant damage in the course of field surveys presents a difficult problem because typical oxidant symptoms--defoliation, growth suppression, and needle mottle--may be caused by other agents. Several techniques have been tested which, in combination, aid in diagnosis: Self-ventilated field chambers (9); histological and histochemical changes in needle tissue (3); selection and increase of both oxidant sensitive and tolerant clones of ponderosa pines by grafting to serve as bioindicators; and air monitoring with instruments. Biological methods have been stressed because of the expense and other technical difficulties during extended periods of air monitoring at remote sites.

Most of the research to date has been a description of the effects on ponderosa pine but other tree species in the ponderosa pine-sugar pine-fir forest have been excluded because damage was not as obvious. Thus far, there has been only speculation about the influence of sustained oxidant damage on the compositional changes of the conifer forest community (7).

In 1971, the Environmental Protection Agency sponsored the preparation of a report entitled "Protocol for a study on the impact of oxidant air pollution from an urban area on a forest ecosystem and recreational area." Such a study, if initiated, would include all life forms and all important physical factors of the environment.

In the meantime, no matter how much research is done on effects, the damage to the conifer forest continues and there is no real hope of abatement in sight. However, a continuation of research on the effects of oxidant air pollution will provide the facts necessary to help convince the public that significant control measures must be instituted without further delay in critical areas. Research may also provide the forest manager with better opportunities to ameliorate the damage simply as a stopgap measure until oxidant air pollution is controlled at its source.

Forest pathologists must remain alert to the trends in air pollution emissions from all sources in their respective localities. New power plants, smelters and other industrial developments can result in a mixture of pollutant gases (O_3, NO_2, SO_2) which may act additively or synergistically to cause plant damage at relatively low concentrations. It is more intelligent to prevent new pollution by exposing the potential dangers in a public forum prior to development rather than to attempt to control emissions or ameliorate damage later.

REFERENCES

1. Cobb, F.W., Jr., and R.W. Stark
   1970. Decline and mortality of smog injury to ponderosa pine. J. Forestry, 68: 147-149.

2. Leighton, P.A.
   1966. Geographical aspects of air pollution. Geograph. Rev., 56(2): 151-174.

3. Evans, L., and P.R. Miller
   1972. Ozone injury to ponderosa pine. A histological and histochemical appraisal. Amer. J. Bot. (<u>In press</u>).

4. Miller, P.R., and A.A. Millecan
   1971. Extent of oxidant injury to some pines and other conifers in California. Plant Disease Reptr., 55(6): 555-559.

5. Miller, P.R., M.H. McCutchan, and B.C. Ryan
   1971. Influence of climate and topography on oxidant concentrations causing injury to conifers in southern California. Proceedings of the VI Symposium of Forest Experts on Fume Damage - Essen, 1970, Forestry Comm. R&D Paper, 82: 43 (Abstract).

6. Miller, P.R., M.H. McCutchan, and H.P. Milligan
   ____. Comparison of oxidant air pollution concentrations in the San Joaquin Valley, Sierra Foothills, and Mineral King Valley--August 1970. Submitted to Atmos. Environ.

7. Miller, P.R.
   1971. Oxidant-induced community change in a mixed conifer forest. Symposium, Amer. Chem. Soc., Los Angeles (Abstract).

8. Miller, P.R., and H.P. Milligan
   (Unpublished data).

9. Miller, P.R., and R.M. Yoshiyama
   ____. Self-ventilated chambers for exposure of plants to ambient oxidant or carbon-filtered air. Submitted to Environ. Science and Tech.

10. Wert, S.L., P.R. Miller, and R.N. Larsh
   1970. Color photos detect smog injury to forest trees. J. Forestry, 68: 536-539.

REMOTE SENSING OF AIR POLLUTION INJURY TO FORESTS [1]

John F. Wear[2]

The ever increasing amounts of air pollution are causing serious damage to many types of forest resources in various parts of the United States. Foresters, land managers, home owners, recreationists, and the general public are concerned about air pollution injury to forests and ornamental trees. The Remote Sensing Project of the Pacific Southwest Forest and Range Experiment Station in conjunction with other federal agencies, Health, Education and Welfare and Tennessee Valley Authority, are conducting studies to detect and classify air pollution damage to forest trees in natural stands by means of remote sensing techniques.

Symptoms of air pollution to trees are foliage discoloration (yellow-green, bright yellow with tan necrotic needles, sparse yellow-red needles), shortening of needles, reduced growth, dropping of leaves, and eventual mortality. This is caused by air oxidants or chemical compounds including fluorides, nitrous oxide, aluminum oxide, copper oxide, ozone, and sulphur dioxide. Air oxidants may be present in combinations such as "smog" in industrial areas (Philadelphia, Los Angeles, etc.) or as a single primary chemical agent such as caused by a copper smelter (Globe, Arizona) or aluminum plant (Spokane, Washington). Effect of these pollutants to trees varies considerably based on concentrations of the air oxidant, the distance from the source, and the length of accumulation. Also, variation exists within and among tree species as to susceptibility; i.e., some trees are more resistant to air oxidant injury than others.

Aerial photographic techniques were tested first in June 1968

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[1]The assistance of Dr. Paul Miller, Pathologist, Riverside, California, in providing details on the various air pollution studies in California is gratefully acknowledged. Lantern slides and reference materials were provided me by R.C. Heller, Remote Sensing Project Leader.

[2]U.S. Forest Service, Division of Timber Management, Portland, Oregon

to detect and evaluate air pollution damage to forest trees on the Angeles National Forest and the San Bernardino National Forest in southern California. Smog emanating from the Los Angeles area is the primary cause of this forest pollution.

Five photographic scales ranging from 1:15,840 to 1:30,000 and four film types (Panchromatic Plus-X, Aerographic Infrared, Ektachrome Infrared, and Anscochrome D/200) were tested on four plot areas (1.5 chains wide and 10 chains long). All plots were rephotographed in August and December, 1968 to determine optimum season of year in which to most accurately evaluate air oxidant damage to ponderosa pine.

Ground procedures consisted of cruising the four plots and analyzing 50 ponderosa pine in each according to a prescribed crown characteristic scoring chart. On the basis of total scores for each crown, trees were placed in vigor categories. Foliage from three trees in each vigor class and from three crown positions were sampled and sent to the University of Michigan for spectral reflectance analysis. This reflectance information was to help determine the best film-filter combination that would discriminate between healthy and smog-affected foliage.

Two photo interpreters, trained to recognize tree species and photographic characteristics of air pollution damage to plants, examined all photographs. The results of analysis and correlations between "ground truth" and PI show that: (1) for initial detection of air pollution damage, a photo scale of 1:8,000 taken with Anscochrome D/200 color film (HF 3) was considered best; and (2) for evaluation of individual tree damage a photo scale of 1:15,840 taken with Anscochrome D/200 (Didymium filter) was considered best. The didymium filter accentuated reds and greens more than either haze filter used in the tests.

Tests for the best time of the year to detect and evaluate air pollution damage indicate December as optimum. New growth from June to August masked actual tree conditions and showed little effect from polluted atmosphere during that period even though the heavy smog period is from July to October.

In 1969 an aerial photographic survey (using best techniques above) covered more than 100,000 acres on the San Bernardino National Forest to estimate oxidant air pollution impact on ponderosa-Jeffrey pine forest areas. A two-stage probability sampling system, combining aerial photography and ground checks, gave an estimate of 1.3 million trees affected by smog (Wert 1969).

Multispectral and thermal IR imagery was recorded by the University of Michigan's multi-channel equipped DC-3 aircraft over known air oxidant affected pine trees on the San Bernardino National Forest in 1969. Data analyses show limited success in detecting trees under pollution stress. Aerial photography described above is by far the most useful system currently available for detecting and evaluating air oxidant damage to forests in southern California.

Feasibility studies using color aerial photography to detect and evaluate sulphur dioxide injury to timber stands in Alabama were cooperatively undertaken with TVA and HEW in 1969 and 1970. Electric power in the Tennessee Valley is largely produced by coal-fired steam plants. The large amounts of gases emitted into the atmosphere contain sulphur dioxide, SO_2, which, upon reaching the ground, cause injury to vegetation. Adverse meteorological conditions frequently cause smoke plumes to spread extensively over the ground, resulting in fumigation of planted loblolly pine, natural pine-hardwood, and natural pine stands.

Ground procedures established seven pairs of plots at seven sampling points, four in the affected area and three 40 miles away as a control area. At each point, two rectangular 1/5-acre plots were marked 5 chains apart. Data was collected on each tree in the plot according to a prescribed system including crown characteristics and effects of SO_2 fumigation.

Aerial photographic tests over the 2-year period included photo scales ranging from 1:800 to 1:7,920 and the two best films from the California study, Anscochrome D/200 with didymium filter and Ektachrome IR. The 1:800 photo scale was best. Ansco D/200 was somewhat better than Color IR for estimating all affected trees (56 percent versus 51 percent) but was approximately the same for severely affected trees only (78 percent versus 80 percent). Percentage of accuracy for SO_2 damage estimates are at a median level and will require yearly re-examination over a 5- or 6-year period to evaluate total impact to trees.

It is apparent from the foregoing studies that detecting and evaluating air oxidant pollution damage in forest stands will require very large-scale color imagery and that estimating impact to the forest resource will necessitate repetitive photography correlated with quality ground truth and good photo interpretation over a long period of time.

REFERENCES

International Union of Forest Research Organization, Section 25
1971. Application of remote sensors in forestry. Joint Report by Working Group, Druckhaus Rombach Co., Freiburg, Germany.

Wert, S.L., P.R. Miller, and R.N. Larsh
1970. Color photos detect smog injury to forest trees. J. For., 68(9): 536-539.

Wert, S.L.
1969. A system for using remote sensing techniques to detect and evaluate air pollution effects on forest stands. Proc. 6th Int. Symp. Remote Sensing of Environment. Univ. of Michigan, Ann Arbor. pp. 1169-1178.

Zealear, K.A., R.C. Heller, N. Norick, and M. Wilkes
1971. The feasibility of using color aerial photography to detect and evaluate sulphur dioxide injury to timber stands. PSW For. and Range Exp. Sta., Berkeley, California.

PANEL II. BIOLOGICAL CONTROL OF FOREST DISEASES

G. W. Wallis, Moderator[1]

The 15th Congress of I.U.F.R.O. was held in Gainsville, Florida, in March and included a symposium on "Biological Control of Forest Tree Diseases." The symposium comprised nine formal papers. Three of the topics are presented here in detail by members of the panel. The following are a few terse comments on the remaining six topics (complete Congress Proceedings will be published for distribution to major centers in the near future).

- SUMMARY OF PAPERS -

BIOLOGICAL CONTROL OF NEEDLE CASTS OF CONIFERS

Drs. K. Ito and O. Chiba of Japan

The authors concerned themselves with a review of pertinent information on the needle cast of pine, Lophodermium, and larch, Mycosphaerella, noting particularly the effect of management practices and site on disease development. They felt that biological control, as used in its narrow sense, had little practical application at this time.

CONTROL THROUGH BIOTIC MEASURES

Dr. Finn Roll Hansen of Norway

Dr. Roll Hansen dealt with control of forest diseases as brought about through removal of the alternate host, use of resistant tree species, breeding for resistance and use of stand manipulation.

BIOCHEMICAL FACTORS AND BIOLOGICAL CONTROL

Dr. Martin Hubbes, Quebec, Canada

Dr. Hubbes reviewed in some detail many of the biochemical findings pertinent to biological control of plant diseases. He adds two approaches which he feels are worthy of more intensive consideration; (1) interfere in the pathway of the host's specific metabolism, altering it in such a way that the host conserves its phenotype but is physiologically no longer recognizable by the pathogen, (2) interfere in the important phases of development characteristic to the pathogen to prevent its growth or suppress multiplication. Parts of these approaches are already being accomplished in the breeding programs presently underway.

1/Pacific Forest Research Centre, Canadian Forestry Service

BIOLOGICAL CONTROL IN AGRICULTURAL PLANT DISEASES

Dr. A. J. Skolko, Canada

Dr. Skolko points out the obviously more promising prospects for biological control in agriculture compared to forestry where we are faced with long rotations, low value per acre crop, large plant size, inaccessibility, etc. A great deal of investigation has been done on biological control in agriculture and the forest scientists should be more aware of this work.

Skolko is in agreement with Ito and Chiba when he suggests that the possibility of using antagonists in the control of pathogens of aerial plant parts is unlikely. In order to be effective, these antagonists would require an extremely high reproductive capacity, persistence under unfavorable environmental and nutritional conditions and be extremely aggressive or antagonistic.

He feels that biological control of root diseases holds more hope. There is much yet to be known in order to sort out cause and effect to prevent a continuation of the unpredictable and erratic control results achieved to date.

His last remarks are worth noting by those working toward biological control: "It is probable that the intriguing prospects of biological control have restricted our vision to the point where we have neglected the possibility of an integrated chemical, genetic and biological approach."

BIOLOGICAL CONTROL OF ROOT DISEASES IN FOREST TREE NURSERIES WITH EMPHASIS ON THE ROLE OF MYCORRHIZAE

Dr. D. H. Marx, USDA, Athens, Georgia

Dr. Marx reviewed first a few of the successes and failures following treatments with soil amendments and chemicals. He then went on to discuss some of the successes that have been evidenced in preventing infection of feeder roots by the development of mycorrhizal components. Penetration of the pathogen may be stopped by a straight mechanical barrier action set up by the mantle and Hartig net or it may be stopped by antibiotic production on the part of the mycorrhizal fungus.

He warns against the use of nonselective fumigants and fungicides for the control of pathogens because of the serious negative effect in destroying mycorrhizal-forming fungi.

BIOLOGICAL CONTROL OF CANKER AND VASCULAR DISEASES OF TREES

Dr. C. L. Wilson, USDA, Delaware, Ohio

Dr. Wilson starts out by stating that man has never succeeded in controlling a vascular or canker disease biologically. His paper then goes on to deal with what he speculates are the prospects for success.

He feels that in the past scientists have always first turned to chemical or genetic means of control, and where these have failed biological methods are sought. Placing biological control in the back recesses of our mind in this way is probably the reason we are still talking of the prospects for successes rather than successes themselves. Biology, economics and common sense all indicate that in most cases a biological approach to control should be pursued first.

If we are to control a tree disease biologically, we must first know the biological and nutritional systems with which we are dealing. If we can learn sufficient about ecological interactions that we can manipulate them to the disadvantage of the pathogen, we are in business.

We are already knowledgeable about enough of the ecosystem of canker and vascular diseases to indicate two different approaches to biological control; (1) an introduction of organisms directly into the system; (2) change the nutritional or other environmental factors which in turn would alter the composition of the microorganisms.

Feeling that with vascular diseases, we are faced with a "closed" ecological system, Wilson is of the opinion that the direct use of antagonists would be the most fruitful control approach. On the other hand, with cankers we are faced with an "open" ecological system, therefore, an alteration of the nutritional milieu would be the more profitable direction to head.

In the introduction of antagonists to control vascular diseases, Wilson points up the repeated failures that have occurred from introducing organisms already present in the ecological system of the pathogen. He favors a search for an antagonist that is foreign. In this respect we should not overlook pathogens which occur in tree species other than those with which we are concerned, e.g., inoculation of elm with the oak-wilt fungus gave some success in control of Dutch elm disease. More attention should be paid to bacteria when utilizing this approach.

The use of fungal parasites to control pathogens has received some attention but not the concentrated effort it deserves. The inoculation of a plant with one fungus to produce a chemical reaction in the host which acts against an unwanted pathogen is an interesting possibility for the future.

BIOLOGICAL CONTROL FOR ROOT DISEASES OF TREES

John Rishbeth, Botany School, University of Cambridge, England

Presented by D. J. Morrison[1/]

Abstract

The only practical example so far of using a specific organism to help control a root disease of trees is the inoculation of pine stumps with the fungus *Peniophora gigantea* against infection by *Fomes annosus*. Stumps of other conifers might be protected against infection by this parasite by inoculating appropriate fungal competitors, such as *P. gigantea* or *Polyporus adustus* in the case of Norway spruce. In some instances such control might be improved by supplementary chemical treatment, and with stumps of broad-leaved trees such treatment would be essential for controlling regrowth. Experiments are outlined in which various wood-rotting fungi were successfully established in stumps of poplar and birch; possibly such a method could be used to reduce the incidence or root disease from *Armillaria mellea* when sites bearing broad-leaved trees are replanted with susceptible conifers. Other possible application of biological control are briefly discussed.

Introduction

In attempting to deal with this complex subject, it might be helpful at the outset to note with Garrett (1970) that in a wider context root disease investigators have followed two main approaches to the problem of obtaining biological control. These are inoculation of soil or plant surfaces with selected competitive or antagonistic microorganisms, and alteration of soil conditions by appropriate crop husbandry measures so as to enhance natural biological control by the soil microflora. Garrett points out that inoculation of natural soil has been uniformly disappointing owing to the resident microflora which exerts a buffering effect. Inoculation of freshly cut stump surfaces, by contrast, seems more likely to succeed because much of the tissue is still living and, therefore, selective in the sense that relatively few microorganisms can colonize it. Even the dead tissues provide a poor substrate for most organisms. In the present state of knowledge, alteration of soil conditions appears generally more suitable for agricultural crops than for forest ones, tree nurseries providing an exception. One further line of approach should perhaps be included, although it impinges to only a limited extent on forestry, namely investigation into various ways of killing standing trees and their effects on the subsequent development of root disease, the most

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1/Pacific Forest Research Centre, Canadian Forestry Service

obvious example being ringing. In this paper a number of methods having potential application to forestry will be briefly discussed. Those involving inoculation with microorganisms will receive special consideration because they seem to offer the most direct means of limiting growth of root parasites in their potential food bases.

Control of *Fomes Annosus* in Pine Stands

Inoculation of pine stumps with *Peniophora gigantea* provides the only practical example so far of using a particular organism to help control a root disease. This fungus tends to prevent establishment of *F. annosus* at the cut surface by means of air-borne spores and to check its growth in stumps from any tissues infected at the time of felling (Rishbeth, 1963). During thinning the method is specially valuable for protecting young pine stands with little or no root infection and is better than chemical stump treatments in heavily infected stands, although it hardly restricts spread of the fungus from existing centers of infection. This is because *F. annosus* is largely independent of stump root systems for radial spread from tree to tree; in addition, *P. gigantea* cannot replace *F. annosus* in roots which are very resinous. This helps to explain why stump inoculation at the time of clear-felling is not more effective against development of root disease in young replanted trees (Greig and Burdekin, 1968).

Large-scale stump inoculation with *P. gigantea* started in Britain in 1964, soon after inocula suitable for use in the forest had been developed. By 1970 the area of pine plantations in which *P. gigantea* is used, during both thinning and clear-felling, reached about 100,000 acres. Inocula were originally prepared in the form of tablets, first in the laboratory and then commercially, but now a concentrated suspension of *P. gigantea* oidia is produced in sachets. This is diluted appropriately and then applied to freshly cut stumps, generally from a plastic container with perforations in the lid. Various other methods of applying the fungus are under consideration and these include, interestingly, addition of oidia to the oil used for lubricating the chain-saw blade, so that felling and stump inoculation are achieved simultaneously (Artman and Stambaugh, 1970). In the southern United States much tree felling in the future will be carried out with mechanical tree harvesters, on suitable sites, and this operation may well be combined with stump inoculation. Workers in a number of other countries, such as Holland, Ireland and France, are interested in the possibility of stump inoculation and in some of them pilot experiments are under way.

In certain exceptional situations stump inoculation could conceivably be used to halt radial extension of *F. annosus* in pines. Many apparently healthy trees would have to be sacrificed in order to achieve this, the number being determinable only by experiment. Attempts to create a cordon sanitaire by means of *P. gigantea*, if successful, would presumably be worthwhile only in particularly valuable stands having a limited number of infection centers from which *F. annosus* would be expected to spread a considerable distance. To obtain the greatest effect, such centers would need to be treated early. This procedure would avoid the high labor cost and soil disturbance associated with trenching, some limitations of which have been discussed elsewhere (Garrett, 1944; Rishbeth, 1952). This method might also be tried for attempting to control rapid radial spread of *Armillaria mellea*, as occurs in *Pinus elliottii* in some areas of the Transvaal, for example.

Recent work in East Anglia suggests that it is desirable to test isolates of *P. gigantea* for effectiveness in stump colonization before using them on a large scale. With eight isolates the mean percentage area of cross-section in the upper portion of stumps occupied by the fungus 8 months after standard inoculation ranged from 67 to only 18. This performance, admittedly under rather adverse conditions, was poorly correlated with that on fresh pine discs in a laboratory trial.

Control of *Fomes Annosus* in Other Conifers

The possibility of using stump inoculation for conifers other than pines has been considered already (Rishbeth, 1968). Since then no further work has been done with European larch, *Larix decidua*, or Douglas-fir, *Pseudotsuga menziesii*. It may be recalled that in one experiment *P. gigantea* alone did not control *F. annosus* at the stump surface in the case of the former species, whereas similar inoculation combined with application of 10 percent sodium thiosulphate did so. Inoculation with *P. gigantea* alone did control infection by *F. annosus* in Douglas-fir stumps, and when it was combined with application of 5 percent ammonium sulphamate, colonization by *P. gigantea* was greatly increased. The failure of this fungus to control *F. annosus* in Norway spruce, *Picea abies*, was associated with the presence of the parasite in heart-rotted tissue prior to felling; in an earlier experiment with stumps of healthy spruce *P. gigantea* alone had given excellent control.

A further experiment with stumps of healthy, 20-year-old Norway spruce may be briefly reported. After 20 months the mean percentage areas of cross-section colonized in stumps inoculated with *F. annosus* only were 31 for this fungus and 8 for *P. gigantea*. The following mean percentages, each derived from 10 stumps were obtained for these two fungi after varied treatments, all of which included inoculation with *F. annosus*:

inoculation with P. gigantea, 5 and 20; the same inoculation combined with addition of 10 percent ammonium sulphamate, 1 and 39; and inoculation combined with addition of thiamin and biotin, 1 Y per stump, 0 and 54. Fairly good control of F. annosus was obtained with Polyporus adustus alone, percentages for the two fungi being 3 and 23. The slow growth of fungi in these stumps was probably associated with their relatively small size and the very dry, exposed site, which may well have favored rapid desiccation. In the same experiment colonization by P. gigantea was increased and that by F. annosus correspondingly depressed after inoculation with the former fungus and addition of 0.2 gram yeastrel, in solution, to each stump. If the beneficial effect of vitamin supplements on such colonization can be confirmed by further experiments, a useful treatment for Norway spruce stumps may result. P. adustus might also be borne in mind as a potential competitor; it too forms asexual spores in culture.

The position with Sitka spruce, Picea sitchensis, is less encouraging. In an experiment comparable with that just described, supplementation with vitamins or addition of 5 percent ammonium sulphamate, combined with inoculation of P. gigantea, resulted in a percentage colonization by this fungus of only 5 and 7 respectively, as compared with nil for controls which were inoculated only. So far no fungus has been found which grows at a rate remotely approaching that of P. gigantea in pine stumps. It is suspected that here too stump desiccation may be partly responsible for the poor results, and experiments have, therefore, been set up at sites having a higher rainfall.

At present, therefore, caution is advisable about the prospects for biological control for species other than pine. Further experiments are needed with a wider variety of fungi. It is clearly desirable to discover species which do not need supplementary treatments for establishment, but the latter need not be ruled out provided that they are simple and inexpensive.

Treatments for Stumps of Broad-Leaved Trees

Foresters have long been concerned about attack, by A. mellea in particular, that develop in susceptible conifer stands at sites formerly bearing broad-leaved trees. It is undoubtedly difficult to assess the economic importance of such attacks but in some instances it is considerable, so that an effective treatment might be justified. That biological methods merit serious consideration is suggested by the failure of procedures derived from tropical experience, namely the ring-barking or poisoning of standing trees, to control invasion of oak stumps by A. mellea (Redfern, 1968). Moreover, in several East Anglian woodlands where hardwood stumps have been treated with 2,4,5-T to control regrowth, unusually rapid invasion by rhizomorphs has occurred (Rishbeth, 1971).

After experiments with wood blocks, Orlos (1957) suggested that various fungi, especially Fomes marginatus, might be used to control A. mellea. He proposed to inoculate barked stumps, apparently already containing the parasite, with F. marginatus, but the results of any such trial were not published. A more promising procedure, in the light of experience with P. gigantea, is to inoculate the freshly cut surface immediately after felling.

In the experiments to be described, production of sporophores provided the main criterion for successful establishment: in the great majority of them conditions favored their development. In a preliminary trial with willow, Salix alba, stumps inoculated with basidiospores of Polystictus versicolor readily became infected if 40 percent ammonium sulphamate was also applied, but somewhat less readily if the bark was treated with 1.5 percent 2,4,5-T in oil. In the absence of these treatments there was little or no infection and much regrowth developed. Observations were then made on larger uninoculated stumps of horse chestnut, Aesculus hippocastanum, most of which had been chemically treated after felling. After 8 months those treated with 2,4,5-T were found to be extensively infected with Stereum purpureum from natural spore sources, as were untreated stumps, whereas Polyporus adustus predominated in stumps treated with 40 percent ammonium sulphamate. Regrowth was controlled well by 2,4,5-T and even better by sulphamate. The type of chemical treatment thus appears to determine the pattern of fungal colonization, as with conifer stumps, but by contrast with these such treatment is essential in most cases to control regrowth. In order to provide a chance for effective biological control, a treatment which also promotes rapid invasion by competing fungi is clearly desirable.

Two experiments were set up with stumps of young balsam poplar, Populus trichocarpa. The first demonstrated that P. versicolor and P. adustus could be successfully established in stumps inoculated with dosages ranging from 3×10^4 to 3×10^2 basidiospores or conidia respectively, and then treated with 40 percent ammonium sulphamate. The second, set up with P. versicolor only, showed that treatment with 2,4,5-T was ineffective for promoting establishment of the fungus with a doage of 5×10^2 basidiospores, but that 40 percent ammonium sulphamate was effective not only with this dosage, as before, but most surprisingly with one as low as five basidiospores. After one year sporophores of the fungus were abundant on inoculated stumps, and after 2-1/2 years the density of their wood was commonly in the range 0.09 - 0.16, as compared with 0.20 - 0.40 for uninoculated stumps, mostly colonized by Stereum purpureum, and with 0.45 for the original wood. In a more recent experiment stumps of birch, Betula verrucosa, were inoculated with basidiospores of different fungi and then treated chemically in various ways. After 3 years the best growth by Polystictus versicolor, Polyporus adustus, Lentinus betulinus and Merulius corium had occurred in stumps treated with 40 percent ammonium sulphamate, by Stereum hirsutum after treatment with 10 percent ammonium sulphamate, and by Stereum purpureum after application of 2,4,5-T. Fungi clearly differ with respect to the chemical most favoring their growth in stumps. It may be added that in these experiments chemical treatment alone seldom resulted in good colonization by wood-rotting fungi.

The controlled inoculation appears feasible for stumps of broad-leaved trees, though probably it would be easier for some species than for others. Establishment can be obtained with mycelial fragments as well as spores. Production of inocula would present certain difficulties, but these might not be insuperable, especially if low dosages were effective. Fungi able to colonize many different types of tree stump, such as P. versicolor and P. adustus, would be more useful than those which are specific. It is difficult to judge the extent to which such inoculation would restrict the build-up of A. mellea. Probably the deeper tissues of a stump, to which A. mellea penetrates relatively late, would be unavailable, whereas it might become dominant in roots through its ability to grow rapidly in the cambial region and thus outflank any inoculated fungus (Rishbeth, 1971). Much would then depend on the relative importance of the main body of the stump and its roots as sources of infection over a period of time. Experiments have been set up in an attempt to elucidate this point. With F. annosus, as in situations where birch stumps constitute a serious source of infection, such control would probably be easier to achieve because it generally needs to operate at the stumps surface only.

Other Possible Applications of Biological Control

At first sight the problems of growing tea or cocoa have little relevance of those of modern forestry. However, the experience of pathologists with root diseases of such crops and of rubber, which provides a closer parallel with timber stands, may well be valuable for foresters in tropical countries; certainly they are likely to encounter ubiquitous pathogens such as Fomes lignosus and Armillaria mellea. The value of ringing standing trees to reduce subsequent damage by A. mellea, a method first proposed by Leach (1939), is well established in Africa. This procedure has been much discussed in the literature and will not be considered further here. It is probable that in some instances other control methods could be developed: for example, where a standing tree is already known to be infected with A. mellea, poisoning with ammonium sulphamate and simultaneous inoculation with a suitable competing fungus might be more effective than ringing. Such a method of control is needed for shade trees over cocoa in West Africa, for example (Rishbeth, unpublished data).

A control method involving closely integrated chemical and biological actions has been developed at the Rubber Research Institute in Malaya (Fox, 1965). In replanting after rubber, early losses are commonly experienced from attacks by F. lignosus; other root parasites appear later. In the procedure now adopted all trees of the former planting are killed by chemical means whilst standing, or are felled and the stumps creosoted. A leguminous cover-crop is then established between the new planting rows which themselves are kept bare to a width of 6 feet. The cover-crop protects the soil from isolation, erosion and leaching; and most importantly in the present context, it provides conditions which encourage vigorous growth and fructification of F. lignosus. But because this growth stops short at the bare planting rows, food reserves tend to become exhausted without a significant increase of root disease on the young trees. Foresters as well should be alert to the possibilities of creating conditions likely to promote rapid disappearance of parasites from root tissues. Indeed it has already been found the Poria weirii survives in wood blocks for a shorter period when buried in soil bearing conifers and red alder than in one bearing conifers alone (Nelson, 1968), though whether such an effect occurs in intact root systems and can be exploited remains to be seen.

Root disease fungi which spread directly through the soil in the form of mycelial strands may be particularly difficult to control by biological methods. Jalaluddin (1967) noted that Rhizina undulata did not develop on alkaline soils around fire sites that otherwise seemed suitable, and more recent work (Rishbeth, unpublished data) has suggested that antagonistic effects from heat-resistant bacteria, such as Bacillus subtilis and B. polymyxa, may be partially responsible. Experiments at an acidic site where the fungus regularly appears after burning were set up in which spores of these bacteria were applied to stump roots or to the soil surrounding them prior to burning. It was hoped that inoculation, followed by partial heart sterilization of the resident microflora, might be more successful than that of natural unsterilized soils attempted by other investigators, but in fact there was no difference with respect to subsequent development of R. undulata between these treatments and the controls. Similar experiments with fungi that colonize bonfire sites would be interesting, but it seems doubtful, even if they were successful, whether a method of this type could be applied to large-scale burning, with which serious attacks are often associated.

REFERENCES

Artman, J. D. and W. J. Stambaugh
1970. A practical approach to the application of Peniophora gigantea for control of Fomes annosus. Pl. Dis. Reptr. 54, 799-802.

Fox, R. A.
1965. The role of biological eradication in root-disease control in replantings of <u>Hevea brasiliensis</u>. In Ecology of soil-borne plant pathogens, K. F. Baker and W. C. Snyder ed., 348-362. Berkeley: University of California Press.

Garrett, S. D.
1944. Root disease fungi. Waltham, Mass.: Chronica Botanica Company.

Garrett, S. D.
1970. Pathogenic root-infecting fungi. Cambridge: University Press.

Greig, B. J. W. and D. A. Burdekin
1968. Control and eradication of <u>Fomes annosus</u> in Britain. Sect. 24, Int. Un. For. Res. Org. Proceedings of the Third International Conference on <u>Fomes annosus</u>, Aarhus.

Jalaluddin, M.
1967. Studies on <u>Rhizina undulate</u>. II. Observations and experiments in East Anglian plantations. Trans. Br. mycol. Soc. <u>50</u>, 461-472.

Leach, R.
1939. Biological control and ecology of <u>Armillaria mellea</u> (Vahl) Fr. Trans. Br. mycol. Soc. <u>23</u>, 320-329.

Nelson, E. E.
1968. Survival of <u>Poria weirii</u> in conifer, alder, and mixed conifer-alder stands. Pac. N.W. Forest and Range Exp. Sta. Res. Note PNW-83, 1-3.

Orlos, H.
1957. Badania nad zwalczaniem opieńki miodowej (<u>Armillaria mellea</u> Vahl) metoda biologiczna. Roczn. Nauk. leśn. <u>15</u>, 195-235.

Redfern, D. B.
1968. The ecology of <u>Armillaria mellea</u> in Britain. Biological control. Ann. Bot. <u>32</u>, 293-300.

Rishbeth, J.
1952. Control of <u>Fomes annosus</u> Fr. Forestry <u>25</u>, 41-50.

Rishbeth, J.
1963. Stump protection against <u>Fomes annosus</u>, III. Inoculation with <u>Peniophora gigantea</u>. Ann. sppl Biol. <u>32</u>, 63-77.

Rishbeth, J.
1968. The possibility of stump inoculation for conifers other than pines. Sect. 24, Int. Un. For. Res. Org. Proceedings of the Third International Conference on Fomes annosus, Aarhus.

Rishbeth, J.
1971. The role of basidiospores in stump infection by Armillaria mellea. In Root diseases and soil-borne pathogens, T. A. Toussoun, R. V. Bega and P. E. Nelson ed. (In press) Berkeley: University of California Press.

BIOLOGICAL CONTROL OF THE MISTLETOES

F. G. Hawksworth

(Since this paper will soon be published by the IUFRO, only an abstract will be included here).

Abstract

There have been a number of compilations of the insects and fungi associated with the mistletoes, but few attempts to encourage them as biological control agents. The dwarf mistletoes (Arceuthobium spp.) are the most destructive mistletoes, and their insect and fungal associates have been most intensively studied. Several insects and fungi are specific to dwarf mistletoes, but they seem to exert only a low degree of natural control. The most promise for biological control seems to be through insect introduction or employment of certain canker fungi that inhabit the host bark in the vicinity of dwarf mistletoe cankers and limit mistletoe shoot production.

RESIN DISEASE OF *ARCEUTHOBIUM AMERICANUM*

Dr. Walter R. Mark[1]

Many fungi attack dwarf mistletoe shoots or act as canker fungi when associated with dwarf mistletoe infections. The fungi attacking the aerial shoots are able to reduce seed production in some areas (Wicker and Shaw, 1967), but since they do not affect the endophytic system their overall effect is not too great. Canker fungi, therefore, seem to hold greater promise as a means of obtaining biological control. Scharpf (1969) reported on the incidence of *Cytospora abietis* on dwarf mistletoe infected *Abies magnifica* and *A. concolor*. This fungus kills dwarf mistletoe infected branches, but its overall effect has not been determined. The fungus will also attack non-mistletoe infected branches, and this may pose a problem if the fungus is increased to the level needed to yield effective control. Another canker disease, tentatively named resin disease, may hold more promise, since its effect on the host tree is much less severe. Resin disease does not usually kill the mistletoe infected branch and has not been observed on non-mistletoe infected branches.

The so-called resin disease of *Arceuthobium americanum* on lodgepole pine has been under observation since 1958 in an area near Fort Collins, Colorado (USDA, 1960). The disease appears to be very effective in eliminating the aerial shoots from the dwarf mistletoe cankers. In the area where disease records have been kept, an average of about 96 percent of the dwarf mistletoe infections have exhibited resin disease symptoms for the period from 1958 to the present. In the same time period approximately 14 percent of the dwarf mistletoe infections have had all aerial shoots killed. The implication of the large shoot mortality is obvious. With the number of aerial shoots so drastically reduced the production of seed and, therefore, the chance of new dwarf mistletoe infections becoming established is greatly reduced.

The disease is easily recognized in the field, where typical symptoms include resin exudation, necrotic discolored bark tissue, dead pine needles remaining attached, and dead resin-soaked dwarf mistletoe shoots. Another observation is that the number of new systemic infections is apparently reduced, but the disease does not seem to affect established systemic infections.

Isolations from naturally infected dwarf mistletoe cankers have yielded ten genera of Fungi Imperfecti and several unidentified fungi. Many of the same fungi were found associated with *Cronartium*

1/Department of Botany and Plant Pathology, Colorado State University, Fort Collins, Colorado

comandrae cankers on lodgepole pine (Powell, 1971). Baranyay (1966) found several fungi associated with dwarf mistletoe on western hemlock, but the pathogenicity of these fungi was not determined. In the resin disease cankers the four most commonly isolated fungi included Alternaria tenuis, Pullularia pullulans, Epicoccum nigrum, and Phoma spp.

Inoculation studies utilizing two techniques were undertaken. A spray of a mycelium and spore suspension did not yield high infection rates. Slit inoculations, where a small portion of mycelium was inserted into the bark in the area of the dwarf mistletoe canker, proved much more successful. With both Pullularia pullulans and Alternaria tenuis 56 percent of the inoculations caused symptoms. This type of inoculation would not be practical for use in a control project except for high value trees. Isolations from resin disease cankers inoculated with either Pullularia or Alternaria yielded predominantly the fungi used for inoculum.

The mechanism by which resin disease kills the aerial shoots has not been worked out. Two possibilities are being investigated. Alternaria tenuis is being checked out for toxin production, since Templeton et al. (1967) found it produced a potent toxin called tentoxin. Histological work is continuing after preliminary work indicated the development of a suberized layer in resin disease cankers. Both of these mechanisms would block the movement of required materials from the host to the dwarf mistletoe shoots; however, the toxin theory does not explain how Pullularia can cause the symptoms.

Although most of the fungi associated with resin disease cankers are saprophytic or weakly parasitic, it must be remembered that they are working on tissue that has been altered by the dwarf mistletoe. One problem encountered with saprophytic fungi is that it is difficult to increase their level to epidemic proportions in the field. This cuts down the potential resin disease has for use in biological control.

REFERENCES

Baranyay, J. A.
1966. Fungi from dwarf mistletoe infections in western hemlock. Can. J. Bot. 44:597-604.

Powell, J. M.
1971. Fungi and bacteria associated with Cronartium comandrae on lodgepole pine in Alberta. Phytoprotection 52:45-51.

Scharpf, R. F.
1969. *Cytospora abietis* associated with dwarf mistletoe on true firs in California. Phytopathology 59:1657-1658.

Templeton, G. E., W. L. Meyer, C. I. Grable, and C. W. Sigel
1967. The chlorosis toxin from *Alternaria tenuis* is a cyclic tetrapeptide. Phytopathology 57:833 (Abstract)

U.S. Department of Agriculture
1960. 1959 Annual Report. USDA, Forest Service. Rocky Mountain Forest and Range Experiment Station 100 pp.

Wicker, E. F. and C. G. Shaw
1968. Fungal parasites of dwarf mistletoe. Mycologia 60:372-383.

ANTAGONISTIC INTERACTIONS IN WOOD-INHABITING MICROORGANISMS AND THEIR EXPLOITATION IN DECAY CONTROL

D. E. Etheridge [1]

Introduction

Investigators have only recently paid attention to interactions between non-Hymenomycetes and Hymenomycetes in the decay process. Consequently, the control of decay by antagonistic organisms is still in an early stage of development, and this is the first attempt to survey the literature on the subject.

In this paper, interactional phenomenon among wood-inhabiting microorganisms is discussed in relation to antibiosis, and the possible application of these processes in decay-control procedures. We may envisage decay control as proceeding in two ways from an understanding of naturally occurring relationships. First, as a direct approach, we may consider interactions between specific organisms and envisage the selection of suitable antagonistic organism and its artificial introduction, as a protective barrier around susceptible host tissues. The second, or indirect approach, involves an understanding of natural successions of microorganisms in trees and wood products. It envisages modification of the environment to induce natural or artificial establishment of a competitive, yet harmless microflora, so that successions may be directed away from a decay climax. Both approaches have been exploited in practical attempts at decay control. I will discuss briefly the major developments in this field and several aspects of the subject that require further study.

Antagonistic Interactions

Two kinds of interaction have been exploited in decay control. One is direct antagonism on hyphal contact or mycoparasitism which, in wood fungi, appears to function as an aggressive mechanism and may result in replacement of one organism by another in natural successions, e.g., *Fomes annosus*, in part by *Peniophora gigantea* in pine stumps (Ikediugwu, 1970). The role of mycohost and mycoparasite, however, is not constant for a particular organism, but depends on specific conditions and the other fungus in the combination. The second is indirect antagonism, involving the release of antibiotics and causing inhibition, sometimes at a considerable distance. This action in wood fungi is regarded

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[1] Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C., Canada

by some to function as a defensive mechanism, to prevent replacement by competitors and to ensure "suprematie de premier occupant," as defined by Pelhâte (1968). The persistent occurrence of the non-decay fungus, Asocoryne sarcoides, in medullary tissues of certain conifers is an important example (Etheridge, 1970).

The nature of the interaction depends on the "right" combination of fungi, host and substrate conditions, such as temperature, nutrients and moisture. This explains the wide variations in fungal interactions; for instance why an individual organism may strongly inhibit a pathogen on one culture medium and not on another; why it may or may not have the same effect with another pathogen, or in the host.

Many fungi have the ability to induce antagonistic activities in one another. Grosclaude (1960) was the first to observe that filtrates from mixed cultures of wood fungi showed greater antibiotic activity than filtrates from pure cultures of the same organisms. Ricard (1970) showed that the virulent "white" form of Trichoderma retained its antibiotic activity in wood containing natural competitors, but rapidly reverted to the "green" non-virulent form when competition was absent in such a medium.

Decay Control by Exploitation of Antagonistic Interactions

These remarks indicate some of the problems involved in the selection and application of microorganisms in decay control. But the real test of usefulness of any organism under field conditions requires that it will successfully compete with the existing microflora and will exert antagonistic action against the pathogen in or on host tissues, as it did in vitro. The following examples of direct and indirect control illustrate this point:

Direct control - Shields and Atwell (1963) found that spraying the ends of birch logs with a water suspension of Trichoderma viride was highly effective against storage decay, but only when the treatment was applied in advance of exposure to decay inoculum; competition by decay organisms during the establishment stage was the major difficulty. Likewise, Grosclaude (1970) found that freshly made wounds on 2-year-old plum trees were completely resistant to the "silver leaf" pathogen, Stereum purpureum, when inoculated with T. viride 48 hours in advance of the pathogen; yet, the treatment was only moderately effective when the pathogen and the antagonist were inoculated together. Similar conclusions may be drawn from the results of Stillwell's experiments with balsam fir logs, which showed that mycelial suspensions of the fungus, Cryptosporiopsis sp., were ineffective in preventing decay in the presence of high levels of decay inoculum (Stillwell, 1966) although, in this case, it is doubtful whether Cryptosporiopsis, a fungus isolated from living yellow birch, actually became established on the balsam fir logs - a non-host. To overcome this difficulty, it has been suggested (Whitney, and Wilson, 1970) that purified preparations of the antibiotic, "cryptosporiopsin," be used instead of the fungus; but this introduces another problem, that of achieving effective penetration and coverage of logs or chip piles with an antibiotic.

Indirect control - intensification of natural competition - A practical solution to the problem of ensuring effective antagonistic action by Trichoderma viride against competitors during the establishment stage has been achieved by the addition of fluorides to timber during seasoning. It appears that the chemical itself has little toxic effect on decay fungi, but the fact that it greatly stimulates the growth of T. viride gives this fungus an initial advantage over decay competitors during the colonization process, which it continues to exploit through the mechanism of antibiosis. Another example of indirect decay control by intensifying natural competition was achieved through treatment of wound surfaces of living balsam fir with nutrients (Etheridge, 1969). After one year, the application of a 5 percent malt extract solution was responsible for a substantial increase in colonization by relatively harmless decay saprophytes and a corresponding reduction in wounds infected by Stereum sanguinolentum, from 46 percent to 13 percent.

Indirect control - introduction of natural competitors - An extremely interesting concept of decay control has been reported recently by Ricard and co-workers (Ricard, 1970, Ricard et al., 1969). The successful inoculation of the antagonistic fungus, Scytalidium sp., by means of steel-tipped propagules fired into Douglas-fir utility poles in service, established that decay control was possible by introducing a natural competitor into an existing ecosystem. The artificial introduction of such an organism, which can develop in a host without causing damage to the wood and simultaneously provide protection against decay, has been defined as an "immunizing commensal" (Ricard and Bollen, 1968).

Conclusions

Antagonistic interactions among wood fungi in culture involve direct mycoparasitism and indirect antibiotic action caused by water-soluble metabolites. Positive effects are usually correlated with similar effects in wood, but the reverse is not always true, limiting the usefulness of studies on artificial media. Wide variability in these interactions occur within and between species on artificial media and in wood, presumably the result of individual differences in virulence, sensitivity and substrate effects. The range of variation and the part played by each process must be evaluated, therefore, before antagonistic fungi can be applied successfully in decay-control procedures. Possibly, the concept of multiple application of two or more species of fungi that have the ability to induce antagonistic activities in one another may be exploited to reduce these inconsistencies, but this principle needs further study. There must be further study also on the problem of establishing antagonistic organisms on non-host substrates, as this is a major limitation in their use as direct control agents. These limitations must be considered, and we must find effective means of determining and ensuring constancy and stability in antagonistic activity of selected organisms before using them in decay control. We must understand more fully the genetics of antibiotic-producing microorganisms.

Although direct control treatments with antagonistic organisms have been used successfully for protection of pruning wounds, logging scars or small storage piles, decay control under forest conditions requires wide-scale and longer-lasting effects that may be achieved only through exploiting natural processes. Both the classical approach to biological control, by intensifying existing competition, and the recently developed concept of immunizing commensality have limited value in the forest unless practical means of application can be devised. The artificial inoculation of seedlings with an immunizing commensal suggested by Ricard (1970) may overcome these limitations, or at least on the applicability of wide-scale preventive control.

REFERENCES

Etheridge, D.E.
1969. Factors affecting infection of balsam fir (*Abies balsamea*) by *Stereum sanguinolentum* in Quebec. Can. J. Bot. 47:457-479.

Etheridge, D.E.
1970. *Ascocoryne sarcoides* (Jacq. ex Gray) Groves and Wilson and its association with decay of conifers. In. Bull. No. 13, Fonds de Rech. Forestieres de l'Université Laval, Québec.

Grosclaude, C.
1960. Sur le rôle antagoniste de *Cystospora leucostoma*. L'antagonisme *C. leucostoma* - *Stereum purpureum* in vitro. Bull. Soc. mycol. Fr. 76(2): 163-170.

Grosclaude, C.
1970. Premiers essais de protection biologique des blessures de taille vis-à-vis du *Stereum purpureum* Pres. Ann de Phytopathologie 3: (In press).

Ikediugwu, F.E.O., C. Dennis, and J. Webster
1970. Hyphal interference by *Peniophora gigantea* against *Heterobasidion annosum*. Trans. Br. mycol. Soc. 54(2); 308-309.

Lindgren, R.M. and G.M. Harvey
1952. Decay control and increased permeability in southern pine sprayed with fluoride solutions. J. Forest Prod. Res. Soc. 2(5): 250-256.

Pelhâte, J.
1968. Etude expérimentale des interactions de moisissures caractéristiques des grains. Rev. Mycol. 33: 28 pp.

Ricard, J.L.
1970. Biological control of *Fomes annosus* in Norway spruce (*Picea abies*) with immunizing commensals. Stud. Forest. Suecica, 83: 50 pp.

Ricard, J.
1970. *Scytalidium*, *Trichoderma* et *Ascocoryne* comme commensaux immunisants pour la protection du bois. Commun. au VII Congr. Int. Pour la Prot. des plantes. Paris 21-25 Septembre.

Ricard, Jacques L. and Walter B. Bollen
1968. Inhibition of *Poria carbonica* by *Scytalidium* sp., an imperfect fungus isolated from Douglas-fir poles. Can. J. Bot. 46: 643-647.

Ricard, J.L., M.M. Wilson and W.B. Bollen
1969. Biological control of decay in Douglas-fir poles. Forest Prod. J. 19(8): 41-45.

Shields, J.K. and E.A. Atwell
1963. Effect of a mold, *Trichoderma viride*, on decay of birch by four storage-rot fungi. Forest Prod. J. 13(7): 262-265.

Stillwell, M.A.
1966. A growth inhibitor produced by *Cryptosporiopsis* sp., an imperfect fungus isolated from yellow birch, *Betula alleghaniensis* Britt. Can. J. Bot. 44: 259-267.

Whitney, W.H. and G.G. Wilson
1970. Outside chip storage - effects on sulphite pulping and pulp-quality. Pulp Pap. Can. 71(15): 57-60.

WORKSHOPS

WORKSHOP I. AIR POLLUTION
DISCUSSION OF MONITORING TECHNIQUES

Clint Carlson, Leader

Discussion considered steps that should be taken concerning future work on air pollution effects to forest vegetation. Members of the workshop are concerned how to get current information on forest pollution into responsible council groups where it may aid pollution abatement action. It was decided that:

1. We need a list of people and projects concerned with the effects of air pollution to forests in the WIFDWC area. Paul Miller volunteered to head a committee to do this. Bob Loomis, Russ Lowman, John Wear and Clint Carlson offered to help.

2. WIFDWC members need to work very closely with the Environmental Protection Agency, State air pollution control committees, and city and local groups in order to get relevant data out for publicity and action programs.

3. Persons (WIFDWC) working on forest air pollution problems should try to attend the National Air Pollution Workshop. This is an excellent organization in which to exchange ideas.

4. An internal group in WIFDWC should be established as a permanent function to coordinate and report to our members new and continuing projects on forest pollution.

5. Forest pathologists in general should be aware of possible sources of air pollution and report on suspected damage to forest vegetation.

6. We should encourage participation by Air Pollution Control committee members in WIFDWC discussions on the effects of air pollution on our forest resources.

WORKSHOP II. CULTURE COLLECTIONS
WHERE DO WE GO FROM HERE?

Roger S. Smith, Leader[1]

After some introductory remarks by the leader, we had semi-formalized presentations from five speakers:

1. Ted Scheffer led off with some explanations of techniques used to culture fungi from wood. He discussed the various "chisel" methods for extracting wood samples and mentioned a technique using a hardwood spatulum for separating wood destroying fungi from other less harmful organisms.

2. Jack Roff discussed the need or otherwise, for more cultures of wood inhabiting fungi. He feels that for some of the present working collections we could substitute good dried cultures, photographs, keys, computer data, etc. for the live culture collection. With the rising labour costs and heavy emphasis on applied research, the occasional use (maybe only once or twice a year) of a culture collection could become hard to justify.

3. Stu Whitney then gave a very lucid account of techniques that he uses for hyphal tip isolations. In this way he can be sure that he has isolated a pure culture from the substrate. He discussed materials and methods and showed some slides of tools readily made-up for this delicate work.

4. John Palmer discussed with great energy the position of the culture collection of wood inhabiting fungi that has recently moved from Maryland to Madison. With a total collection of 12,000 different isolates, any sort of modification of keys or techniques becomes extremely difficult. He clearly stressed the importance of external factors such as temperature, relative humidity and medium on the fruiting process in homobandiomycetes and lastly stressed the interesting effects of light quality in this area.

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[1]Forest Products Research Laboratory, Vancouver, British Columbia, Canada

5. Jim Ginns was unable to attend the meeting, so a written presentation from him was read out by the leader. He stated the present position of the Nobles culture collection and some of its previous history. With 3,000 isolates representing 600 species of wood inhabiting fungi, this collection also poses some significant labour problems. Although the total number of isolates identified by Ginns has now fallen, the actual amount of work involved has not fallen in proportion. We are getting left with the difficult fungi. He mentioned co-operation between laboratories and suggested the future value of electronic data processing for alleviating some of the present work pressure.

Lastly, several points were raised from the floor and discussed among the participants. The problem of unification of culture collections was raised but for various political reasons this still seems a faraway dream.

CULTURE COLLECTIONS: DECAYED WOOD TO CULTURE

Ted Scheffer [1/]

Isolation Techniques

Aims:

1. To isolate one or all organisms present, depending on objective. Different kinds--decay, soft rot, stain, and mold fungi, and especially bacteria, may require different media for either culturing or separation in culture. Malt agar is most widely used basic medium. Incorporation of sawdust sometimes helpful (Grant and Savory). Host-wood infusion may help in special cases, e.g., for western redcedar and bald cypress heartrots.

2. To bring what is wanted into pure culture.

[1/] School of Forestry, Oregon State University, Corvallis, Oregon

Procedures, basically two:

1. Extraction of wood specimens individually. Small bits aseptically removed with knife, chisel, or punch. (Small size facilitates extraction of individual species.) Larger specimens removed, as small blocks, increment cores, plugs, etc.--aseptically handled, or flame sterilized when cultured. Enclosure with paradichlorobenzene will protect against contamination prior to flaming. (Larger size facilitates rapid sampling and involvement of more wood, but tends to give more mixed cultures.)

2. Extraction of specimens en masse. As sawdust, obtained with small saw blade or modified drill bit. As small-drill borings.

(These methods approach dilution-plate technique, thus may have greatest potential for isolating <u>all</u> species present. Doubtfully needed for Hymenomycetes only--e.g., Dr. Karrik (Stockholm) success with pole-decay fungi.)

Separations in culture can be troublesome:

Fungi from bacteria, usually easy--by acidification.

Hymenomycetes from molds, often difficult. Greaves and Savory found 200 species of fungi in 4 pieces of wood. No particular trouble at Oregon State University isolating wood rotters from Douglas-fir poles in Oregon.

Necessary at present to rely on numerous isolations and frequent transferring in culture, to obtain desired fungi. Eventually will be more separatory media, e.g., phenolic cpds. to isolate white rotters. Dr. Nilson (Stockholm) adds 1 percent saponin and 0.05 percent streptomycin sulfate to suppress <u>Trichoderma</u> and <u>Gliocladium</u> molds when isolating from chips.

Identification in Culture

Various criteria. For wood-destroying Hymenomycetes, the Nobles system is most widely used.

Primary need often is merely to ascertain if a Hymenomycete is present, e.g.: for commercial inspection of poles in line; at Oregon State University for selecting experimental poles.

1. By microscopical evidence in clamp connections.

2. By colorometric testing of the wood itself, e.g., alizarine red-S for early pine decay by *P. gigantea*; osmium tetroxide for brown rot.

3. By simple, in vitro test of capacity to weaken wood.

Need for Isolating and Identifying Wood-Inhabiting Microorganisms

Basic principle is to know the "enemy"--e.g.:

1. Not until 1954 was soft rot recognized (by Savory) as the result of attack by non-Hymenomycetes.

2. Prior to 1950, it was not known that deterioration of cooling-tower slats in mainly soft rot rather than chemical.

3. Only rather recently did we know that bacteria can damage wood.

To select representative species and strains for accelerated laboratory testing of preservative or natural resistance to microbiological degradation.

To better characterize results of field tests, in order to make them more universally comparable (fungi can be variable even on the same test site).

To select representative species and strains for physiological studies in search of vulnerable attributes (e.g., need for "thiamine" in wood).

To make appropriate selections for study of species successions or combinations possibly significant in decay of wood.

REFERENCES

Grant, G., and J.G. Savory
1968. Method for isolation and identification of fungi on wood. For. Prod. Res. Lab., Princess Risborough, Aylesbury, Bucks. 31 pp.

Greaves, H. and J.G. Savory
1965. Studies of microfungi attacking preservative-treated timber, with particular reference to methods for their isolation. J. Inst. Wood Sci., 3(15): 45-50.

Levy, J.F.
1967. Necessity for developing reliable techniques for the isolation and identification of fungi from wood. Wood, 32(6): 37-39.

Nobles, M.K.
1965. Identification of cultures of wood inhabiting hymenomycetes. Can. J. Bot., 43: 1097-1139.

Okigbo, L.C., H. Greaves, and J.F. Levy
1966. Some aspects of the effect of external environment on the decay of wooden fence posts. Brit. Wood Pres. Assoc. News Sheet, 65: 1-3.

WORKSHOP III. EFFECT OF PEST CONTROL ON ENVIRONMENTAL QUALITY

John M. Staley, Leader[1]

Our discussion attracted 32 participants. It was not purposely restricted but stuck close to disease control measures. We concluded that these measures probably improved environmental quality rather than damaged it. Where abuses occur, other scapegoats are more prominent than are the misuses of pest control recommendations.

The group took their responsibilities towards environmental protection seriously. They felt that guidelines for evaluating environmental impacts are lacking. The tradeoffs between improvement and damage are usually difficult to appraise.

The recent requirement for environmental evaluations, and environmental impact statements on the part of land managers proposing pest control actions, was discussed. The U.S. Forest Service and the State of California both require this type of

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1/Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado

action. In addition, some proposed actions require open public hearings. In California, proposed pest control actions require annual appraisal and scheduling, with provision for emergency actions.

Other positive controls to safeguard the environment include the discontinuance of Hg compounds in nursery disease control and the requirement of registration of chemical agents by area, by species, method and rate of application, and by disease.

The requiring of evaluations and the restriction on chemical use have caused problems which are being worked out as the new requirements are implemented. The restrictions on use of chemicals have raised the need for development of substitute measures. These problems are yet unsolved.

There was expressed a need for guidelines for evaluation of environmental impact. It was concluded that we must continue to work as well as possible with only incomplete understanding to guide us in our responses to the pressures of the environmental movement and to initiate such actions in keeping with our responsibilities as foresters where we see the opportunities more clearly than others.

The contribution of healthy forests to environmental quality was recognized, as were the value of plant symptoms and disease surveys for early warning systems against biologically damaging environmental influences.

The group felt in general that the concern over forest disease control measures was a kind of backwash from the wave of concern over use of insecticides and other pollution problems, but that it is a concern that merits continuing responsible consideration and action.

Several avenues of discussion were not pursued in this session. Among these were the use of biological control agents, genetic resistance against plant pathogens, and licensing of pest control actions. Some of these subjects were, however, covered in other sessions of the 1971 meeting. It is my feeling that the issues raised in this discussion should be repeatedly brought up as elements of future pest control discussions.

FIELD TRIP REPORTS

NEEDLE CAST AND BLISTER RUST FIELD TRIP

About 50 members and guests inspected two ponderosa pine plantations in the Three Cabin area, Tiller District, Umpqua National Forest, where Hart Bynum and George Harvey discussed a relatively new foliage disease of offsite ponderosa pine. The disease, commonly referred to as Bynum's blight, is caused by *Lophodermella morbida* and was first noted in southwestern Oregon in 1967. Since that time it has been detected in 38 plantations in Oregon.

The first "stop" was a "drive-through" of a severely infected plantation. The second stop was for lunch and an inspection of the 1969 work site for epidemiology and fungicide studies. Demonstration trees had been bagged in late May 1971 to show the difference in current year needle health between foliage exposed to the spore cast and foliage which had been protected for the entire sporulation period. Field studies indicate that:

1. The hysterothecia open and spore discharge occurs during rainy periods during June and early July.

2. The disease does not appear to be systemic; i.e., needles protected from spore cast remain healthy until normal needle drop from the tree.

3. The organism appears to infect only juvenile needles just emerging from the fasicle sheath. Foliage protected in the juvenile stage one year does not become infected as mature foliage in subsequent years.

4. Several fungicides applied as protectants have been moderately successful. Timing is all-important. Secondary needle fungi become very important when *L. morbida* is apparently "knocked back." Fungicide trials will continue.

5. Other western hard pine and east side ponderosa pine have been outplanted at the Umpqua and Willamette study sites. Some infection has taken place, but no formal evaluation of results has been made as yet.

The field trip concluded with a tour of the Bureau of Land Management Rust-Resistant Sugar Pine Seed Orchard at Merlin, Oregon. Gerry Barnes, Project Leader of the Dorena Seed Orchard project, Umpqua National Forest, explained the goals and direction of his program and those of the BLM. Rust-resistant western white pine and sugar pine will be available in the near future. Pete Prack, Forester, BLM, led a tour of the seed orchard facility which is currently undergoing expansion.

WHITE FIR DEFECT FIELD TRIP

Approximately 50 members and guests attended an all day field trip to the Snowy Butte area, Butte Falls Ranger District, Rogue River National Forest, where Paul Aho discussed and showed examples of decay problems he is studying in white fir (*Abies concolor*). Fourteen trees were felled and bucked before the field trip to illustrate the more important problems. Paul indicated that *Echinodontium tinctorium* causes a very high percentage of the total decay in white fir and that conks of this fungus are the most important and reliable indicators of defect. Group discussion on how this fungus infects a tree was very interesting, especially Dave Etheridge's description of *E. tinctorium* infection of western hemlock. Basal scars, especially old fire wounds, are the second most important indicator of decay. While many hymenomycetes can and do enter white firs through these injuries, *Pholiota adiposa* does so most commonly. Of special interest to many attending the field trip was a canker rot of both white and red (*A. shastensis*) firs presumably caused by *Fomes pini*. Nomenclature for this fungus is still under study. Conks of this fungus are the third most important defect indicator. However, because the amount of decay associated is so erratic, it is difficult for cruisers and scalers to make accurate defect estimates for individual trees or logs.

COMMITTEE MEETINGS

DWARF MISTLETOE COMMITTEE REPORT

Robert F. Scharpf, Chairman 1/

Mistletoe Research and Development Activities

I. Taxonomy, Hosts and Distribution

A. The manuscript for a monograph on the taxonomy and biology of the dwarf mistletoes was submitted for publication as a USDA monograph last summer, galley proofs were returned in March 1971, so publication should be sometime this fall. - F.G. Hawksworth, USFS, Fort Collins, and D. Wiens, University of Utah.

An unusual infection center of *Arceuthobium cyanocarpum* on *Pinus ponderosa* was found near Boulder, Colorado. The situation is unique because it is in pure ponderosa pine, and no limber pine, the usual host of *A. cyanocarpum* in this area, occurs perhaps within 5 miles or so. Also, this center is at an elevation of about 6,100 feet which is over 2,000 feet lower than the main population of the species on limber pine. J. Fisher, Colorado State University, and F.G. Hawksworth, USFS.

A pinyon (*Pinus edulis*) infected by *A. divaricatum* was found at Fort Collins, Colorado. The tree had been transplanted 3 years previously, apparently from New Mexico. The discovery is of interest because the parasite is thriving in an area nearly 300 miles north of its northern limits on the east slope of the Rockies. F.G. Hawksworth, USFS.

The limber pine dwarf mistletoe (*A. cyanocarpum*) was found for the first time in the Sangre de Cristo Range in southern Colorado. This locality is about 50 miles southwest of the previously known southern limits of the species in Colorado on Pikes Peak. - F.G. Hawksworth, USFS, and

1/Forest Disease Research, Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, Berkeley, California

J.G. Laut, Colorado State Forest Service.

The fir dwarf mistletoe (presumably A. abietinum f. sp. magnificae) has been found for the first time on Abies lasiocarpa. The discovery was made in the Marble Mountains in northern California. - D.V. Hemphill, Pacific Union College, California, and F.G. Hawksworth, USFS.

Three new hosts for A. cyanocarpum were found on the San Francisco Peaks, Arizona. The principal host for this dwarf mistletoe here is Pinus aristata, but it was found occasionally on Picea pungens and Abies lasiocarpa var. arizonica and rarely on Pinus stobiformis. The latter three are "new" hosts for this species. - F.G. Hawksworth, P.C. Lightle, and M.J. Weiss, USFS.

The limber pine dwarf mistletoe, Arceuthobium cyanocarpum, was found for the first time in the Bighorn Mountains in northern Wyoming. A heavily infected limber pine stand was noted east of Hyattville in Bighorn County. This area is about 60 miles south of the closest previously known distribution of the parasite on the Crow Indian Reservation in southern Montana. - Don Brown, USFS, Denver.

B. Arceuthobium americanum was collected for the first time on Picea glauca in British Columbia during the 1970 field season. - J.A. Baranyay, Pacific Forest Research Centre, Victoria, British Columbia.

C. The first collection of A. laricis on Abies grandis in British Columbia was made south of Slocan Lake by E. Morris, Forest Insect and Disease Survey.

Arceuthobium tsugense was found on Sitka spruce near Corvichan Lake, Vancouver Island. This location is about 350 miles south of the only previously known locations for this combination near Ketchikan, Alaska and Kitimat, British Columbia.

II. Physiology and Anatomy

A. Studies on the anatomy of the pollen grains of Arceuthobium were continued. Methods being used include scanning electron microscope and conventional palynological techniques. About one-third of the genus have been analyzed to date and many distinctive features of the various species are apparent. It is hoped that, when the analyses of the genus are completed, specific identification by pollen may be feasible. It would then be possible to compare modern and fossil Arceuthobium pollen as an aid in interpreting past forest history. - Estella Leopole, U.S. Geological Survey, Denver, and F.G. Hawksworth, USFS.

B. A manuscript on "Light affects penetration and infection of pines by dwarf mistletoe" has been submitted for publication. - Robert F. Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

C. I'm currently investigating host specificity of Arceuthobium tsugensis. Seeds of A. tsugensis germinate and develop on various flowering plants, although generally dying before establishing parasitism. The reasons for this failure to infect are being studied to determine the physiological or morphological basis for reactions on nonhosts. This study will be expanded this fall to include other Arceuthobium species and additional nonhosts. - Dr. Robert Tinnin, Portland State University, Portland, Oregon.

A comparative study of the anatomy of the epidermis of Phoradendron flavescens, P. californicum, P. juniperinum var. libocedri, P. bolleanum, and Arceuthobium campylopodum. Anatomy of vascular tissues and sclerenchyma in the above named species of Phoradendron. Anatomy of the endophytic system of Phoradendron juniperinum. Anatomy of the endophytic system of Arceuthobium tsugensis. Electron microscopy of the endophytic system of Arceuthobium campylopodum. - Dr. Clyde Calvin, Portland State University, Portland, Oregon.

D. A study is near completion on the anatomical changes of both host and parasite at the time of penetration of young ponderosa pine by Arceuthobium campylopodum. - Null, Calvin, Portland State University, Portland, Oregon, and Knutson, USFS, Corvallis.

E. Preliminary research seems to indicate that the difference between the maximum values of water potential for ponderosa pine and A. vaginatum is quite small, if it exists, near the lower elevational limits of the parasite (6,000 feet). At higher elevations, the difference is much greater (the potential of the mistletoe being more negative). Since the maximum values determined for the dwarf mistletoe shoots harvested at different elevations were similar, the difference in water potential appears to be primarily a function of host water stress. Similar work is underway to determine if water stress determines the distribution of A. vaginatum at Grand Canyon, Arizona. - J.T. Fisher and C.P.P. Reid, Colorado State University.

F. A. vaginatum seeds that had begun to swell were placed in atmospheres of different relative humidities to determine the effects on germination. Seeds placed in atmospheres with relative humidities of 5.5, 8.0, 20.0, 33.0, 54.5, and 74.5 percent for two weeks failed to germinate. Seeds placed in an atmosphere with 96.4 percent relative humidity showed 62 percent germination. J.T. Fisher and C.P.P. Reid, Colorado State University.

III. Lifecycle Studies

A. A manuscript is in preparation on the pollination ecology of A. americanum in lodgepole pine. Studies were conducted on the Wasatch National Forest in northern Utah and on the Roosevelt National Forest in northern Colorado. Insects are the primary pollination agents. Many insects (at least 20 species, mainly flies and ants) are involved in pollination of A. americanum. Wind dispersed pollen only to distances of less than a meter or so. - Sue Gregor and D. Wiens, University of Utah; R.E. Stevens and F.G. Hawksworth, USFS, Fort Collins.

Further evidence of the limited effects of wind in pollination of Arceuthobium was obtained in a grove of transplanted ponderosa pines in Denver. Several trees, many of which were infected by A. vaginatum subsp. crytopodum, were transplanted about 35 years ago from the nearby foothills. In August 1971, 14 of about 100 trees were infected--all with only low bole infections. Five of the trees had staminate infections and nine had pistillate infections. Although most of the trees with pistillate infections were within 12 to 15 feet of trees with staminate plants, no fruits had been pollinated. The staminate plants had flowered in the spring as evidenced by remnants of open flowers. Presumably the normal complement of pollinating insects are absent in this artificial situation, and wind alone was not able to effect pollination. - F.G. Hawksworth, USFS, and J. Fisher, Colorado State University.

B. Greenhouse grown ponderosa pine (1-2 years old) dwarf mistletoes flowered in February 1971 (day length - 10 hours). These plants produced mature fruits by late July. The natural overwintering of the embryo apparently is not necessary for normal physiological development of the fruits.

A manuscript is in preparation on various aspects of ponderosa pine dwarf mistletoe seed, including radicle growth under different regimes, post-harvest dormancy, tropistic responses of growing radicles, and effects of freezing on seed survival. - Knutson, USFS, Corvallis, Oregon.

C. On October 15-18, 1968, 5 pinyon pine trees were inoculated with 561 freshly collected seed of A. divaricatum. On June 23, 1970, one infection from these inoculations had produced a very short aerial shoot. On August 3, 1971, two additional infections had produced short shoots and a number of swellings were noted. The trees will be kept under observation for several more years to determine the length of time elapsed between exposure to infection and the appearance of aerial shoots. - Paul C. Lightle, Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico.

IV. Host-Parasite Relations

A. Two manuscripts that deal mostly with spread of dwarf mistletoe into ponderosa and Jeffrey pines in California have been submitted for publication. They are entitled (1) Seed production and dispersal by dwarf mistletoe in Jeffrey pines in California and (2) Spread of dwarf mistletoe from discrete seed sources into young stands of ponderosa and Jeffrey pines. - Robert F. Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, and J.R. Parmeter, University of California, Berkeley.

B. Spread and intensification plots in thinned ponderosa pine were established in Fiscal Year 1971 in two widely separated areas in Oregon. The plots will be maintained for 10 or more years.

A series of three joint I&DC-FDR administrative/research studies of the intensification of mistletoe in ponderosa pine are planned, preliminary work will begin in Fiscal Year 1972. Brief descriptions of each study follow:

1. Study the effects of spacing and infection level before thinning on ponderosa pine mistletoe after stand treatment, 5 to 7-inch d.b.h. class.

2. Same as No. 1, except all size classes will be included.

3. Study the effect of site on intensification of ponderosa pine mistletoe.

Similar studies will be established in eastside and southwest Oregon Douglas-fir as funding and manpower permit. - John T. Wortendyke, Region 6, Portland, Oregon.

C. This summer I'm taking data on the distribution of dwarf mistletoe on thinned ponderosa pines. Hopefully, this will throw further light on our ability or inability to live with stands infected by this pest. - Lewis F. Roth, Oregon State University, Corvallis, Oregon.

D. Hemlock dwarf mistletoe was found for a second time on Sitka spruce in Alaska. - Thomas H. Laurent, Institute of Northern Forestry, Juneau, Alaska.

V. Effects on Hosts

A. A research paper on a technique for simulating the effects of dwarf mistletoe on yields of lodgepole pine is in press. Also, a manuscript using the same technique to estimate losses in southwestern ponderosa pine is nearly completed. The method has a great many potential applications in pathology not only for dwarf mistletoes, but for other diseases as well. - C.A. Myers, F.G. Hawksworth and J.L. Stewart, USFS.

A study is underway investigating the effects of dwarf mistletoe (Arceuthobium americanum) on the wood properties of Rocky Mountain lodgepole pine. Three comparisons were made using a one-way analysis of variance as the test of significance. The three comparisons are: (1) between wood from a non-infected tree (control) and infected wood; (2) between wood from a non-infected tree (control) and non-infected wood from an infected tree; (3) between infected wood and non-infected wood from an infected tree.

Preliminary observations indicate: (1) a decline in modulus of elasticity, modulus of rupture, and work to proportional limit in infected wood; (2) a higher specific gravity in infected wood; (3) a higher percentage of pitch in infected wood; (4) an increase in longitudinal shrinkage in infected wood; (5) a higher percentage of latewood in non-infected trees; (6) a wider growth ring in non-infected trees; (7) a narrow growth ring in the non-infected regions of an infected tree.

Tracheid length and fibril angle measurements are still under observation. The study should be completed in December 1971. - Douglas R. Piirto, Colorado State University.

B. Impact of dwarf mistletoe on true firs in California is still being investigated. Preliminary results suggest that "released" trees or trees not suffering from overstory suppression suffer little impact from dwarf mistletoe. - Robert F. Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, and Neil MacGregor, Region 5, San Francisco, California.

C. Four hemlock dwarf mistletoe-infected western hemlock stands were sampled representing three age classes, ranging from 40 to 120 years. In all, 184 trees were cut in various infection classes for stem analyses to study the impact of the disease on western hemlock. - J.A. Baranyay, Pacific Forest Research Centre, Victoria, British Columbia, Canada.

D. A quantitative study of mistletoe effect on western hemlock is being planned. This study will be conducted and financed by I&DC in the Regional Office. - Thomas H. Laurent, Institute of Northern Forestry, Juneau, Alaska.

E. The September issue of Forest Science should contain a paper I prepared, of rather "spin off" nature drawing attention to the importance of competition among trees in aggravating mistletoe damage--"Effect of mistletoe on growth of small ponderosa pines." Lewis F. Roth, Oregon State University, Corvallis, Oregon.

F. In connection with a study on wetwood in white fir, the effects of dwarf and true mistletoe on lumber properties such as grade, volume, degrade and overrun also were explored. The data are still under analysis but currently suggest few significant effects attributable to either type of mistletoe when the confounding effect of differences in log diameter is controlled statistically. One exception was the volume of boards in shop grades which was significantly higher for logs containing dwarf mistletoe than for logs without detectable defect, even after controlling for diameter. - W. Wayne Wilcox, University of California, Richmond, California.

G. Impact of infection on tree growth is reflected in comparisons of root length and weight. On 11 matched pairs of one-year old ponderosa pine seedlings, infected trees had shorter roots (95 vs. 128 cm) and weighed less (620 vs. 900 mg) than roots of corresponding uninfected trees. - Knutson, USFS, Corvallis, Oregon.

VI. Ecology

A. "Increase of dwarf mistletoe infections on young lodgepole pine."--Submitted for publication in Canadian Journal of Forest Research. "Dwarf mistletoe spread in young lodgepole pine stands in relation to density of infection sources."--Bi-monthly Research Notes. Volume 26(5) September-October, 1970. - John A. Muir, Canadian Forest Service, Forest Research Laboratory, Edmonton, Alberta.

B. Field tests were initiated in the fall of 1970 to determine the relative rates of survival of seed of *A. tsugense* (from lodgepole pine and western hemlock), *A. americanum* and *A. douglasii* planted in 4 bioclimatic zones in British Columbia. Overwintering success was indicated by percentage of seeds retained on the branches, percentage shrivelled (non-viable) and percentage with visible radicles. The results of May 1971 inspections for percentage of seeds with radicles are shown in the table below. Most interesting was the absence of viable seeds of *A. douglasii* at the 130-Mile Lake site in the Cariboo. This location is well north of the present range of Douglas-fir dwarf mistletoe in British Columbia. *A. tsugense* seeds (from hemlock) survived in the Interior Hemlock Zone but at a rate about half that indicated for the Coastal

Western Hemlock Zone. A. americanum seeds germinated at a higher rate in the Coastal Western Hemlock Zone where it is absent, and in the Interior Western Hemlock Zone where it is not common, than within one of its natural locations (Cariboo Aspen - Lodgepole pine-Douglas-fir). The trials will be repeated this fall. - Richard B. Smith, Canadian Forestry Service, Canada.

Dwarf Mistletoe	Tree species planted on	Bioclimatic Zone[1/]			
		1	2	3	4
		% with radicles			
A. douglasii	Douglas-fir	NP[2/]	17	8	0
A. tsugense (hemlock)	Hemlock	44	NP	22	NP
A. tsugense (hemlock)	Lodgepole pine	48	NP	22	NP
A. tsugense (L. pine)	Hemlock	72	NP	74	NP
A. tsugense (L. pine)	Lodgepole pine	62	NP	59	NP
A. americanum	Lodgepole pine	81	NP	82	52

1/ 1.=Coastal Western Hemlock - Victoria Watershed
2.=Interior Douglas-fir - Oyama (Okanagan Valley)
3.=Interior Western Hemlock - New Denver (Slocan Lake)
4.=Cariboo Aspen - Lodgepole Pine - Douglas-fir - 130-Mile Lake (15 miles north of Lac la Hache).

2/ NP = No seeds planted.

C. A manuscript has been submitted detailing a mechanism of potential defense against mistletoe infection by Prosopis juliflora (mesquite). - Calvin, Cowles, Null and Tinnin, Portland State University, Portland, Oregon.

D. Dry seed of ponderosa pine dwarf mistletoe seeds survived freezing better (30 percent) than wet or soaked seed (1 percent). This could have predictive value if it applies to field seed, i.e., if winter freezing is preceded immediately by rain, a low level of new infections will occur the following spring.

Ponderosa pine dwarf mistletoe seed storage techniques for year-around retrieval have been published as PNW-145, 8 pages, entitled, "Dwarf mistletoe seed storage best at low temperature and high relative humidity." - Knutson, USFS, Corvallis, Oregon.

VII. Control-Chemical

A. The chemical control tests at Bandalier National Monument will receive the final examination this fall. Evaluation will follow the examination and a report will be written next spring. - Paul C. Lightle, Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico.

B. Preliminary greenhouse tests using young infected ponderosa pine show that growth regulators will translocate from the lower bole and selectively kill established dwarf mistletoe infections. - Knutson, USFS, Corvallis, Oregon.

VIII. Control-Biological

A. As part of an invited paper to the 1971 I.U.F.R.O./F.A.O. symposeum on biological control of forest diseases, the parasitic fungi on Arceuthobium in North America were summarized. Ten fungi that attack shoots are known: Colletotrichum gloeosporioides, Wallrothiella arceuthobii, Septogloeum gillii, Pestalotia (3 sp.), Nectria (2 sp.), Alternaria tenuis, and Metasphaeria wheeleri.

Also, data on five "canker-fungi" syndromes (fungi that inhabit the host cortex and associated mistletoe endophytic system) are summarized. It is suggested that the most promise for biological control of the dwarf mistletoe may be through introduction of shoot-feeding insects or encouragement of canker-fungi. - F.G. Hawksworth, USFS, Fort Collins, Colorado.

The disease termed "Resin Disease" has been observed on infections of Arceuthobium americanum (on lodgepole pine) for many years. Sample plots in areas where the disease is present at epidemic levels indicate that approximately 90 percent of the dwarf mistletoe infections have shoot mortality of 1/3 or more. Typical symptoms include extensive resin flow from the bark and a resin soaked appearance of the shoots. The disease is of the canker type and apparently causes little damage to the lodgepole pine branches. Isolations have yielded approximately 15 species of imperfect fungi. Preliminary results of field inoculations indicate that two species may be involved, with up to 50 percent of those inoculations resulting in infections. - Walter Mark, Colorado State University.

B. *Colletotrichum gloeosporioides* was found for the first time on *Arceuthobium californicum* in northern California. - Robert F. Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

C. The fungus parasite of dwarf mistletoe shoots called *Septogloeum gillii*, D.E. Ellis, appears to be a species of *Cylindrocarpon*. A valid name for the fungus will be published soon. - John A. Muir, Canadian Forest Service, Edmonton, Alberta, Canada.

D. A manuscript has been submitted on techniques for year-around propagation of young infected ponderosa pine seedlings. These seedlings will be used to evaluate various control methods.

A research prospectus has been submitted which will evaluate *Colletotrichum gloeosporioides* as a control agent for dwarf mistletoes. - Knutson, USFS, Corvallis, Oregon.

IX. Control-Silvicultural

A. Plots to demonstrate the practicability of control of ponderosa pine dwarf mistletoe (*A. vaginatum* subsp. *cryptopodum*) in recreation-residential-urban forests have been established in three different forest areas in Colorado. These plots, where control consisted of pruning lightly and moderately infected trees and felling heavily infected ones, are mostly on private lands. About three or four more plots are planned in other ponderosa pine areas in the State. Also, similar plots will be established in lodgepole pine. - J.G. Laut, Colorado State Forest Service, and F.G. Hawksworth, USFS, Fort Collins.

B. Control in Fiscal Year 1971 was completed by 13 Forests on about 9,500 acres by sanitation thinning, destruction and regeneration after logging, and removal of infected overstory from newly regenerated areas.

An administrative study of the effects of pruning mistletoe brooms from old-growth ponderosa pine has been initiated. - John T. Wortendyke, Region 6, Portland, Oregon.

C. The validity of hypotheses from items IV and V I have listed above can only be tested by growth studies. We are accordingly modifying old thinning plots in infected pine stands at Pringle Falls to provide this test. - Lewis F. Roth, Oregon State University, Corvallis, Oregon.

D. Completed installation of study in Douglas-fir concerning the effects of thinning on intensity of dwarf mistletoe and on growth of trees, and have completed half of the establishment work concerning the same study in lodgepole pine. Reference: Study Plan for the Establishment of a Dwarf Mistletoe Growth Impact, Associated Mortality, and Spread and Intensification Study in Infected Stands of Douglas-fir, Lodgepole Pine, and Western Larch. - Oscar J. Dooling, Region 1, Missoula, Montana.

E. Control evaluation plots at Grand Canyon and Mescalero were examined during 1970. The data from Grand Canyon has been worked up and a report written which evaluates the control effort after 20 years. The conclusion reached was that the control measures applied have been effective in reducing the level of infection without undue alteration of, or disturbance to, the ponderosa pine stands in the treated area. These stands are now thrifty, relatively free of dwarf mistletoe, and contain ample reproduction to insure the perpetuation of ponderosa pine along the East Rim Drive. This report will not be published or widely circulated; however, a Station Research Paper covering the whole Grand Canyon project, and containing much of the report material, is planned for this fiscal year by Hawksworth and Lightle. The Mescalero data will be worked up and a report written this fall. - Paul C. Lightle, Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico.

X. Surveys

A. "Survey of dwarf mistletoe incidence in a young lodgepole pine forest." Submitted for publication Bimonthly Research Notes. - John A. Muir, Canadian Forest Service, Edmonton, Alberta, Canada.

B. Detection and presuppression surveys based upon the 6-class mistletoe rating system were completed by 16 forests on about 160,000 acres in Fiscal Year 1971.

Efforts to adapt the 3rd nearest neighbor sampling techniques developed for lodgepole pine in the Rocky Mountains will begin in Fiscal Year 1972. - John T. Wortendyke, Region 6, Portland, Oregon.

C. The land manager needs reasonably accurate data on the intensity and distribution of dwarf mistletoe in order to determine feasibility and priority of treatment in timber stand improvement work. A survey procedure to collect the data is being field tested in Colorado and Wyoming in 1971 for operational use in 1972.

The patchy and aggregated distribution of dwarf mistletoe necessitates a special sampling scheme to obtain reasonably accurate data about the disease. A survey design involving separate extensive and intensive sampling phases and requiring stand reentry to complete is now being tested. The extensive phase involves data collection from sample plots and mapping of dwarf mistletoe-infected areas. The intensive phase requires reentry to collect data from additional sample plots in only the infected portions of the stand. Stand data is collected simultaneously with the dwarf mistletoe information, then assimilated for use in a simulated yield program developed by Dr. Hawksworth et al. The computerized program provides yield tables, reflecting any impact from dwarf mistletoe, which will help the land manager in making management decisions. - Don Brown, Region 2, USFS.

XI. Miscellaneous

A. The Hawksworth Mistletoe Index, which is being put on computer tape for "instant" information retrieval, is nearly ready for use. About 98.7 percent of the citations used are now on tape, most of the editing has been done and, barring any budget freezes, the index should be ready for use by January 1972. - Robert F. Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley; F.G. Hawksworth, USFS; and E. Wicker, Intermountain Forest and Range Experiment Station.

B. The Dwarf Mistletoe Glossary Committee compiled and defined over 160 terms, and prepared 18 illustrations. The Glossary is in the final draft stage and will be presented to the membership for discussion during our meeting. The publication will be printed and distributed in October as a Pacific Forest Research Center Special Paper. - J.A. Baranyay, F.G. Hawksworth and R.B. Smith, Glossary Committee.

C. I would like to report the completion of the simulation model of the western dwarf mistletoe - ponderosa pine system. Dr. Lewis Roth and I have not begun publication of the results, but we hope to begin preparation of the manuscript shortly. I will give a brief talk at WIFDWC concerning the model. The simulation is a one-year increment, stochastic model. It consists of four major submodels: tree crown, mistletoe plant fertility, infection transfer and infection establishment. - Mary Ann Strand, Oregon State University, Corvallis, Oregon.

D. M.S. Thesis - This study will be an investigation of nutritional and metabolic aspects of dwarf mistletoe infections to determine the relative contributions of the host phloem and xylem to the welfare of the parasite by means of ringing experiments correlated with morphological studies. - Patti Barnhart, Portland State University, Portland, Oregon.

M.S. Thesis - This work involves improving methods of aerial survey and evaluation of coniferous trees infected with mistletoes. It is basically a biophysical problem, i.e., detection changes in the physical properties of the trees and correlating them with physiological changes caused by the mistletoe infections. - Bill Brea, Portland State University, Portland, Oregon.

M.S. Thesis - This study is a comprehensive investigation of the distribution of Arceuthobium douglasii in Douglas-fir on the west slopes of the Cascades in Oregon, to be completed by June 1973. - K. Still, Portland State University, Portland, Oregon.

Ph.D. Thesis - I am investigating in detail the anatomical changes which occur in both the host, ponderosa pine, and the parasite, _Arceuthobium compylopodum_, during and immediately following the penetration of pine tissue by the mistletoe. Both light and electron microscopy are being used to determine the anatomical changes in both plants which must occur for the establighment of the parasitic state. - Richard Null, Portland State University, Portland, Oregon.

Summation of Tests for Chemical Control of Dwarf Mistletoe

Robert F. Scharpf

Prologue

This report is an attempt to present a brief summary of the tests for chemical control of dwarf mistletoes in the Western United States. Previous workers summed up the tests to 1962 and these are included here as part of the current summation. In making a compilation of this type, it should be understood that any attempt only approximates the work that has been done. Incomplete tests, tests underway and the multitude of variables among the tests makes the reporting of details nearly impossible. Therefore, the following report is presented to familiarized researchers and disease control people with a general picture of the present and past tests on chemical control of dwarf mistletoes.

A. Summation of tests made up to 1955 (reported in the proceedings of the 3rd WIFDWC).

1. 5 agencies reporting

2. 260 tests applied

   a) 209 initial sprays
   b) 32 resprays
   c) 19 injections

3. One or more concentrations of 59 separate formulations, mixtures or trade products.

4. Results - None of the formulations met the ideal requirements of killing the dwarf mistletoe plant without killing the host.

B. Summation of tests made from 1955-1962 (reported in the proceedings of the 10th WIFDWC).

1. 3 agencies reporting

2. An estimated 50 tests applied involving about 20 different chemicals on several different mistletoes.

3. Results - Some promising materials suggested for direct control of dwarf mistletoes on pines. Further tests needed.

C. Summation of tests made from 1962 to 1971 (Table 1).

1. 8 agencies reporting

2. About 25 tests applied involving various concentrations of 9 different chemicals and several different species of dwarf mistletoe.

3. No promise of chemical control in all tests except one. Even in this instance, the product is being dropped by the manufacturer who does not consider the market worth developing.

Table 1. Summary of tests for chemical control of dwarf mistletoes (1962-1971)

Agency	Chemical	No. Trees (or infections) Treated	Remarks
USFS, R-5 (MacGregor)	2,4DA; 2,4DP; 4, CPA 2,4 DA; 2,4,5 TP; water-oil	711	Further development work needed
USFS, R-5 (MacGregor)	Stove oil; control	640	No results to date
USFS, R-5 (MacGregor)	2,4,5TP; 2,4 D control	160	No results to date
USFS, USFS, RMF &REF, Albuquerque & U.S. Park Service Bandalier, NM (P. Lightle; E. Lampi)	2,4,5 TP	432	Final reading will be made in fall of 1971.

Agency	Chemical	No. Trees (or infections) Treated	Remarks
USFS, RMF & RES (Hinds, Stewart, Hawksworth)	2,4,5 TB; 2,4,5 TP	105	Not promising for control
	Bidrin; Di-Syston	40	Not promising for control
	Meta-Systox-R; Di-Syston	75	Not promising for control
(Feetmore McCreeters)	K-9-P	Many	Practicability uncertain
Canadian Dept. of Forestry, Victoria, B.C. (L.C. Weir)	Meta-Systox-R	50	Not promising for control
USFS, Ogden, Utah (Al Tegethoff)	2,4,5, TP	120	No results to date
UC, Berkeley (Art McCain)	2,4,5,TP	60	Not promising for control
California Div. of Forestry (Dick Hunt)	2,4-D	14	Questionable use for control
Natural Resources Mgt. Corp. (W.D. Thomas, Jr.)	Paraquat	15	Not promising for control
	Ortho XE-175	35	Shows promise for control

Epilogue

The search for a practical chemical control of dwarf mistletoe, like the search for the origin of man, continues. Like early day ethnologists and paleontologists, we had good evidence to suggest that our goals could be achieved. Certainly our understanding of the evolutionary sequence of eohippus through to the modern day horse was not particularly difficult to come by. Likewise, with the development and use of highly selective herbicides for weed control in agriculture, a selective chemical control of a small parasitic mistletoe seemed simple indeed. Unfortunately, after many years, we are no closer to finding a suitable selective control for mistletoe than our noted colleagues are to finding the answers to our own origin. It is even possible that in both cases the secrets are locked in antiquity. However, the quest for knowledge goes on, and deep within the heart of the western pathologist lies the belief that the key to the chemical control of dwarf mistletoes, like the missing link in the understanding of the origin of man, will someday be found. At that time, we will rightfully be able to take our place beside our good friend, the horse.

FOREST DISEASE CONTROL COMMITTEE REPORT

L. C. Weir, Chairman[1]

In view of the almost complete lack of support in the form of reports of forest disease control tests being conducted by Conference members, a re-assessment of the need for such a committee seems advisable.

To avoid misconceptions and/or misunderstanding, it was proposed by the chairman of the committee that he reiterate the purpose and membership in the committee for consideration of the Conference members and that its status be resolved during the business meeting at the 1972 meeting.

The following extract has been condensed from the business portion of the 14th Proceedings:

> A committee has been proposed to present annually, to WIFDWC members, the results of all forest disease control tests con-

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[1] Forest Pathologist, Oregon State Forestry Department, Salem, Oregon

ducted by the Conference membership. The tests would be reported in three categories: chemical, biological and silvicultural.

Members of the conference who were actively engaged in forest disease control work and present at the 14th annual meeting were appointed to the committee. At the 18th annual meeting, the committee membership was expanded to include those whose research involved control testing albeit not as a primary purpose for the research. Thus, as it stands at the moment, those whose work includes control testing should send in results of the tests for membership perusal. Since, as stated, the response to requests for results has been very disappointing, the proposal for re-assessment of the need for the committee was made. Members who attend the 20th annual meeting in 1972 should be prepared to discuss abandonment or continuation, the latter implying full and complete support.

FOREST DISEASE RECREATION HAZARD COMMITTEE REPORT

Lee A. Paine, Chairman [1]

Side Effects

When formal collection of records of mechanical failures on recreation sites began, over 40 percent of failures were causing property losses, bodily injuries or fatalities. Since that time, the proportion has been decreasing to a level of 10 percent in 1970. This suggests at least a 75 percent reduction in the accident rate since the first and second years previous to general use of the Tree Failure Report form. We strongly suspect that the encouraging trend in accident reduction has been largely a result of the tree hazard research program by making recreation site managers and administrators more aware of existing hazard on recreation sites. Once aware of the potentials for loss, a local manager can often reduce hazard to a fraction of its previous level without serious ecological or esthetic losses to the site.

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[1] Forest Disease Research, Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, Berkeley, California

Beware of Conifers

Of the 4,500 failure records analyzed to date, 58 percent were in conifers, oaks accounted for only 7 percent, and other hardwoods contributed 35 percent. Approximately 3/4 of all losses were suffered by recreationists and/or resulted from bodily injuries or fatalities. The other 1/4 were losses to fixed property. For all accidents, the mean loss was greatest for conifers, then hardwoods exclusive of oaks, and lastly oaks.

The average loss caused by conifers to recreationists was an astonishing $5,800. This includes all d.b.h. classes and failure classes such as limbs. Recreationists suffered an average $1,860 loss in accidents caused by hardwoods other than oak, but only $327 loss from oak accidents. Only for oaks does the average loss for fixed property run somewhat higher than for recreationists. The overall mean loss per accident for all species and sizes and for both fixed property and recreationists was nearly $1,500.

Publications

The necessity for managing hazard within economic, ecological and esthetic limits dictates an evaluation of hazard for each individual situation to provide for a reasonable rating and selection procedure. Research Paper PSW-68/1971, "Accident hazard evaluation and control decisions on forested recreation sites" was issued this year with suggestions for realistic evaluation of hazard. Damage potential tables provide the basis for making evaluations and identification of the factors involved in hazard help the recreation manager to arrive at logical and consistent decisions. However, we feel that the level of hazard control to be maintained should be a management decision, best made at the regional level for each organization. A publication to assist administration in setting this level is in preparation.

Scope of Reports

Failure reports are now being received from all regions including Hawaii and Alaska, although they have not been formally requested from areas east of the Mississippi River.

Frequent requests for field assistance in problem areas, for training, and for assistance in legal investigations suggest a need for service specialists in this field and for teams of specially trained inspectors for evaluation of hazard on recreation sites, power line rights-of-way, and leasee and concession areas.

NEW OR MODIFIED PROJECTS[1/]

United States Forest Service

Region 1 - Development of impact determination methods for root diseases. Development of impact determination methods for natural rusts.

Region 2 - Development of a dwarf mistletoe survey impact procedure for 15- to 40-year old lodgepole pine stands. Costs so far have been $2 to $3 per acre.

Region 3 - Using simulated yield study equations to prepare thinning contracts for dwarf mistletoe-infected pine stands.

Region 4 - No answer.

Region 5 - Preliminary root disease impact survey. This is a cooperative project being conducted by Pest Control, R-5, U.C., Berkeley and PSW--Mike Srago, Jim Byler, Dick Smith and Dick Parmeter.

Dermea pseudotsugae survey--Mike Srago, Pest Control, R-5.

Smog Impact Survey on the San Bernardino National Forest--Mike Srago, Ken Swain, Pest Control, R-5; Paul Miller, PSW.

Aerial photography and root disease surveys. Mike Srago, Jules Caylor, Pest Control, R-5; Fields Cobb, U.C., Berkeley.

Limb rust study. Dave Nelson, INT Station; Jim Byler, Pest Control, R-5.

Impact evaluation of white pine blister rust--Jim Byler, Neil MacGregor, Pest Control, R-5.

Region 6 - Pruning dwarf mistletoe brooms from old-growth ponderosa pine (administrative study).

Monitoring populations of *Fusarium* and *Pythium* spp. at the Bend Nursery.

1/ A complete up-to-date list will be published in the 1972 Proceedings.

Development of root rot surveys for the Douglas-fir forest type. (Cooperative project with Pacific Southwest and Pacific Northwest Forest and Range Experiment Stations and the Oregon State Forestry Department.)

Pacific Northwest F.R.E.S.

Distinguishing living and dead endophytic tissues.

Effects of light and temperature on development of dwarf mistletoe.

Pacific Southwest F.R.E.S.

Influence of the forest canopy on total oxidant concentrations (Dave R. Miller).

Impact of dwarf mistletoe in released stand of red fir in California. (An administrative study, N. MacGregor, Region 5 and R.F. Scharpf, PSW). Field study to determine if impact of dwarf mistletoe in released stands is great enough to require special protection measures or special criteria in choosing stand for release cutting.

Incidence of dwarf mistletoe in red fir regeneration (an administrative study, N. MacGregor, Region 5 and R.F. Scharpf, PSW). A field study to determine the interval following logging before regeneration adjacent to or surrounded by infected overstory must be removed to prevent infestation buildup, and damage of the young stand.

Elytroderma deformans - mortality and growth impact on Jeffrey pines. (R.F. Scharpf and R.V. Bega, PSW). A field study designed to determine the effect of _Elytroderma_ needle disease on high value recreational stand of Jeffrey pines in the Tahoe Basin, California, following a severe buildup of the disease.

Incidence of heart rot associated with tussock moth white fir top kill (R.F. Scharpf).

Intermountain F.R.E.S.

Growth impact, associated mortality, and spread and intensification of dwarf mistletoe in stands of Douglas-fir, lodgepole pine, and western larch. (Oscar Dooling in cooperation with E.F. Wicker.) Objectives: To determine (1) the effects of precommercial thinning for dwarf mistletoe control on growth impact and associated mortality and (2) the effects of these same treatments on spread and intensification of the parasite.

Seasonal and yearly canker development. (R.D. Hungerford). Objective: To develop a canker classification system based on signs and symptoms and the frequency with which changes are observed for the purpose of predicting the progress and ultimate destiny of cankers.

Cytology and ontogeny of *Cronartium ribicola*. (J.Y. Woo) Objective: To investigate the cytological and developmental phases of the life cycle of *C. ribicola*.

Diseases causing mortality of aspen in the Gros Ventre elk wintering range. (R.C. Krebill) Objective: To determine incidence of pathogens associated with mortality of aspen in the Gros Ventre elk winter range and to estimate the rate of breakup of the aspen overstory.

A serological study of Peridermia in the *Cronartium coleosporioides* complex. (D.L. Nelson and P.B. Carter) Objective: To make a serological comparison of these Peridermia, to interpret the results relevant to present taxonomy, and to arrive at a natural definition of their evolutionary relationships.

Rocky Mountain F.R.E.S.

No new projects.

Universities

University of California

Impact of root diseases in Yosemite Valley (L.S. Felix, F.W. Cobb, J.R. Parmeter Jr. and N. MacGregor). Survey and evaluation of the incidence and damage of _F. annosus_ and _Armillaria mellea_ in Yosemite Valley, with studies on center initiation, rate of spread, associated vegetation changes, hazard and control.

Forest Products Laboratory

Defects and decays of forest products (W.W. Wilcox). Bioassay, to demonstrate the presence and distribution of pentachlorophenol in the cell walls of Cellon-treated Douglas-fir wood by means of differential resistance to attack by wood-decay fungi.

Colorado State University

Study of pinyon pine rot (_Verticicladiella wagnerii_) (N. Oshima).

Resin disease of dwarf mistletoe on lodgepole pine (W.R. Mark).

University of Hawaii

Death and decline of ohia and koa forests in Hawaii (F.F. Laemmlen).

Ecology of _Phytophthora cinnamomi_ Rands in forest soils (E.E. Trujillo).

Oregon State University

The biology and control of _Armillaria_ in ponderosa pine (L.F. Roth).

University of Wyoming

Root diseases of aspen in Wyoming (W.D. Ross).

Relationship between root pathogens, their hosts, and attack by bark beetles (C.W. McAnelly).

Studies of Rocky Mountain fungi, with emphasis on parasitic fungi (W.G. Solheim).

University of British Columbia

No new project.

No answer was received from:

U. of Washington - Seattle; U. of California - Davis; U. of Arizona - Tucson; Montana State University - Missoula; Austin State College - Nacogdoches; U. of Idaho; St. John's College - Santa Fe; Washington State Univ. - Pullman; Utah State University.

State Forestry Departments

Colorado

Dutch elm disease detection surveys in all municipalities in Colorado and accompanying laboratory diagnosis of all suspect trees (J.G. Laut).

Dwarf mistletoe control in rural and suburban residential developments (J.G. Laut).

Oregon

No new projects.

Canadian Forestry Service

Pacific Forest Research Centre - Victoria

Frequencies of field resistance to *Cronartium ribicola* and of canker inactivation in *Pinus monticola* (J. C. Hopkins).

Taxonomic and cultural studies in the forest fungi (A. Funk).

Forest disease: Diagnostic and taxonomic services and research (W. G. Ziller).

Appraisal of damage caused by forest pests in B.C. (J. A. Baranyay).

Detection and reporting, Forest Insect and Disease Survey (D. A. Ross). (Formerly 68-A-1).

Development of a continuous nursery disease survey (W. J. Bloomberg).

Occurrence of endophytic fungi in conifer seedlings (W. J. Bloomberg).

Histopathology of corky root of Douglas-fir and the role of fungi in its development (W.J. Bloomberg).

Chemical control of diseases of Douglas-fir seedlings in the nursery (W. J. Bloomberg).

Disease sampling in Douglas-fir plantations (G.W. Wallis).

Poria weirii root rot: biology and control (G.W.Wallis), D.J. Morrison). (Modified project, formerly 53-D-3).

Fomes annosus root and butt rot: biology and control (G.W. Wallis, D.J. Morrison). (Modified project, formerly 65-D-2).

Northern Forest Research Centre - Edmonton

The effect of atmospheric effluents on the forest (R. Blauel, L.W. Carlson, D. Hocking, A.A. Loman, J.M. Powell, M.D. Shrimpton).

Monitoring nursery systems (L.W. Carlson).

Forest insect and disease survey in the Prairie Provinces, Yukon and Northwest Territories (W.G.H. Ives, R.A. Blauel, Y. Hiratsuka and H.R. Wong).
Objective: To gain an improved knowledge of forest insects and diseases in the region for the purpose of minimizing damage to the forest attributable to these organisms and to provide an advisory service to management agencies and the public (replaces 53-A-1 and 67-K-11).

Foliage disease and H-Stem diseases, rusts and cankers. Forest tree rusts of western North America (Y. Hiratsuka).
Objective: To acquire a comprehensive knowledge of the forest tree rusts of western North America with particular emphasis on the Prairie Region in terms of identity, host range, life history, distribution and pathogenicity (replaces 67-H-8 and 67-H-8).

Species of Mycosphaerella on Salicaceae in western interior of Canada (Harry Zalasky).

Septoria canker on poplar, and progeny tests of introduced clones (Harry Zalasky).

Winter injury in poplar - a histological study (Harry Zalasky).

Prevention of winter injury to conifers and other hardwoods (Harry Zalasky).

Western Forest Products Laboratory - Vancouver

The evaluation of potential wood preservatives--Thiram and Thiram-Oxathiin mixtures (Roger S. Smith and Mrs. C. B. Johansen).

An analysis of aspen chip deterioration during outside storage (Roger S. Smith and Mrs. C.B. Johansen).

TERMINATED PROJECTS

United States Forest Service

Region 1-3 - No change.

Region 4 - No answer.

Region 5 - *Fomes annosus* control test using borax on Jeffrey and ponderosa pine stumps (D.A. Graham).

Region 6 - *Fomes annosus* control test in western hemlock (administrative study in cooperation with Washington Department of Natural Resources).

Pacific Northwest F.R.E.S.

No change.

Pacific Southwest F.R.E.S.

Borax testing for *Fomes annosus* control in true firs (R.S. Smith and R.V. Bega).

Decay of slash in the mixed conifer type of the Sierra Nevada of California (W.W. Wagener and H.R. Offord).

Intermountain F.R.E.S.

65-K-2. The incubation period of *Tuberculina maxima* Rostr. (J.W. Kinney and E.F. Wicker).

68-H-2. Nuclei of Jeffrey pine limb rust fungi (R.G. Krebill and D.L. Nelson).

Rocky Mountain F.R.E.S.

62-G-2. Red rot in merchantable ponderosa pine in the Black Hills. Summary publication: Decay of ponderosa pine sawtimber in the Black Hills, by T.E. Hinds, USDA, Forest Serv. Res. Pap. RM-65, 11pp. 1971.

Universities

University of California

Seed and cone diseases of *Sequoia sempervirens* (J.N. Davidson and J.R. Parmeter, Jr.).

University of Hawaii

Ecology of *Phytophthora cinnamomi* Rands in forest soils (E.E. Trujillo).

Oregon State University

Distribution of dwarf mistletoe seed around a single plant source (L.F. Roth).

Effect of the tree crown on flight of mistletoe seed from within the crown (L.F. Roth).

University of Wyoming

None.

University of British Columbia

None.

Canadian Forestry Service

Pacific Forest Research Centre - Victoria

Botrytis gray mold of seedlings (W.J. Bloomberg).

Diseases of Douglas-fir seed during cone storage (W.J. Bloomberg).

Needle cast of Douglas-fir (A.K. Parker).

Host-parasite relationships of the needle cast fungi Rhabdocline, Scirrhia, and Melampsora (A.K. Parker).

The nature of the association of *Stereum chaillettii* to logging damage in spruce - balsam stands (A.K. Parker).

Control of canker diseases of lodgepole pine (L.C. Weir).

60-F-3. Losses resulting from growth reduction and mortality in lodgepole pine stands infected by dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm) (J.A. Baranyay).

62-F-15. Use of aerial photography in detecting dwarf mistletoe-infected lodgepole pine trees (J.A. Baranyay).

53-H-6. Forest tree rusts of British Columbia (W.G. Ziller).

Hypodermataceae of conifers (W.G. Ziller).

Histopathology of corky root of Douglas-fir and the role of fungi in its development (W.J. Bloomberg).

Chemical control of diseases of Douglas-fir seedlings in the nursery (W.J. Bloomberg).

68-A-1. Forest disease survey in British Columbia (J.H. Ginns). (Now included in BC 096 by D.A. Ross.)

68-J-2. Taxonomy and cultural characters of wood destroying fungi in western North America (J.H. Ginns). Terminated due to his resignation and move to Ottawa.

68-B-3. Effect of frost damage on growth and form of Douglas-fir (J.H. Ginns).

68-C-4. Occurrence and biology of Rhizina root rot in British Columbia (J.H. Ginns).

68-D-1. Distribution and losses caused by root rots in British Columbia (J.H. Ginns).

68-E-1. Effect of *Elytroderma deformans* on growth of ponderosa pine (J.H. Ginns).

64-4-1. Dermea dieback of Douglas-fir in the Cariboo Region, British Columbia (A.K. Parker).

67-K-6. Silvicultural control of *Poria weirii* (L.C. Weir). (Now included in B.C. 072, Wallis and Morrison.)

Northern Forest Research Centre - Edmonton

62-F-14. A study of the factors influencing seed production of *Arceuthobium americanum* on lodgepole pine (J.E. Nighswander).

53-G-13. "Red stain" and decay of lodgepole pine injured by fire in Alberta (V.J. Nordin).

53-A-1. Forest disease surveys in Alberta, the Rocky Mountain National Parks, and Northwest Territories (R.J. Bourchier). (now included in 71-A-).

67-H-8. Stem rusts of pine - basic cytological, taxonomic and life history studies (Y. Hiratsuka and J.M. Powell). (now included in 71-E- and 71-H-).

67-H-9. Taxonomy and biology of forest tree rusts in western North America with special emphasis on the species of *Pucciniastrum*, *Chrysomyxa* and *Melampsora* (Y. Hiratsuka). (now included in 71-E- and 71-H-).

67-K-11. Application of immunofluorescent method for identification of forest fungi (Y. Hiratsuka). (now included in 71-A-).

59-G-1. The influence of site on variations in red heartwood stain of lodgepole pine (J.E. Nighswander).

Diplodia tumefaciens on poplar (Harry Zalasky).

Rhytidiella moriformans paper (Harry Zalasky).

Western Forest Products Laboratory - Vancouver

54-J-1. Occurrence and relative significance of fungi decaying wood in service (Roger S. Smith and J.W. Roff).

68-K-? Gamma radiation as a method for sterilizing wood blocks used in standard decay tests (Roger S. Smith and Mrs. C. V. Sharman).

BUSINESS MEETING

September 15, 1971

I. Secretary-Treasurer's Report

A. Because the proceedings from the 18th WIFDWC were not available, only a brief summary of some of the 1970 meeting highlights were put together from memory and read as follows:

1. Discussion of the possibility of a National Disease Work Conference. Bob Scharpf will continue his investigation.

2. Honorary members to be added to the list - Douglas R. (Reed) Miller.

3. Contribution of $25 to The Nature Conservancy in Willis Wagener's name.

4. Proceedings publication problems with advice that the job of secretary should be accepted only by those members who can put the document together on time without publication expense to the Conference.

5. Discussion of Mexico City as the meeting place for the 1972 Conference which was voted down.

6. Discussion of Victoria as the 1972 meeting place because of the 20th anniversary date. No vote was taken.

7. Decision to hold the 1971 Conference in Juneau, Alaska.

8. Election of officers:
   Joe Baranyay - Chairman
   Dave Graham - Secretary-Treasurer
   R.B. (Dick) Smith - Interim Program Chairman (Appointed).

B. Financial Statement for 1970:

Balance available as of September 1, 1970	$281.00
Income from Registration	1,115.00
Sub-total	1,396.00

Expenses

Conference	$1,159.00
Contribution	25.00
Sub-total	1,184.00
Balance as of October 1, 1970	$212.00

Both reports were accepted by the membership without change or correction.

II. Old Business

A. Discussion of Mexican participation.

This topic has been discussed several times during previous business meetings without reaching an acceptable solution. Chairman Baranyay asked for recommendations from the members.

It was pointed out that it is necessary to write to department chairmen--not just to those members we would like to have attend. This is the responsibility of the Chairman.

Frank Hawksworth will bring the Mexican membership and key contact list up-to-date during the American Phytopathological Society meeting at Mexico City in August 1972. He will report his findings to the membership during the 1972 conference.

B. Historical Record

Gordon Wallace is heading up this project. So far he has received only very limited replies to his letters asking for information and photographs. A plea was made to all members to send information to Gordon as soon as possible. This is not limited to WIFDWC. It is intended to include all forest pathology of the West. He would like personal items such as anecdotes and photographs. A list of past social achievement award winners was suggested.

An acknowledgement for the $25 gift in memory of Dr. Willis W. Wagener was received from the president of the Nature Conservancy.

The following letter from Mrs. Wagener to Bob Scharpf was read:

Dear Bob:

You must know how very much I appreciate the contribution to The Nature Conservancy by WIFDWC in memory of Willis. He had looked forward to attending that Conference and I am sure he was with you in spirit. Also, I shall always treasure the beautiful card I received, signed by so many of you, during the Conference.

Sincerely,

Maude Wagener

III. New Business

A. The following new honorary life members were accepted:

Benton Howard
Dwight Hester

B. There are approximately 30 people on our membership list who are not actively participating (we now have slightly over 20 on the list). Because of rising administrative costs, a membership list revision appears desirable.

The statement of policy adopted during the Fifth Conference included the following section on membership in the WIFDWC:

Membership to be open to persons actively engaged in:

1. Research, survey, control, or extension activities pertaining to tree diseases or deterioration of forest products,

2. Administration of the activities listed in (1), and

3. University teaching of forest pathology or forest products pathology.

During the Eighth Conference a number of motions amending this statement of policy and the definition of membership were passed.

But after consideration in an open session (as determined by a letter ballot) at the Ninth Conference in Banff, all of the motions were tabled "because of the possible detrimental effects they might have in creating an overly formal and inflexible constitution."

The following suggestions were made by various members:

1. Take names off the list if they have not attended within the last 3 to 5 years.

2. Send out a questionnaire with the proceedings asking if the member is still interested and if so to respond on a return card. A contribution of $1 would be required for membership extension in order to receive the proceedings without attending the Conference.

3. Circulate a list prepared by the Chairman and Secretary indicating whom they think should be dropped from membership during 1971 to other key members for suggestions.

The following motion was made by Bob Bega and seconded by Don Leaphart. It was passed unanimously by voice vote:

> With the exception of the Mexican delegation, a membership requirement of attending at least one conference during a consecutive five year period is hereby established. The current (1971) membership list, with some possible exceptions, is to be revised by the Secretary on this same basis. Guests and invited participants should only receive a copy of the proceedings for the conference they attended. Their names will not be retained or added to membership lists.

C. Active, Terminated and New Projects

The present list which was prepared in 1967 is out of date. It was agreed that this list is very beneficial and that it reflects the main interests of WIFDWC.

Don Leaphart volunteered to prepare an updated list that will be included in the 1971 proceedings.

D. 1972 Meeting

Chairman Baranyay invited the group to Victoria, B.C. and stressed the desirability to return to that city for the 20th anniversary meeting.

John Laut extended an invitation to Colorado.

Bob Bega suggested that the University of Hawaii would be willing to host the next conference but because of current U.S. Forest Service travel limitations, the location would have to be in the U.S. in order for very many Forest Service pathologists to participate.

Ken Russell suggested Port Angeles, Washington.

Bob Scharpf suggested Glenwood Springs, Colorado, specifying a February date.

It was mentioned that the World Forestry Conference will be held in Buenos Aires on October 7 to 18, 1972.

After considerable discussion regarding the need to hold the conference in one of the western States because of U.S. Forest Service travel restrictions, the following vote was recorded:

Colorado	40
Victoria, B.C.	22
University of Hawaii	9

E. Election of Officers

Frank Hawksworth nominated Paul Lightle for Chairman. Bob Bega moved that the nominations be closed. This was done and Paul was elected by unanimous ballot.

Bob Bega nominated Dave Etheridge for Secretary-Treasurer but Dave declined because of other conflicts.

Don Leaphart then nominated Art McCain. Bob Bega moved that the nominations be closed. This was done and Art was elected by unanimous ballot.

F. Commendations

A special thanks was extended to Hart Bynum for the excellent arrangements and all the hard work that he and his wife did towards making this conference a success.

The 1971 business meeting was adjourned after a move to do so by Bob Bega and a second by John Palmer.

The business meeting was reopened during the morning of September 16 after considerable discussion in regard to reconsideration of the 1972 conference location.

Dick Parmeter suggested that procedures be developed for letting the membership know prior to voting (at least one day) what the meeting location and date alternatives are. It may be possible to establish an "annual invitation ceremony" during the first or second day of the conference with the vote taken one day later.

Tom Laurent moved that the Victoria location for the 1972 conference be subjected to a revote. This was seconded by Vivian Muir who suggested taking the vote after the coffee break.

There were 62 members in attendance for the voting. Three members voted against Victoria, three members did not vote and 56 voted in favor of the Victoria location. The 1972 conference will be held in Victoria, B.C. The date is to be set by the program committee but it was agreed that it will be during either the third or fourth week of September.

By voice vote the majority of the membership agreed that Colorado would be a suitable location for the 1973 conference.

It was pointed out that the Conference proceedings are confidential and that they are not to be cited without the express consent of the author(s). All secretaries were instructed to provide for including a statement to this effect on the cover of each issue.

Chairman-elect Paul Lightle has appointed Larry Weir to serve as Program Chairman, along with H.S. (Stu) Whitney and R.S. (Dick) Smith, Jr. as committee members for the 1972 conference program.

Additional program suggestions for the 1972 conference are to be sent to Larry Weir, Oregon Department of Forestry, Salem, Oregon, as soon as possible. The program committee was instructed to schedule topics less likely to prompt a lot of discussion on Fridays. Adjournment should also be scheduled for 3:00 p.m. on the last day.

Financial Statement - 1971

Bank balance as of May 19, 1971			$198.29
Less bank service charges			194.89
Income			
Registrations			
Regular	73 @ $6.00	$438.00	
Students	5	-	
Honorary	3	2.00 1/	
Guests	6	-	
Banquet tickets	88 @ $6.00	528.00	
Total Income			$968.00
Expenses			
Lunches		$87.75	
Ice		1.77	
Receipt books		1.08	
Pop		11.10	
Banquet, coffee & meeting room		623.10	
Bus (Fish Lake trip)		83.70	
Bus (Tiller trip)		107.50	
Photographer		20.00	
Sub-total expenses			$936.00
Tentative Balance			
(Deposited 9/24/71 to WIFDWC acct.)		$32.00	$226.89
Less bank service charge ($.85)			226.04
Less late bill for coffee ($32.15)		- .15	193.89
Correction of previous error (1/24/72) + $5.50 (check charged to wrong account)			$199.39
Less bank service charges		$3.49	
Bank Balance - as of February 17, 1972			$195.90

1/ Contribution by Toby Childs for field trip, lunch and bus expense.

SUGGESTED TOPICS FOR THE 1972 WIFDWC

Compiled by Richard S. Smith, Jr., Interim Program Chairman[1/]

1. The Impact of Forest Diseases on the Forest. What are our forest values and how does disease effect a reduction (loss) in value? How do we determine loss?

2. Fomes annosus - A Reassessment on a National Basis. Up-to-date information on impact, biological evaluation, control (silvicultural, biological, chemical), research needed and new information.

3. Chemical Control of Dwarf Mistletoe. Can we achieve it? Do we need it and if so, where? Present status of the art.

4. Research Priorities in Forest Disease Research. How do we determine them? Do we have the knowledge at present to determine priorities?

5. A Techniques Demonstration. We could have either a session or an exhibit in conjunction with the meetings.

6. Forest Disease Surveys. Brief description of those in current use including purpose, techniques and findings. Needs in this area, uses of.

7. Air Pollution. Another panel with more up-to-date information on air pollution.

8. Up-to-date run down on specific diseases, i.e., needle diseases, cankers, etc.

9. Future of WIFDWC. Direction the conference might take in the next 10 to 20 years.

10. Systemic Fungicides. Applications, modes of action, potential uses in forest pathology.

11. Wood Quality and Forest Management. Topics could include scarring and disease, partial cutting mistletoe, log stumpage, lumber production.

12. Dutch Elm Disease. Status and potential in the West. Eastern experience by guest speaker (see Dave Ethridge or John Laut). Current national situation.

[1/]Forest Disease Research, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

13. White Pine Blister Rust - Genetics Resistance Programs. History, recent advances, present status, future plans.

14. Forest Pathology 50 Years in the Future. Contributions from some of our older members on the outlook for forest pathology in areas of their interest, including economics.

15. Photo Techniques. John Laut volunteered to discuss 35 mm photo techniques. Could be a special session, a workshop or an evening program.

16. Forest Disease Control. Environmental, cultural and silvicultural control of forest diseases.

17. Implications of off-site plantations and movements of gene populations into new areas.

18. Impact of Forest Tree Diseases on the other uses of the forest and trees with experts from other disciplines representing these uses, i.e., recreation, watershed, landscape, architecture, range, etc.

PUBLICATIONS

Andrews, S. R. 1971. Red rot of ponderosa pine. U.S. Forest Service, Forest Pest Leaflet 123, 8 pp.

Bachelor, F. W., A. A. Loman, and L. R. Snowdon. 1970. Synthesis of pinosylvin and related heartwood stilbenes. Can. J. Chem. 48(10): 1554-1557.

Baranyay, J. A. and R. B. Smith. 1970. Dwarf mistletoe workshops planning and execution. Can. Forest. Serv. Internal Rept. BC-23.

Barton, B. M. and Roger S. Smith. 1971. Brown stain in kiln dried *Abies amabilis* lumber. Bimonthly Res. Notes, 26(3): 24.

Bloomberg, W. J. and J. Trelawny. 1970. Effect of thiram on germination of Douglas-fir seed. Phytopath. 60: 1111-1116.

Brookhouser, L. W. and Glenn W. Peterson. 1971. Infection of Austrian, Scots, and ponderosa pines by *Diplodia pinea*. Phytopathology, 61: 409-414.

Cserjesi, A. J. 1969. Depletion of water-soluble preservatives in laboratory tests. Bimonthly Research Notes, 25(2): 15.

______________. 1969. Toxicity and biodegradation of dihydroquercetin. Can. J. Microbiol. 15(10): 1137.

Cserjesi, A. J. and J. W. Roff. 1970. Accelerated laboratory test for evaluating toxicity of fungicides for lumber. Mat. Res. & Stand. 10 no. 3.

Davidson, R. W. 1971. New species of Ceratocystis. Mycologia 63: 5-15.

Etheridge, D. E. 1971. Antagonistic interactions in wood-inhabiting micro-organisms and biological control of decay. Symposium on Biol. Control of For. Diseases, XV IUFRO Congress, Sec. 24, Gainesville, Florida.

______________. 1971. Inventario y fomento de los recursos forestales Republica Dominicana: patologia y entomologia forestales. F.A.O. Informe tecnico 1/FO:SF/DOM 8, Rome. (Not released for general distribution). 31 pp.

______________. 1971. New pests and diseases of forest trees in the Dominican Republic. FAO Plant Protection Bulletin, 19: 21-22.

Etheridge, D. E., H. M. Craig, and L. D. Taylor. 1970. Factors affecting suitability of western hemlock as a substrate for spore germination and growth of the Indian paint fungus. Northwest Science, 44(4): 244-252.

Etheridge, D. E., H. M. Craig, and S. H. Farris. 1971. The mode of infection of the Indian paint fungus in western hemlock. XXXVII Proc. Can. Phytopath. Soc. No. 38. (In press).

Grasham, J. L., and A. E. Harvey. 1970. Preparative techniques and tissue-selection criteria for _in vitro_ culture of healthy and rust-infected conifer tissues. USDA Forest Service, Research Paper INT-82, 7 pp.

Graham, D. A. 1971. Evaluation of borax for prevention of annosus root rot in California. Plant Disease Reporter, 55(6): 490-494.

Harvey, A. E. and J. L. Grasham. 1970. Susceptibility of cultured tissues from _Pinus albicaulis_, _Pinus flexilis_, and _Pseudotsuga menziesii_ to invasion by _Cronartium ribicola_. Phytopathology, 60: 153 (Abstr.)

______________________________. 1970. Survival of _Cronartium ribicola_ on a medium containing host tissue culture diffusates. Mycopathologia et Mycologia Applicata, 40: 3-4.

Harvey, A. E., J. L. Grasham and C. C. Waldron. 1971. The effects of growth regulating compounds on healthy and blister rust-infected tissue cultures of _Pinus monticola_. Phytopathology, 61: 507-509.

Harvey, A. E., and J. L. Grasham. 1971. Inoculation of a non-host tissue culture with _Cronartium ribicola_. Can. J. Bot. 49: 881-882.

Harvey, A. E. and J. Y. Woo. 1971. Histopathology and cytology of _Cronartium ribicola_ in tissue cultures of _Pinus monticola_. Phytopathology, 61: 773-779.

Hatton, J. V., R. S. Smith and I. H. Rogers. 1969. Ideal chip pile in B.C. Interior -- long, low, narrow and pine. Can. Pulp and Paper, 22(12): 32-33.

Hawksworth, F. G. and D. Wiens. 1970. New taxa and nomenclatural changes in Arceuthobium (Viscaceae). Brittonia 22: 265-269.

______________________________. 1970. Arceuthobium - Dwarf mistletoe. In Manual of the vascular plants of Texas. D. S. Correll and M. C. Johnston, Texas Research Foundation, pp. 503-504.

______________________________. 1970. Biology and taxonomy of the dwarf mistletoes. Ann. Review of Phytopath, 8: 187-208.

Hinds, T. E. 1971. Decay of ponderosa pine sawtimber in the Black Hills. U.S. Forest Serv. Sta. Pap. RM-65, 11 pp.

Hiratsuka, Y. 1970. Emergence of the aeciospore germ tubes of Cronartium coleosporioides (=Peridermium stalactiforme) as observed by scanning electron microscope. Can. J. Bot., 48: 1692 + plate.

Hiratsuka, Y. 1971. Spore surface morphology of pine stem rusts of Canada as observed under a scanning electron microscope. Can. J. Bot., 49: 371-372 + 6 plates.

Leaphart, Charles D. 1971. Controlled felling of large trees to prevent breakage. USDA Forest Service Res. Note, INT-128, 5 pp.

Leaphart, Charles D. and Albert R. Stage. 1971. Climate: A factor in the origin of the pole blight disease of Pinus monticola Dougl. Ecology, 52: 229-239.

Loman, A. A. 1970. The effect of heartwood fungi of Pinus contorta var. latifolia on pinosylvin, pinosylvinmonomethyl ether, pinobanksin, and pinocembrin. Can. J. Bot., 48(4): 737-747.

Loman, A. A. 1970. Bioassays of fungi isolated from Pinus contorta var. latifolia with pinosylvin, pinosylvinmonomethyl ether, pinobanksin and pinocembrin. Can. J. Bot. 48(7): 1303-1308.

Mitchell, Patrick C. 1970. Implementation of an on line conversational information retrieval system in a transaction oriented teleprocessing environment. Ph.D. Dissertation. Washington State University.

Myers, C. A., F. G. Hawksworth, and J. L. Stewart. 1971. Simulating yields of managed, dwarf mistletoe infested lodgepole pine stands. U.S. Forest Service, Res. Pap. RM-72, 15 pp.

Peterson, Glenn W. 1970. Response of ponderosa pine seedlings to soil fumigants. U.S. Agr. Res. Serv., Plant Disease Reporter, 54: 572-575.

________________. 1970. Seed-protectant chemicals affect germination of ponderosa pine seed. Tree Planters' Notes 21(4): 25-29.

Peterson, Glenn W. and Ralph A. Read. 1971. Resistance to Dothistroma pini within geographic sources of Pinus nigra Arnold. Phytopathology, 61: 149-150.

Peterson, Glenn W. 1971. Chemical control of Phomopsis juniperovora blight of junipers: a review. Tree Planters' Notes (In press).

Peterson, R. S. 1971. Wave years of infection by gall rust on pine. Plant Dis. Rep., 55: 163-167.

Powell, J. M. 1970. Cronartium comandrae in Canada, its distribution and hosts. Can. Plant Dis. Surv., 50: 130-135.

Powell, J. M. 1971. The arthropod fauna collected from the comandra blister rust, Cronartium comandrae, on lodgepole pine in Alberta. Can. Entomologist, 103: 908-918.

Powell, J. M. 1971. Occurrence of Tuberculina maxima on pine stem rusts in western Canada. Can. Plant Dis. Surv., 51: 83-85.

Powell, J. M. 1971. Additional records of Mycodiplosis larvae (Diptera: Cecidomyiidae) feeding on rust fungi. Can. Plant Dis. Surv., 51: 86-87.

Powell, J. M. 1971. Fungi and bacteria associated with Cronartium comandrae on lodgepole pine in Alberta. Phytoprotection, 52(2): 45-51.

Roff, J. W. 1970. Mould growth on kiln-dried lumber. B. C. Lumber. September.

Roff, J. W., M. Salamon, and G. W. Swann. 1971. Water repellent treatment could cut lumber costs. Can. For. Ind. May.

Scharpf, Robert F. 1970. Seed viability, germination and radicle growth of dwarf mistletoe in California. Pacific SW Forest and Range Exper. Sta. Res. Paper PSW-59, 18 pp. illus.

Scharpf, Robert F. and R. V. Bega. 1971. Diseases of native vegetation in the Tahoe Basin of California and Nevada. Tahoe Regional Planning Agency Report.

Scharpf, Robert F. and J. R. Parmeter, Jr. 1971. Seed production and dispersal of dwarf mistletoe in Jeffrey pines in California. Pacific SW Forest and Range Exper. Sta. Res. Note PSW-247, 5 pp., illus.

Sharman, Christine V. and R. S. Smith. 1970. Gamma radiation sterilization of ponderosa pine and birch sapwood. Wood and Fiber, 2(2): 134-143.

Sharman, Christine V. 1970. Catalogue of the culture collection. Revised July 1970. VP-X-7. Western Forest Products Laboratory, Vancouver, B.C.

Smith, R. B. 1971. Development of dwarf mistletoe (Arceuthobium) infections on western hemlock, shore pine, and western larch., Can. Journ. Forest Res. 1: 35-42.

Smith, R. S. 1970. Black stain in yellow cedar heartwood. Can. J. Botany, 48(10): 1731-1739.

__________. 1970. Responsibilities and risks involved in the use of wood protecting chemicals. Occupational health review, 21(3-4): 1-6.

__________. 1970. Oxathiins to prevent wood decay. Bimonthly Res. Notes, 26(3): 24.

Smith, R. S. and A. J. Cserjesi. 1970. Degradation of nootkatin by fungi causing black heartwood stain in yellow cedar. Can. J. Botany, 48(10): 1727-1729.

Smith, R. S. and Christine V. Sharman. 1971. Effect of gamma radiation wet-heat and ethylene oxide sterilization of wood on its subsequent decay by four wood destroying fungi. Wood and Fiber, 2(4): 356-362.

Sutherland, Jack R. 1970. Some forest nursery seedling hosts of the nematode Xiphinema bakeri. Can. J. Plant Sci., 50: 588-590.

Wallis, G. W., H. A. Richmond, J. W. Godfrey and H. M. Craig. 1970. Deterioration of fire-killed timber at Taylor River, Vancouver Island, British Columbia. Inform. Rept. BC-X-52. Forest Research Lab., Victoria.

Wallis, G. W., G. Reynolds and H. M. Craig. 1971. Decay associated with logging scars on immature western hemlock in coastal British Columbia. Inform. Rept. BC-X-54. Forest Research Lab., Victoria.

Weir, L. C. and A. L. S. Johnson. 1970. Control of Poria weirii study establishment and preliminary evaluations. Can. and Forest. Serv. Internal Rept. BC-14.

Wicker, Ed F. 1970. Retention of infectivity and pathogenicity by Tuberculina maxima in culture. Mycologia, 62(6): 1209-1211.

Wicker, Ed F., and J. M. Wells. 1970. Incubation period for Tuberculina maxima infecting the western white pine blister rust cankers. Phytopathology, 60: 1693.

Wiens, D. and B. A. Barlow. 1971. The cytogeography and relationships of the Viscaceous and Eremolepidaceous mistletoes. Taxon., 20: 313-332.

Woo, J. Y. and A. D. Partridge. 1969. The life history of Rhytisma punctatum on bigleaf maple. Mycologia, 61: 1085-1095.